SITE CHARACTERIZATION WORK PLAN

MARINERS MARSH PARK (PHASE I)
3418 RICHMOND TERRACE
STATEN ISLAND, NEW YORK 10303

NYSDEC SITE NO.: 243036

Submitted to:
New York State Department of Environmental Conservation
Division of Environmental Remediation
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Prepared for:
The City of New York
Department of Parks & Recreation

Prepared by:
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TRC Project No. 554398

OCTOBER 2024

CERTIFICATIONS

I, Emily Kessler, CHMM, certify that I am currently a New York State Qualified Environmental Professional [as defined in 6 NYCRR Part 375] and that this Site Characterization Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and DER Green Remediation (DER-31).

Emily Kessler
Emily Kessler, CHMM

October 8, 2024
Date

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ABBREVIATIONS AND ACRONYMS

$\mu g/m^3$	Micrograms per cubic meter
ASP	Analytical Services Protocol
ATC	ATC Associates, Inc.
AWQSGV	New York State Ambient Water Quality Standards and Guidance Values
bgs	Below Ground Surface
CAMP	Community Air Monitoring Plan
CP-51	Commissioner Policy 51
DER	Department of Environmental Remediation
DER-10	DER Technical Guidance for Site Investigation and Remediation
DO	Dissolved Oxygen
DQO	Data Quality Objectives
DUSR	Data Usability Summary Report
DNAPL	Dense non-aqueous phase liquid
DPR/Parks	New York City Department of Parks and Recreation
ELAP	Environmental Laboratory Approval Program
GPS	Global positioning system
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
LAWES	Land, Air, Water Environmental Services, Inc.
LNAPL	Light Non-Aqueous Phase Liquid
NTU	Nephelometric Turbidity Unit
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated Biphenyl
PFAS	Per- and polyfluoroalkyl substances
PID	Photoionization Detector
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SC	Site Characterization
SCO	Soil Cleanup Objective
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List

ABBREVIATIONS AND ACRONYMS (CONTINUED)

TIC	Tentatively Identified Compound
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

In accordance with the Order on Consent and Administrative Settlement (Index No. R2-20230509-107) (Consent Order) executed between New York City Department of Parks and Recreation (DPR or Parks) ("Respondent") and the New York State Department of Environmental Conservation (NYSDEC), and at the request of DPR, TRC Engineers, Inc. (TRC) has prepared this Site Characterization Work Plan (SC Work Plan) for the Phase I area of Mariners Marsh Park located at 3418 Richmond Terrace, Staten Island, New York 10303 (hereafter referred to as the "Site"). The Phase I area of Mariners Marsh Park (the "Site") is currently closed to the public and encompasses approximately 25 acres of the northeast portion of Mariners Marsh Park. The Site is not currently listed in the Registry of Inactive Hazardous Waste Disposal Sites; however, the NYSDEC assigned Site Number 243036 with a Classification of P to the Site.

The overall objective of the SC is to obtain data useful for determining whether the Site poses little or no threat to public health and the environment or if it poses a threat which requires further investigation. The SC may also obtain data useful for determining the remedial measures necessary, if any, for reopening the Site to the public. This SC Work Plan will be implemented in accordance with the protocols in NYSDEC Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10).

Following completion of the SC, DPR will submit an SC Report documenting the findings and conclusions of the investigation.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Location and Setting

The Phase I area of Mariners Marsh Park (the "Site") encompasses approximately 25 acres of the northeast portion of Mariners Marsh Park, a 107-acre park located near the North Shore of Staten Island, New York. The legal description for the Site is Block 1318, portion of Lot 9. Mariners Marsh Park is bordered to the north by Richmond Terrace; to the east by residential properties followed by Holland Avenue; to the south by Arlington Railyard followed by undeveloped land; and to the west by the New York Container Terminal facility (formerly a Proctor & Gamble facility). DPR has divided Mariners Marsh Park into five phases, with the goal of re-opening the Phase I area to the public, followed by the reopening of the other phases of the Park at a later date. A Site Location Map is presented in *Figure 1.* A Site Plan depicting the five phases is presented in *Figure 2.* In general, the surrounding land use may be characterized as a mixture of industrial and residential uses.

2.2 Current Site Use

The Site is currently closed to the public with a secure fence but is intended for use as a public park. TRC understands that a fence was installed in 2017 around the perimeter of the Site, which restricts access to the Site.

2.3 Historic Site Use

Between at least 1903 and 1917, the subject property was occupied by Milliken Brothers Structural Iron Works and Rolling Mill, which included numerous buildings, gas producers, furnaces, mills, traveling cranes, and reservoirs. Between 1917 and 1931, the subject property was occupied by Downey Shipbuilding Yard, which occupied many of the existing buildings. Building remnants exist in the form of footings and a series of concrete structures believed to support a rail system that was used to transport rolled steel. Coal was reportedly used as a fuel source at the Site and residual coal ashes and slag were spilled and/or dumped on the ground. The subject property remained vacant between 1931 and 1974.

The City of New York purchased the subject property in 1974 from American Export Industries Inc. In 1993, two ballfields were installed on the northern portion of the subject property under the Field of Dreams initiative. In 1997, the subject property was transferred from the City of New York to Parks and established as Mariners Marsh Park. Between 1997 and 2003, Mariners Marsh Park was utilized as a public park for passive recreational use. An environmental investigation was conducted in 2001 under New York City's 1997 Brownfield Pilot grant from USEPA. The investigation led to additional investigation, and subsequently, in an abundance of caution, the park was closed to the public in 2003.

2.4 Site Geology and Hydrogeology

The geology of Staten Island consists primarily of unconsolidated glacial deposits overlying crystalline bedrock. Based on available literature (Buxton, Soren, Posner, and Shernoff, 1981) the subsurface geology of the Site likely includes the following formations: Pleistocene upper glacial deposits, Gardiners Clay, Jameco Gravel, Cretaceous Raritan Formation consisting of sands and clays, and crystalline bedrock. The depth to crystalline bedrock for the area is estimated to be approximately 60 feet below ground surface (bgs).

Prior investigations on the Mariners Marsh Park identified fill material throughout the park including brick, concrete, ash, and cinder from approximately 2 to 5 feet bgs. Generally, fill material is underlain by fine to coarse sand, gravel, and silt.

Mariners Marsh Park is located approximately 600 feet south of Newark Bay. There are several ponds and wetlands at Mariners Marsh Park. According to information obtained from prior reports prepared by Metcalf & Eddy of New York, Inc. in 2003 and CDM Federal Programs Corporation in 2011, groundwater is present at the Site at depths ranging from approximately 1 to 4 feet bgs and groundwater flow is estimated to be predominately north, toward Newark Bay. Estimated groundwater levels and/or flow directions may vary due to seasonal fluctuations in precipitation, local usage demands, geology, and underground structures.

3.0 PREVIOUS INVESTIGATIONS

As a result of previous Site use by a previous owner and occupant (see Section 2.3), numerous environmental studies were conducted at the Site. TRC has conducted an evaluation of the existing data at the Site, which is summarized in a Records Search Report, dated March 2024, and provided under a separate cover (see Appendix A). Generally, the Phase I area of Mariners Marsh Park consists of three (3) "areas of concern" including the former recreation area, trails/pathways/former railroad spurs, and a historic sherardizing building. Contaminants of concern identified in the former recreation area include metals in soil, chlorinated solvents and metals in groundwater, and chlorinated solvents in soil vapor; in the trails/pathways include polycyclic aromatic hydrocarbons (PAHs), metals, and one polychlorinated biphenyl (PCB) in soil; and in the sherardizing area include metals in soil. The "areas of concern" are depicted in *Figure 3*.

4.0 SITE CHARACTERIZATION INVESTIGATION OBJECTIVES AND METHODS

This section of the Work Plan presents the objectives and methods for the proposed additional investigation for the Site and follows the guidance for an investigative work plan in NYSDEC DER-10, Technical Guidance for Site Investigation and Remediation. The Work Plan has been prepared in consideration of the Site history and findings of previous investigations (refer to Sections 2.0 and 3.0).

4.1 Objectives

The principal objectives of the SC are to complete the characterization of soil, sediment, groundwater, and soil vapor at the Site and confirm groundwater flow direction. The data obtained during the implementation of the SC will be utilized to determine whether the Site poses little or no threat to public health and the environment or if it poses a threat that requires further investigation. The SC may also obtain data useful for determining the remedial measures, if any, necessary for reopening the Site to the public. To obtain spatial coverage throughout the Site, the Site will be divided into 14 grids. Due to budget constraints, the SC Work Plan will be implemented over multiple sub-phases. The first sub-phase (“Mobilization 1”) of the SC will be implemented in the eastern portion of the Site in Grids 2, 5, 8, 11, and 14, as shown in *Figure 4,* with a second sub-phase for the implementation of the SC in the western portion of the Site at a later date.

4.2 Scope of Investigation

The scope of the planned field investigation activities has been organized into the following tasks:

- Task 1 – Utility Clearance and Geophysical Survey
- Task 2 – Soil Sampling
- Task 3 – Monitoring Well Installation and Development and Groundwater Sampling
- Task 4 – Soil Vapor Sampling
- Task 5 – Sediment Sampling
- Task 6 – Permanent Monitoring Well Location Survey
- Task 7 – Management of Investigation Derived Waste

Additionally, quality control and quality assurance procedures are summarized in the following task:

- Task 8 – Quality Assurance/Quality Control (QA/QC) Data Evaluation

The site-specific sampling techniques and analytical methods to be used in implementing the SC are presented in the Quality Assurance Project Plan (QAPP) in *Appendix B*.

4.3 Health and Safety Protocols

The field investigation activities will be performed in accordance with the Community Air Monitoring Plan (CAMP) in *Appendix C* and the site-specific Health and Safety Plan (HASP) in *Appendix D*. Generally, the CAMP consists of continuous monitoring for VOCs and particulates and action levels to protect the downwind/off-site receptors from potential airborne contaminants released during field investigation activities, in accordance with NYSDOH guidance. The HASP will be adhered to by all personnel involved in the field investigation activities and ensures the protection of the health and safety of personnel during field investigation activities in accordance with federal Occupational Safety and Health Administration (OSHA) and TRC standards.

4.4 Task 1 – Utility Clearance and Geophysical Survey

Required New York One Call notifications will be made at least three days prior to intrusive work, and the locations of underground utility lines in public roads and rights-of-way will be marked out.

Prior to intrusive work activities, a geophysical survey will be performed to confirm the proposed sampling locations are clear of underground utilities. Greenstar Environmental Solutions, LLC, under subcontract and supervision by TRC, will survey a 30-foot by 30-foot maximum area around each of the proposed boring locations. To identify the proposed boring locations, TRC will load a base map showing the sample locations into a hand-held global positioning system (GPS) unit. TRC will employ a combination of the handheld GPS and other measuring devices to identify the sample locations in the field. A summary of the results of the GPR survey will be included with the SC Report. The effectiveness of the geophysical survey equipment may be limited by the depth and composition of Site soils and fill material and interferences caused by nearby aboveground physical features (e.g., chain-link fencing, power lines.)

4.5 Task 2 - Soil Sampling

Hand augers and a track-mounted or dolly-mounted direct push drill rig (Geoprobe) will be utilized to advance a total of 46 soil borings throughout the Site and in and adjacent to the former sherardizing building and former rail spurs. Further, soil borings will be biased toward upland areas and will not be advanced in areas with standing water. Please refer to *Figure 4* for the proposed boring locations.

The rationale for each boring and soil sample location is presented below and in *Table 1*.

Sample Identification	Rationale
TRC-SB-01A through TRC-SB-14A, TRC-SB-01B through TRC-SB-14B, and TRC-SB-01C through TRC-SB-14C	Assess surface and subsurface impacts throughout the Site, assess impacts from historic on-Site operations, provide spatial coverage, and create a horizontal profile of soil conditions across the Site.
TRC-SHER-01 through TRC-SHER-04	Assess surface and subsurface impacts from the historic sherardizing building.

The soil sampling program will include the following:

- To obtain spatial coverage throughout the Site, the Site will be divided into 14 grids. TRC will advance three (3) soil borings in each grid (totaling 42 borings). Additionally, four (4) soil borings (TRC-SHER-01/SB-09A, TRC-SHER-02, TRC-SHER-03, TRC-SHER-04) will be installed in the vicinity of the historic sherardizing building.
- Land, Air, Water Environmental Services, Inc. (LAWES), under subcontract and supervision by TRC, will utilize a dolly mounted direct push Geoprobe rig to advance 4- or 5-foot long 2-inch diameter macrocore samplers lined with acetate sleeves to collect continuous soil samples to the following depths. Hand augers will be utilized to collect samples where access to the Geoprobe is restricted due to dense vegetation and/or terrain.
    - Soil borings, except for borings proposed for groundwater sampling, will be advanced to depths up to approximately 5 feet bgs.
    - Borings proposed for groundwater sampling (the “A” series borings, i.e., TRC-SB-01A to TRC-SB-14A) will be advanced 5 feet below the groundwater interface. Note that groundwater is expected to be encountered at depths ranging from 1 – 4 feet bgs.

- Soil samples collected from each boring will be screened with a PID and inspected for indications of contamination (e.g., staining, odors, etc.). Geologic descriptions of the soil and field screening results will be recorded in field logs.
- Approximately two (2) discrete grab soil samples from each soil boring will be selected and submitted for laboratory analysis based on the following rationale. Soil samples will not be collected from saturated soil; therefore, based on expected depth to groundwater (1 – 4 feet bgs) only one shallow sample per boring location may be collected for laboratory analysis.
    - If no apparent impacted soils are identified, one (1) soil sample will be collected from the upper two feet of soil (0-2 feet), and a second sample will be collected from the 2 feet interval above the groundwater interface, assuming groundwater is encountered at depths of 4 feet bgs or greater. The proposed approach would result in up to six (6) discrete soil samples for each grid box, and up to eight (8) soil samples from vicinity of the historic sherardizing building, for a total of 92 soil samples.
    - If impacted soils are identified, one (1) sample will be collected from the upper 6 inches of soil (0-6 inches), one (1) soil sample will be collected from the most impacted zone (based on odors, staining, or elevated PID readings), and a third sample will be collected from a depth of 2 feet below the first clean soil encountered. If no apparent underlying clean interval is observed, the third soil sample submitted for analysis will be the sample collected from the bottom interval of the boring, or the two-foot interval above groundwater, whichever is shallower.
- Soil samples submitted for laboratory analysis will be analyzed for the following parameters utilizing the following analytical methods:
    - Target Compound List (TCL) / NYSDEC Commissioner Policy 51 (CP-5) Volatile organic compounds (VOCs): EPA Method 8260C
    - TCL and CP-51 Semivolatile Organic Compounds (SVOCs) including 1,4-dioxane: EPA Method 8270D
    - TCL Pesticides: EPA Method 8081B
    - TCL Herbicides: EPA Method 8151
    - PCBs: EPA Method 8082A

  - Target Analyte List (TAL) Metals: EPA Method 6010C (and 7471B for mercury and 7196A for hexavalent chromium) and cyanide
- Two (2) soil samples per grid and the samples collected from the former sherardizing building area will additionally be analyzed for per- and polyfluoroalkyl substances (PFAS) via EPA Method 1633. Based on the Site history in which the Site was historically used for industrial purposes from 1902 to 1931 (i.e., prior to the invention of PFAS) and after was vacant/used for ballfields, the number of samples sufficiently characterizes PFAS at the Site. The two (2) soil samples collected per grid for PFAS analysis will be biased toward evidence of field impacts, if identified. If no impacts are identified, the samples will be biased toward groundwater sampling locations. Refer to the QAPP in *Appendix B* for the specific list of PFAS compounds to be reported.
- Duplicate samples will be collected at a frequency of 1 per 20 soil samples and analyzed for the parameters listed above.
- Soil samples will be containerized in laboratory prepared jars, labeled, sealed, and placed in a chilled cooler for shipment to Hampton Clarke, Inc., a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory for analysis. NYSDEC Analytical Services Protocol (ASP) Category B deliverable packages will be provided.

4.6 Task 3 – Monitoring Well Installation and Development and Groundwater Sampling

The work under this task includes the installation of ten (10) temporary monitoring wells and installation, development, and sampling of up of six (6) permanent monitoring wells to assess groundwater conditions at the Site (refer to *Figure 4* for proposed monitoring well locations).

The rationale for each monitoring well location is presented below and in *Table 1*.

Sample Identification	Rationale
Temporary Groundwater Monitoring Wells	
TRC-GW-02 and TRC-GW-06 to TRC-GW-14	Provide spatial coverage throughout the Site and assess groundwater impacts from historic on-Site operations.
Permanent Groundwater Monitoring Wells	
MW-11, MW-16, MW-17, and MW-18	Existing permanent monitoring wells installed by ATC in 2010. Provide spatial coverage on the northwestern

	portion of the Site, delineate historic chlorinated solvent contamination, and establish groundwater flow direction.
TRC-GW-04 and TRC-GW-05	Provide spatial coverage on the northeastern portion of the Site, and establish groundwater flow direction.
Contingency Permanent Wells (Installation required if MW-11, MW-16, MW-17, and MW-18 are not viable)	
TRC-SB-01A, TRC-SB-03A, TRC-SB-03B, and TRC-SB-03C	Provide spatial coverage on the northwestern portion of the Site, delineate historic chlorinated solvent contamination, and establish groundwater flow direction.

The groundwater monitoring well installation and sampling program will include the following:

Temporary Groundwater Monitoring Wells

- Ten (10) temporary groundwater monitoring wells will be installed a previously installed boreholes TRC-SB-02A and TRC-SB-06A to TRC-SB-14A (temporary well IDs: TRC-GW-02 and TRC-GW-06 to TRC-GW-14).
- Temporary monitoring wells will be installed using 1-inch diameter schedule 40 PVC with at least 5 feet of 10-slot well screen (temporary well point) into previously installed boreholes up to 5 feet below the observed groundwater interface. The annular space surrounding each well casing will be filled with clean sand (Morie No. 1).

Permanent Monitoring Wells

- Existing permanent groundwater monitoring wells MW-11, MW-16, MW-17, and MW-18 (installed by ATC Associates, Inc. [ATC] in 2010), where chlorinated solvent contamination was identified in 2010, will be redeveloped if deemed viable. If a well is deemed viable for re-development, it will be re-developed by LAWES utilizing surging and pumping techniques in accordance with USEPA's 2018 Guidance for Design and Installation of Monitoring Wells. Groundwater quality parameters (e.g., temperature, conductivity, turbidity, oxidation-reduction potential, etc.) will be monitored prior to, during (at an approximate frequency of once per well volume purged), and at the conclusion of re-development. Re-development will be considered complete when either turbidity is below 50 nephelometric turbidity units (NTUs), the well purges dry, or 10 well volumes have been removed, whichever occurs first. Re-development water from each monitoring well will be containerized in drums as IDW, characterized, and labeled for off-Site disposal.

- If existing permanent groundwater monitoring wells MW-11, MW-16, MW-17, and MW-18 are deemed not viable for redevelopment, new permanent groundwater monitoring wells will be installed in the vicinity at TRC-SB-01A, TRC-SB-03A, TRC-SB-03B, and TRC-SB-03C. Additionally, two (2) permanent groundwater monitoring wells will be installed at TRC-GW-04 and TRC-GW-05. The locations of the permanent groundwater monitoring wells were selected to delineate historic chlorinated solvents in groundwater and to establish groundwater flow direction.
- Permanent monitoring wells will be constructed using 2-inch diameter polyvinyl chloride (PVC) monitoring well riser and screen and installed to approximately 5 feet below the observed water table. Each well will be screened from approximately 5 feet above the observed water table to 5 feet below the observed water table. Clean silica sand, Morie No. 1, or similar, will be placed in the annular space around each groundwater monitoring well to a minimum of one foot above the top of the well screen, two feet being optimal. A two-foot bentonite seal will be placed above the sand pack. Permanent monitoring wells will be completed with a stick-up outer protective casing. Well construction diagrams will be prepared for each well.
- Following installation, the permanent groundwater monitoring wells will be developed using backwashing or mechanical surging methods in accordance with USEPA’s 2018 Guidance for Design and Installation of Monitoring Wells until three to five well volumes are removed and the water is reasonably free of turbidity and field parameter readings (temperature, conductivity, oxidation reduction potential (ORP), pH, and dissolved oxygen [DO]) sufficiently stabilize. During well development, TRC will actively monitor and track the volume of water purged and the field parameter readings. Field measurements will be recorded in a field logbook. Fifty nephelometric turbidity units (NTUs) or less will be the turbidity goal, but not an absolute value. The groundwater monitoring wells will be allowed to equilibrate for at least 24 hours prior to sampling.

Groundwater Sampling

- On the day of groundwater sampling and prior to initiation of sampling activities, a synoptic round of water level measurements will be collected from the six (6) permanent groundwater monitoring wells will be gauged. The water table elevations (refer to Section

4.8) will be used to determine Site-specific groundwater flow. Additionally, a headspace reading will be collected, using a PID, from each monitoring well location.

- Although not anticipated, if light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL) is encountered in a temporary or permanent well point, groundwater from that well will not be analyzed and DPR will be notified immediately.
- Prior to sampling, groundwater from each well will be purged until field parameters have stabilized in accordance with USEPA Low-Stress (Low-Flow) sampling procedures. Since the wells will be sampled for PFAS analysis, a turbidity level of 10 NTUs or less is the well purging goal. Other field parameters including temperature, conductivity, ORP, pH, and DO will also be monitored and, prior to sampling, field parameters should generally be within ±10% for three consecutive readings, three to five minutes apart. During purging, TRC will actively monitor and track the volume of water purged and the field parameter readings. Field measurements will be recorded in a field logbook. Once groundwater conditions have stabilized and groundwater levels have recovered, the samples will be collected.
- A total of 16 groundwater samples (plus a field duplicate, and trip blanks) will be collected from the temporary and permanent groundwater monitoring wells using low-flow sampling methods. The samples will be submitted for laboratory analysis for the following parameters utilizing the following analytical methods:
    - TCL and CP-51 VOCs: EPA Method 8260D
    - TCL and CP-51 SVOCs: EPA Method 8270D
    - TCL Pesticides: EPA Method 8081B
    - TCL Herbicides: EPA Method 8151
    - PCBs: EPA Method 8082A
    - TAL Metals (field-filtered and unfiltered): EPA Method 6010C (and 7471B for mercury and 7196A for hexavalent chromium) and cyanide
    - 1,4-Dioxane: EPA Method 82670D with Selective Ion Monitoring (SIM)
    - PFAS: EPA Method 1633
- Duplicate samples will be collected at a frequency of 1 per 20 groundwater samples and analyzed for the parameters listed above. Additionally, two (2) trip blank samples will be analyzed for TCL and CP-51-listed VOCs plus TICs.

- Groundwater samples will be containerized in laboratory supplied jars, labeled, sealed, and placed in a chilled cooler for shipment to the laboratory. Groundwater samples will be analyzed by an ELAP-certified laboratory approved by the NYSDOH and NYSDEC ASP Category B deliverable packages will be provided.

4.7 Task 4 – Soil Vapor Sampling

This task includes the collection of sub-slab vapor samples to determine the concentrations of VOCs in soil vapor. Fourteen (14) soil vapor samples (TRC-SV-01 to TRC-SV-14) will be collected at the locations shown on *Figure 4.*

Soil vapor sampling will be conducted in accordance with the NYSDOH "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" and ASTM International (ASTM) Standard E 2600-22.

The soil vapor samples will be collected using a direct-drive rig (i.e., Geoprobe) to advance the vapor point to the desired sample depth. Soil vapor samples will be generally collected at a depth of 5 feet bgs or one foot above the water table, whichever is shallower. Note that a soil vapor sample will not be collected if groundwater is present at depths shallower than 1 foot bgs. The adequacy of each seal will be tested in accordance with the NYSDOH-approved method for vapor sampling using a 5-gallon bucket or cardboard box placed over the soil vapor sampling point and sealed from the ambient air using bentonite. Helium tracer gas will then pumped into the bucket. The above grade end of the tubing, which is the sample collection point, will then be attached to a helium gas detector. The adequacy of the seal will be verified by direct helium readings of less than 10 percent.

The temporary soil vapor probes will be purged using a PID to evacuate one to three volumes of soil vapor. The concentrations of ionizable vapors measured with the PID will be recorded. During purging, the purge flow rate will not exceed 0.200 liters per minute (L/min). After purging, each probe will be connected via Teflon tubing to a laboratory-supplied batch-certified clean 6-liter SUMMA canister. Using a 0.05 L/min flow regulator, the sample collection time will be approximately 120 minutes.

After sample collection, the soil vapor samples will be shipped overnight to Alpha Analytical, an ELAP-certified laboratory for analysis of VOCs by USEPA Method TO-15 and methane via USEPA Method TO-3C. Method TO-15 will provide detection limits of 0.20 $\mu g/m^3$ for carbon tetrachloride, cis-1,2-DCE, 1,1-dichloroethene, TCE, and vinyl chloride allowing for comparison with the lowest action levels for these compounds in the NYSDOH "Final Guidance for

Evaluating Soil Vapor Intrusion in the State of New York". The detection limit for all other compounds will be 1 μg/m^3. NYSDEC ASP Category B deliverable packages will be provided.

Following sampling, soil vapor probes will be removed, and the ground surface will be restored (i.e., patched with clean sand and/or soil cuttings).

4.8 Task 5 – Sediment Sampling

This task includes the collection of four (4) sediment samples (TRC-SED-01 to TRC-SED-04) at the locations shown on *Figure 2.* Since the Site consists of tidally influenced wetlands, sediment sample locations and quantity are subject to change based on wetland conditions at the time of sampling (i.e., whether the locations are inundated).

A hand auger will be used to collect four (4) sediment samples from approximately 0 to 0.5 feet below the sediment surface to be submitted for laboratory analysis for the following parameters utilizing the following analytical methods:

- TCL and CP-51 VOCs: EPA Method 8260C
- TCL and CP-51 SVOCs (including 1,4-dioxane): EPA Method 8270D
- TCL Pesticides: EPA Method 8081B
- TCL Herbicides: EPA Method 8151
- PCBs: EPA Method 8082A
- TAL Metals (field-filtered and unfiltered): EPA Method 6010C (and 7471B for mercury and 7196A for hexavalent chromium)
- PFAS: EPA Method 1633
- Total organic carbon (TOC) via EPA Method 9070 and percent solids.

Duplicate samples will be collected at a frequency of 1 per 20 groundwater samples and analyzed for the parameters listed above.

Sediment samples will be containerized in laboratory prepared jars, labeled, sealed, and placed in a chilled cooler for shipment to Hampton Clarke, a NYSDOH ELAP-certified laboratory for analysis. NYSDEC ASP Category B deliverable packages will be provided.

4.9 Task 6 – Permanent Monitoring Well Location Survey

The coordinates and elevations of the top of the casing of the six (6) redeveloped and/or newly installed permanent monitoring wells and the adjacent ground surface will be surveyed to determine water table elevations and groundwater gradient. The survey will be performed by a land surveyor licensed to practice in the State of New York.

4.10 Task 7 – Management of Investigation Derived Waste

Investigation derived waste (IDW) is anticipated to include the following: decontamination fluids and well purge and development water, and soil cuttings. IDW will be containerized in New York State Department of Transportation-approved 55-gallon drums for off-site disposal. Used personal protective equipment (PPE) and disposable sampling equipment will be bagged as regular refuse and disposed as solid waste, unless grossly contaminated. All IDW will be handled in accordance with 6 NYCRR Part 360, as applicable.

4.11 Task 8 – Quality Assurance /Quality Control (QA/QC)

A QA/QC program for the SC will be instituted to verify that the project analytical data objectives were met. The QA/QC program will be implemented consistent with the QAPP, which specifies the data quality objectives (DQOs) for each analytical parameter for the entire investigation. During the program, the collection of QC samples will be monitored to verify that the field QC samples are collected at the proper frequency. Finally, the QA/QC program will include data validation for analytical data generated during this SC, as specified in the QAPP (refer to *Appendix B)*.

The results of the data validation will be summarized in Data Usability Summary Reports (DUSRs), which will be included in the SC Report.

5.0 PROJECT PERSONNEL

Key project personnel and contact information are identified in the table below. Resumes of key TRC project personnel are in *Appendix E*.

Key Personnel and Contact Information

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David Wickliffe, Hampton Clarke	Laboratory Services	(222) 679-402 / dwickliffe@hcvlab.com
Kevin Hoogerhyde, Alpha Analytical	Laboratory Services	(201) 812-2640 / Kevin.Hoogerhyde@pacelabs.com
Pete Nimmer, PG, LSRP, Greenstar Environmental Solutions	Geophysical Surveying Services	(917) 655-5123
TBD	Land Surveying Services	TBD

Name	Role	Phone Number / Email
Nancy Weaver, Environmental Data Services, Inc. (EDS)	Data Validator	(561) 475-2000 / nweaver@env-data.com

6.0 REPORTING

6.1 Daily Reporting

Daily reports will be prepared and submitted by the noon of the next day following each day of field activities. The daily reports will include the following:

- A description of weather conditions;
- A summary of health and safety during field activities;
- A summary of work performed including CAMP activities;
- A description of representatives on-site and equipment utilized;
- A summary of materials generated and/or transported;
- A summary of planned activities; and
- Photographs of the work activities.

6.2 Site Characterization Report

Following completion of field activities and after receipt of surveying and laboratory data, a comprehensive Site Characterization Report (SC Report) will be prepared. Note that multiple SC Reports may be prepared following each mobilization at the Site. The SC Report(s) will conform to the guidelines set forth in NYSDEC DER-10 Sections 3.13 (Site Characterization Report) to the extent consistent with the scope of the investigation described above and to the extent necessary and applicable. The SC Report(s) will include the following:

- A description of the Site physical setting;
- A description of the scope of the Site Characterization investigation;
- Descriptions of investigation methods;
- Scaled Site plan showing sampling locations;
- Field sample screening data and documentation (logs, chain-of-custody forms, etc.);
- Results of analyses of samples, including laboratory data packages, and a discussion of the findings;
- Data Usability Summary Reports;

- Map summarizing the results of the sampling, showing locations of and highlighting exceedances of relevant regulatory standards, criteria, and guidance;
- Groundwater surface elevation contour map showing apparent gradients and inferred predominant local groundwater flow directions in the northern portion of the Site;
- A summary of the general nature of contamination on the site to the extent investigated by the SC including, without limitation, the numbers of areas of concern requiring further investigation and/or remediation;
- A description of each area of concern identified, if any, suspected and actual contamination and suspected source of discharge or disposal; and
- Conclusions and/or recommendations for whether additional investigation is required.

7.0 SCHEDULE

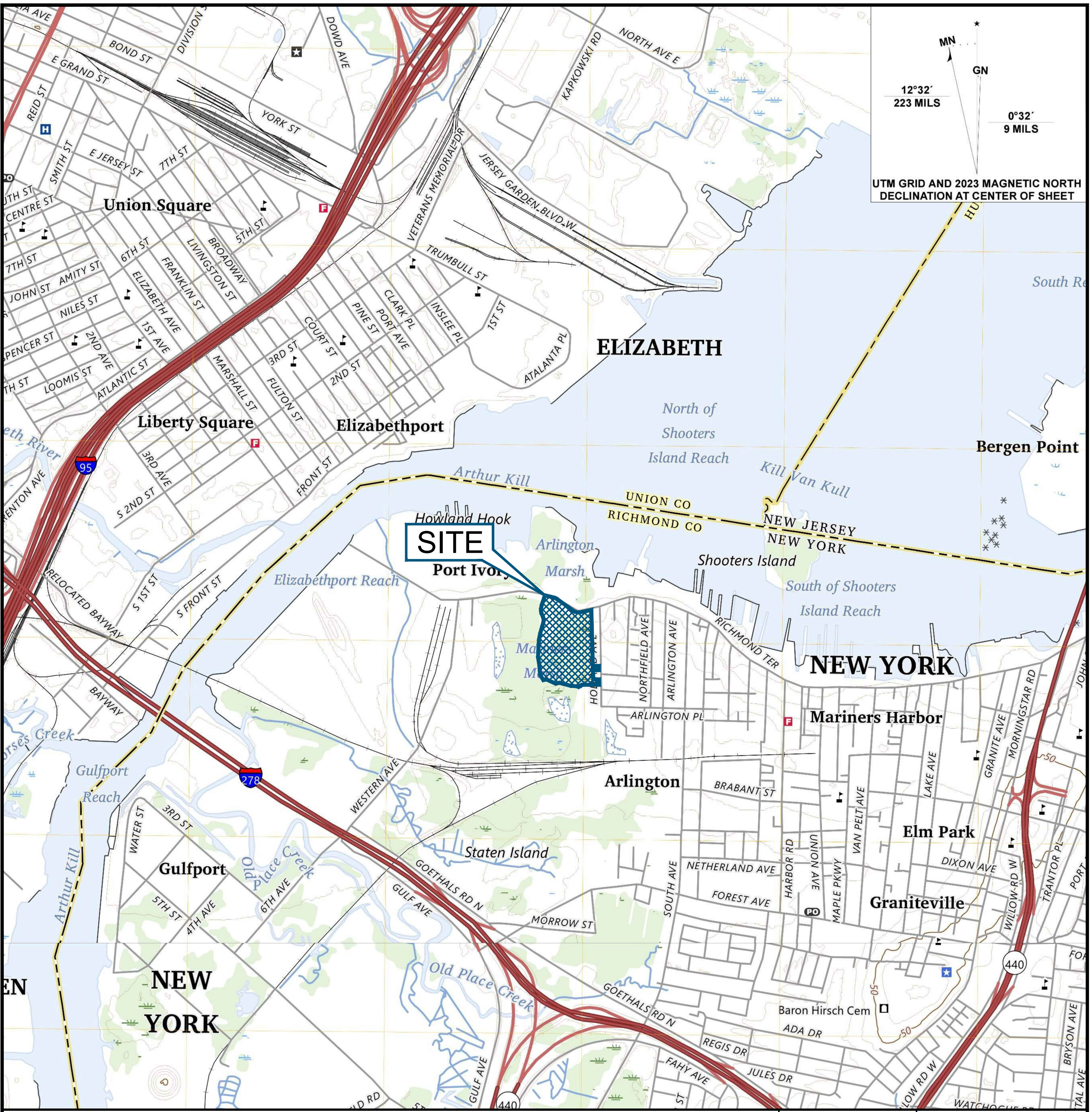
It is anticipated that the first sub-phase of the SC Work Plan (Mobilization 1) will be implemented following NYSDEC approval of the SC Work Plan. NYSDEC will be notified at least 7 days prior to the start of field activities. Presented below are estimated completion dates for key milestones associated with implementation of the Mobilization 1. Once the project is underway, this schedule will be updated periodically and summarized in the regular monthly project progress reports during project implementation. The schedule for implementation of the second sub-phase of the SC Work Plan will be provided to the NYSDEC at a later date.

KEY MILESTONE	**ESTIMATED TIME TO COMPLETION IN BUSINESS DAYS FROM APPROVAL OF THE SC WORK PLAN**
NYSDEC Approval of SC Work Plan	0
Begin Mobilization 1 Site Characterization Field Activities	15
Complete Mobilization 1 Site Characterization (including laboratory analyses)	45
Submit Mobilization 1 Site Characterization Report to NYSDEC	90

8.0 REFERENCES

1. 6 NYCRR 375: New York State Department of Environmental Conservation Rules and Regulations, Remedial Program Requirements.
2. 6 NYCRR 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations.
3. ASTM E 2600-22 “Standard Guide for Vapor Encroachment Screening on Property Involved in Real Estate Transactions.”
4. Bureau of Toxic Substance Assessment, New York State Department of Health, *Trichloroethene (TCE) In Indoor and Outdoor Air August 2015 Fact Sheet*.
5. Bureau of Toxic Substance Assessment, New York State Department of Health, *Tetrachloroethene (Perc) In Indoor and Outdoor Air September 2013 Fact Sheet*.
6. Buxton, Soren, Posner, and Shernoff, 1981, “Geologic Map of New York State.”
7. New York State Department of Environmental Conservation (NYSDEC) Commissioner Policy-51 / Soil Cleanup Guidance, October 2010.
8. NYSDEC Division of Environmental Remediation (DER)-10, Technical Guidance for Site Investigation and Remediation, May 2010.
9. New York State Department of Health, “Guidance for Evaluating Soil Vapor Intrusion in the State of New York”, October 2006, as amended.

FIGURES



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QUADRANGLE LOCATION

MAP INCLUDES INFORMATION FROM THE FOLLOWING MAP SHEET(S):
TP, ELIZABETH, NJ, 7.5 MINUTE DATED 2023,
S, ARTHUR KILL, NY-NJ, 7.5 MINUTE DATED 2023.

MAP OBTAINED THROUGH USE OF TOPOVIEW WITH THE INTERFACE CREATED BY THE NATIONAL GEOLOGIC MAP DATABASE PROJECT (NGMDB), IN SUPPORT OF THE TOPOGRAPHIC MAPPING PROGRAM, MANAGED BY THE USGS NATIONAL GEOSPATIAL PROGRAM (NGP).

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PROJECT:

NEW YORK CITY PARKS AND RECREATION - CAPITAL PROJECTS DIVISION
MARINERS MARSH PARK PHASE 1 - 3418 RICHMOND TERRACE
BOROUGH OF STATEN ISLAND, RICHMOND COUNTY, NY

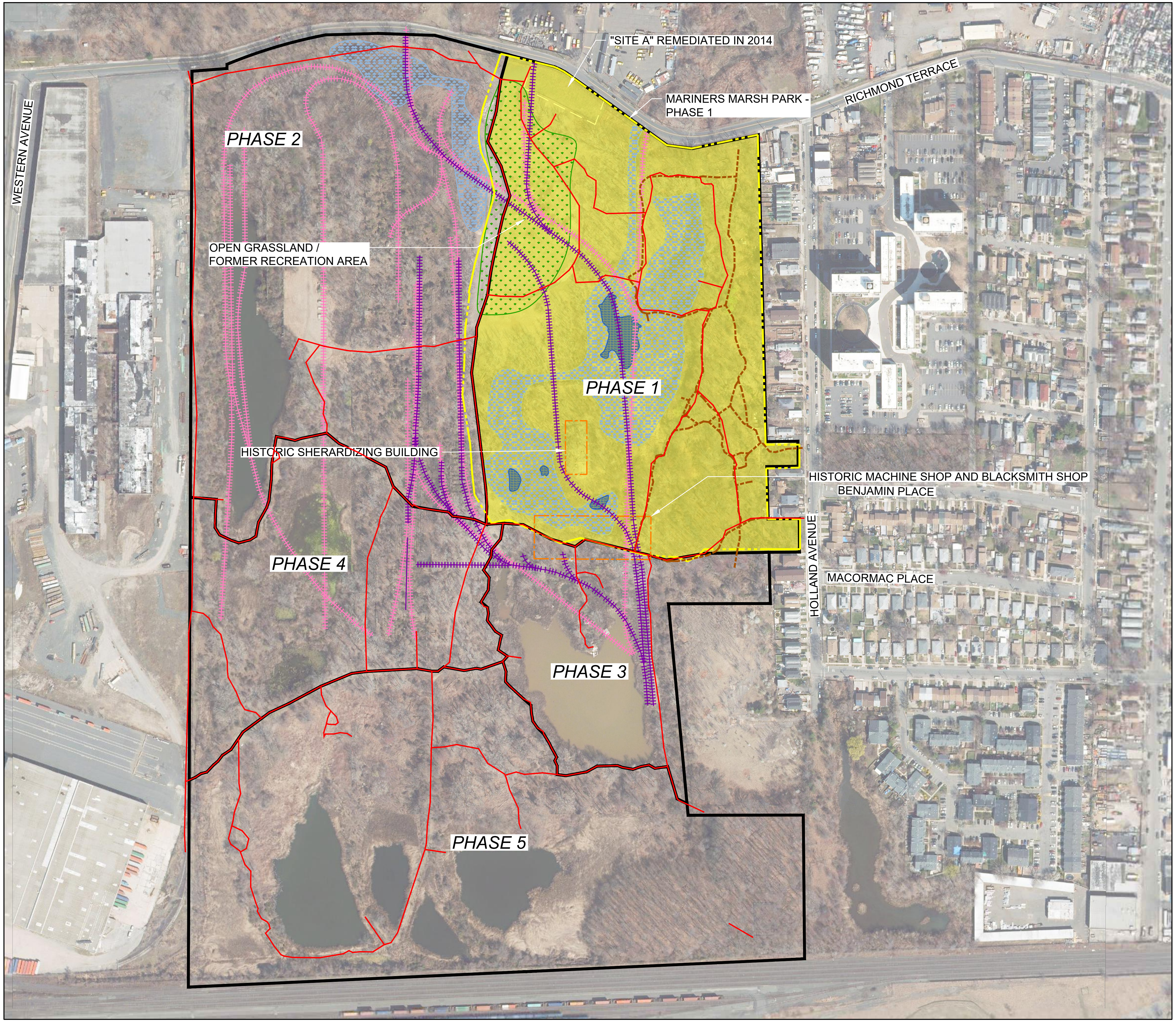
TITLE:

SITE LOCATION MAP

DRAWN BY:	H. DELGADO
CHECKED BY:	E. HE
APPROVED BY:	E. KESSLER
DATE:	SEPTEMBER 2024
PROJ. NO.:	554398.0000.0000
FILE:	Fig 1 - Site Loc. Map (MM).dwg

FIGURE 1

8.5x11 --- ATTACHED XREF'S: --- ATTACHED IMAGES: BAL OMM Figures (002); NJ_Elizabeth_20230611_TM; NY_Arthur_Kill_20230509_TM;
DRAWING NAME: \\nyc-fp1\Projects\NYC Parks Contract 20216200991\554398.0000 - Mariners Marsh Park\3_Deliverables\Work Plan\Figures\TRC WD\ Fig 1 - Site Loc. Map (MM).dwg --- PLOT DATE: September 03, 2024 - 8:27PM --- LAYOUT: 8.5x11P

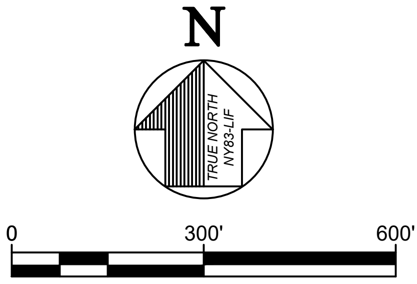


LEGEND (SYMBOLS NOT TO SCALE):

▭	MARINERS MARSH PHASE 1 BOUNDARY
—	HISTORIC TRAILS, PATHWAYS, AND DESIRE LINES
- - -	2024 TRAILS, PATHWAYS, AND DESIRE LINES
🟩	OPEN GRASSLAND / FORMER RECREATION AREA
▤	POND
▨	WETLAND
++++	FORMER RAILROAD SPUR - SANBORN 1910
++++	FORMER RAILROAD SPUR - SANBORN 1917

NOTES:

1. AERIAL IMAGE BACKGROUND SOURCED FROM ESRI DATABASE DATED AUGUST 3, 2018.
2. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
3. SOURCE: FIGURE 1 FROM REQUEST FOR PROPOSAL PACKAGE AND EXISTING CONDITIONS PLAN FROM MARINERS/ARLINGTON MARSH PARK MASTER PLAN, NYC PARKS.



SCALE: 1" = 300'
SHEET SIZE: 11" BY 17"

ASSUMED GROUNDWATER FLOW DIRECTION

PROJECT:

NEW YORK CITY PARKS AND RECREATION - CAPITAL PROJECTS DIVISION
MARINERS MARSH PARK PHASE 1 - 3418 RICHMOND TERRACE
BOROUGH OF STATEN ISLAND, RICHMOND COUNTY, NY

TITLE:

SITE PLAN

DRAWN BY:	H. DELGADO	PROJ NO.:	554398.0000.0000
CHECKED BY:	E. HE	**FIGURE 2**	
APPROVED BY:	E. KESSLER		
DATE:	SEPTEMBER 2024		

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New York, NY 10018
Phone: 212.221.7822
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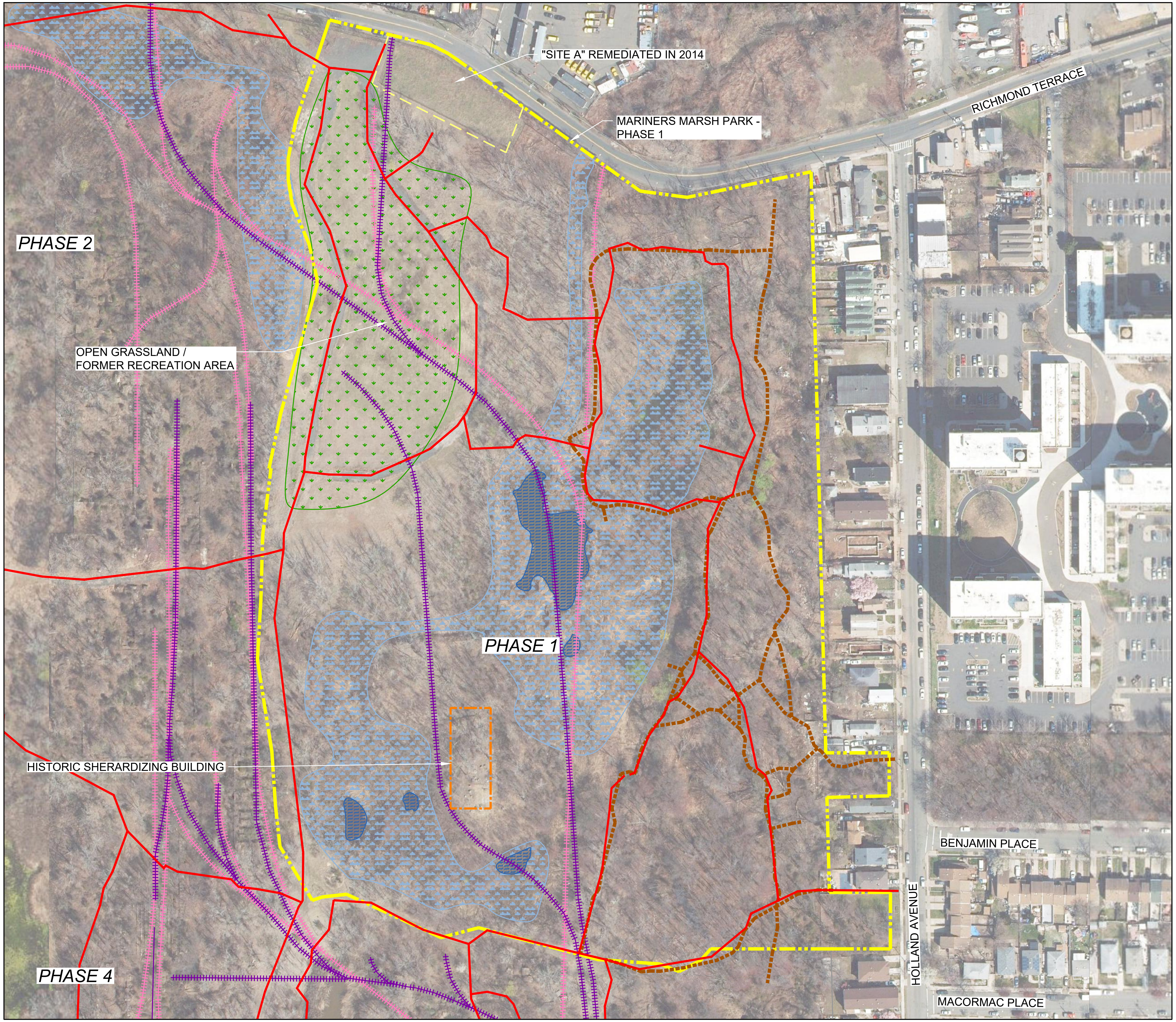
FILE NO.: Fig 2 - Site Plan (MM).dwg

11x17 --- ATTACHED XREF'S: StatenIsland --- ATTACHED IMAGES: Esri Database Image 08.03.2018 (Mariners Marsh); Esri Database Image 08.03.2018 (Mariners Marsh)NorthCZ2; Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ; Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ2; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ2; Mariners Marsh- basemaps_Page_1; Mariners Marsh- basemaps_Page_2;
DRAWING NAME: \\nyc-fp1\Projects\NYC Parks Contract 20216200991\554398.0000 - Mariners Marsh Park\3_Deliverables\Work Plan\Figures\TRC WD\ Fig 2 - Site Plan (MM).dwg --- PLOT DATE: September 24, 2024 - 4:56PM --- LAYOUT: 11X17L

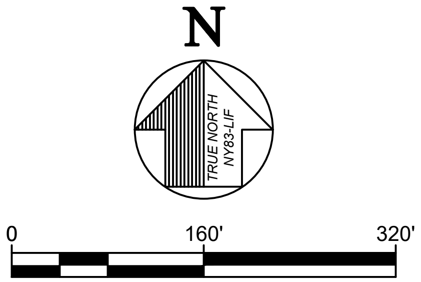


LEGEND (SYMBOLS NOT TO SCALE):

🟨	MARINERS MARSH PHASE 1 BOUNDARY
🟥	HISTORIC TRAILS, PATHWAYS, AND DESIRE LINES
🟫	2024 TRAILS, PATHWAYS, AND DESIRE LINES
🟩	OPEN GRASSLAND / FORMER RECREATION AREA
🟦	POND
▨	WETLAND
╫	FORMER RAILROAD SPUR - SANBORN 1910
╫	FORMER RAILROAD SPUR - SANBORN 1917

NOTES:

1. AERIAL IMAGE BACKGROUND SOURCED FROM ESRI DATABASE DATED AUGUST 3, 2018.
2. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
3. SOURCE: FIGURE 1 FROM REQUEST FOR PROPOSAL PACKAGE AND EXISTING CONDITIONS PLAN FROM MARINERS/ARLINGTON MARSH PARK MASTER PLAN, NYC PARKS.



SCALE: 1" = 160'
SHEET SIZE: 11" BY 17"

ASSUMED GROUNDWATER FLOW DIRECTION

PROJECT:

NEW YORK CITY PARKS AND RECREATION - CAPITAL PROJECTS DIVISION
MARINERS MARSH PARK PHASE 1 - 3418 RICHMOND TERRACE
BOROUGH OF STATEN ISLAND, RICHMOND COUNTY, NY

TITLE: **LOCATIONS OF FORMER RECREATION AREA, FORMER RAILROAD SPURS, AND HISTORIC SHERARDIZING BUILDING**

DRAWN BY:	H. DELGADO	PROJ NO.:	554398.0000.0000
CHECKED BY:	E. HE	**FIGURE 3**	
APPROVED BY:	E. KESSLER		
DATE:	SEPTEMBER 2024		

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Phone: 212.221.7822
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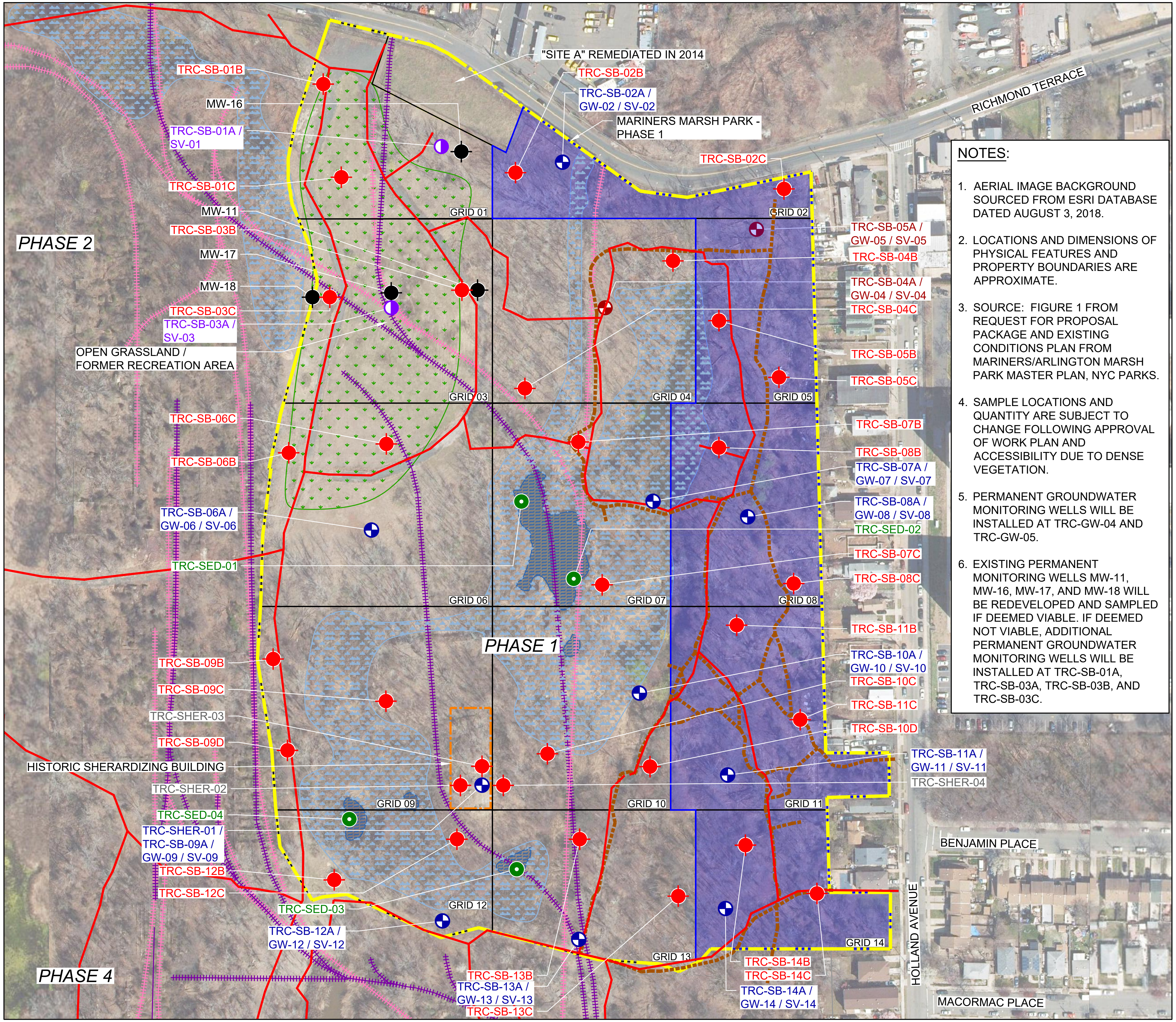
FILE NO.: Fig 3 - Locs of Fmr. Rec. Area, Fmr. RR Spurs, & HSB (MM).dwg

11x17 --- ATTACHED XREFS: StatenIsland --- ATTACHED IMAGES: Esri Database Image 08.03.2018 (Mariners Marsh); Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ; Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ2; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ2; Mariners Marsh- basemaps_Page_1; Mariners Marsh- basemaps_Page_2;
DRAWING NAME: \\nyc-fp1\Projects\NYC Parks Contract 20216200991\554398.0000 - Mariners Marsh Park\3_Deliverables\Work Plan\Figures\TRC WD\ Fig 3 - Locs of Fmr. Rec. Area, Fmr. RR Spurs, & HSB (MM) .dwg --- PLOT DATE: September 24, 2024 - 4:51PM --- LAYOUT: 11X17L

11x17 --- ATTACHED XREFS: StatenIsland --- ATTACHED IMAGES: Esri Database Image 08.03.2018 (Mariners Marsh); Esri Database Image 08.03.2018 (Mariners Marsh)NorthCZ2; Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ; Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ2; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ2; Mariners Marsh- basemaps_Page_1; Mariners Marsh- basemaps_Page_2;
DRAWING NAME: \\nyc-fp1\Projects\NYC Parks Contract 20216200991\554398.0000 - Mariners Marsh Park\3_Deliverables\Work Plan\Figures\TRC WD\ Fig 4 - Prop. Samp. Plan (MM).dwg --- PLOT DATE: September 24, 2024 - 4:53PM --- LAYOUT: 11X17L

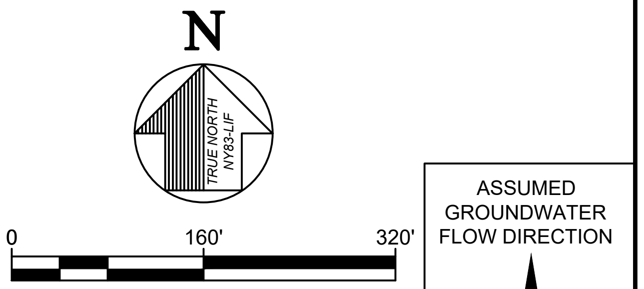


NOTES:

1. AERIAL IMAGE BACKGROUND SOURCED FROM ESRI DATABASE DATED AUGUST 3, 2018.
2. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
3. SOURCE: FIGURE 1 FROM REQUEST FOR PROPOSAL PACKAGE AND EXISTING CONDITIONS PLAN FROM MARINERS/ARLINGTON MARSH PARK MASTER PLAN, NYC PARKS.
4. SAMPLE LOCATIONS AND QUANTITY ARE SUBJECT TO CHANGE FOLLOWING APPROVAL OF WORK PLAN AND ACCESSIBILITY DUE TO DENSE VEGETATION.
5. PERMANENT GROUNDWATER MONITORING WELLS WILL BE INSTALLED AT TRC-GW-04 AND TRC-GW-05.
6. EXISTING PERMANENT MONITORING WELLS MW-11, MW-16, MW-17, AND MW-18 WILL BE REDEVELOPED AND SAMPLED IF DEEMED VIABLE. IF DEEMED NOT VIABLE, ADDITIONAL PERMANENT GROUNDWATER MONITORING WELLS WILL BE INSTALLED AT TRC-SB-01A, TRC-SB-03A, TRC-SB-03B, AND TRC-SB-03C.

LEGEND (SYMBOLS NOT TO SCALE):

▬ · ▬	MARINERS MARSH PHASE 1 BOUNDARY
🟦	MOBILIZATION 1
▬	HISTORIC TRAILS, PATHWAYS, AND DESIRE LINES
▬ ▬	2024 TRAILS, PATHWAYS, AND DESIRE LINES
🟩	OPEN GRASSLAND / FORMER RECREATION AREA
▤	POND
▨	WETLAND
┼┼┼┼	FORMER RAILROAD SPUR - SANBORN 1910
┼┼┼┼	FORMER RAILROAD SPUR - SANBORN 1917
⊕ , ⊕	PROPOSED SOIL BORING SAMPLE LOCATION
◐	PROPOSED SOIL BORING AND SOIL VAPOR SAMPLE LOCATION
⊕	PROPOSED SOIL BORING, TEMPORARY GROUNDWATER MONITORING WELL, AND SOIL VAPOR SAMPLE LOCATION
⊕	PROPOSED SOIL BORING, PERMANENT GROUNDWATER MONITORING WELL, AND SOIL VAPOR SAMPLE LOCATION
⊙	PROPOSED SEDIMENT SAMPLE LOCATION
⊕	EXISTING PERMANENT GROUNDWATER MONITORING WELL LOCATION (2010 ATC)
GRID ##	SAMPLE GRID AND IDENTIFICATION



SCALE: 1" = 160'
SHEET SIZE: 11" BY 17"

PROJECT:

NEW YORK CITY PARKS AND RECREATION - CAPITAL PROJECTS DIVISION
MARINERS MARSH PARK PHASE 1 - 3418 RICHMOND TERRACE
BOROUGH OF STATEN ISLAND, RICHMOND COUNTY, NY

TITLE:

PROPOSED SAMPLING PLAN

DRAWN BY:	H. DELGADO	PROJ NO.:	554398.0000.0000
CHECKED BY:	E. HE		**FIGURE 4**
APPROVED BY:	E. KESSLER		
DATE:	SEPTEMBER 2024		

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FILE NO.: Fig 4 - Prop. Samp. Plan (MM).dwg

TABLES

Table 1
Summary of Proposed Samples
The City of New York Department of Parks & Recreation
Site Characterization Work Plan
Mariners Marsh Park (Phase I), Staten Island, New York

Sample Identification	Type of Sampling Location	Rationale	Number and Types of Samples for Analysis	Laboratory Analyses
TRC-SB-01A / SV-01 through TRC-SB-14A / SV-14	Soil Boring and Soil Vapor Probes	Assess surface and subsurface impacts throughout the Site, impacts from current/historic on-Site operations, provide spatial coverage, and create a horizontal profile of soil conditions across the Site.	Approximately 28 discrete soil samples(1)	Full suite(2)
			14 soil vapor samples	TO-15 and USEPA TO-3C (methane)
TRC-SB-01B through TRC-SB-14B, and TRC-SB-01C through TRC-SB-14C	Soil Boring	Assess surface and subsurface impacts throughout the Site, impacts from current/historic on-Site operations, provide spatial coverage, and create a horizontal profile of soil conditions across the Site.	Approximately 56 discrete soil samples(1)	Full suite(2)
TRC-SHER-01 through TRC-SHER-04	Soil Boring	Assess surface and subsurface impacts from the historic sherardizing building.	Approximately eight (8) discrete soil samples(8)	Full suite(2)
MW-11, MW-16, MW-17, and MW-18	Permanent Monitoring Well	Provide spatial coverage on the northwestern portion of the Site, delineate historic chlorinated solvent contamination, and establish groundwater flow direction.	Four (4) groundwater samples	Full suite(2)
TRC-SB-01A, TRC-SB-03A, TRC-SB-03B, and TRC-SB-03C	Contingency Permanent Well (Installation required if MW-11, MW-16, MW-17, and MW-18 are not viable)	Provide spatial coverage on the northwestern portion of the Site, delineate historic chlorinated solvent contamination, and establish groundwater flow direction.	Four (4) groundwater samples	Full suite(2)
TRC-GW-02 and TRC-GW-06 to TRC-GW-14	Temporary Monitoring Well	Provide spatial coverage throughout the Site and assess groundwater impacts from historic on-Site operations.	Ten (10) groundwater samples	Full suite(2)
TRC-GW-04 and TRC-GW-05	Permanent Monitoring Well	Provide spatial coverage on the northeastern portion of the Site, and establish groundwater flow direction.	Two (2) groundwater samples	Full suite(2)
TRC-SED-01 to TRC-SED-04	Sediment Sampling Location	Provide spatial coverage of ponded areas of the Site and assess impacts from historic on-Site operations.	Four (4) sediment samples	Full suite(2)

Notes:

bgs – Below ground surface

PCBs – Polychlorinated biphenyls

TAL – Target Analyte List

TCL – Target Compound List

TICs – Tentatively Identified Compounds

VOCs – Volatile organic compounds

SVOCs – Semivolatile organic compounds

(1) If no apparent impacted soils are identified, one (1) soil sample will be collected from the upper two feet of soil (0-2 feet), and a second sample will be collected from the 2 feet interval above the groundwater interface, assuming groundwater is encountered at depths of 4 feet bgs or greater. If impacted soils are identified, one (1) sample will be collected from the upper 6 inches of soil (0-6 inches), one (1) soil sample will be collected from the most impacted zone (based on odors, staining, or elevated PID readings), and a third sample will be collected from a depth of 2 feet below the first clean soil encountered. If no apparent underlying clean interval is observed, the third soil sample submitted for analysis will be the sample collected from the bottom interval of the boring, or the two-foot interval above groundwater, whichever is shallower. For the purposes of this scope of work, it has been assumed that 2 samples from each soil boring will be submitted for laboratory analysis.

(2) Full suite in soil borings – TCL listed VOCs, TCL listed SVOCs, TAL metals + cyanide, pesticides, herbicides, and PCBs. Two (2) soil samples per grid will be additionally analyzed for PFAS. Full suite in groundwater and sediment samples - TCL listed VOCs, TCL listed SVOCs (including 1,4-dioxane), TAL metals + cyanide, pesticides, herbicides, PCBs, and PFAS. Soil vapor samples will be analyzed for TO-15 and USEPA TO-3C (methane).

APPENDIX A

Records Search Report

The Records Search Report prepared by TRC, dated March 2024, is provided under a separate cover and is publicly available online on DECInfo Locator (Index of /data/DecDocs/243036). Documents reviewed in the Records Search Report include the following:

1. *Contaminant Test Results and Memorandums, Field of Dreams,* Staten Island, dated August 1993.
2. *Phase I Environmental Site Assessment*, Lawler, Matusky & Skelly Engineers, LLP, July 2001.
3. *Limited Phase II Environmental Site Investigation*, Metcalf & Eddy, Inc., June 2003.
4. *Phase I Environmental Site Assessment*, Metcalf & Eddy of New York, Inc., July 2005.
5. *Mariners Marsh Park Federal Brownfield Site 243824N Health Consultation/Technical Assist, prepared by Agency for Toxic Substances and Disease Registry (ASTDR)*, dated July 27, 2006.
6. *Quality Assurance Project Plan and Mariners Marsh Photo Log*, Weston Solutions, Inc., March 9, 2006.
7. *Brownfields Phase II Environmental Site Investigation Report*, Metcalf & Eddy of New York, Inc., October 2007.
8. *Final Supplemental Phase II Environmental Site Investigation Report*, ATC Associates, Inc., August 23, 2010.
9. *Response to Comments Letter for Mariners Marsh Park Supplemental Phase II Environmental Site investigation,* ATC Associates, Inc., January 11, 2011.
10. *Memorandum. Subject: Comparison of Analytical Results for Metals in Soil Samples Collected During Phase II ESIs at Mariner's Marsh Park by Metcalf & Eddy in 2003 and 2007 to Current NYSDEC Soil Cleanup Objectives*, ATC Associates, Inc., April 12, 2011.
11. *Final Phase II Environmental Site Assessment*, CDM Federal Programs Corporation (CDM), October 31, 2011.

12. *Final Site Assessment and Delineation Report, Surface and Subsurface Soil Investigation,* prepared by Removal Support Team 2, Weston Solutions, Inc., dated November 2011

13. *Final Removal Action Report*, Weston Solutions, Inc., October 2012.

14. *Remedial Closure Report, Mariners Marsh Park*, prepared by AKRF Engineering, P.C., dated September 2013.

15. *New York Linear Construction Project Report*, Spectra Energy NJ-NY Expansion Project, prepared by TRC Engineers, Inc., dated February 2014

16. Freedom of Information Law (FOIL) Request submitted to New York State Department of Environmental Conservation (NYSDEC), TRC Engineers, Inc., November 20, 2019.

17. *Revised Supplemental Investigation Report,* 82 Davidson Street (AKA 60 Davidson Street), Staten Island, New York 10303, NYSDEC Spill #2100001, prepared by GEI Consultants, Inc., P.C., dated January 2023.

18. *Spill Closure Report,* NYSDEC Spill #2100001, 82 Davidson Street (AKA 60 Davidson Street), Staten Island, New York, prepared by GEI Consultants, Inc., P.C., dated January 2024.

19. FOIL Request submitted to NYSDEC, TRC Engineers, Inc., November 27, 2023.

APPENDIX B

Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the field activities described in the scope of work. The QAPP also describes specific protocols for field sampling, sample handling and storage, and laboratory analysis. The data generated from the analysis of samples will be used to characterize soil, groundwater, and soil vapor at the Site; confirm groundwater flow direction at the northern portion of the Site; and, develop remedial action decisions.

Project Organization and Responsibility

A qualified person will coordinate and manage the sampling and analysis program, data reduction, QA/QC, data validation, analysis, and reporting. TRC will direct the sampling activities and coordinate laboratory and remedial investigation activities. Data validation will be performed by Environmental Data Services, Inc. (EDS) of Palm Beach Gardens, FL. Specifically, the third-party data validator will be Nancy Weaver of EDS. The TRC Project Quality Assurance (QA) Officer will be Elizabeth Denly and will report directly to the Project Manager, Emily Ebert.

A qualified person will ensure that the QAPP is implemented and will oversee data validation. A qualified person will provide oversight and technical support for the sampling and analytical procedures followed in this project. This individual has the broad authority to approve or disapprove project plans, specific analyses, and final reports. The Project QA Officer is independent from the data generation activities. In general, the QA officer will be responsible for reviewing and advising on all QA/QC aspects of this program.

Laboratories used will be New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified laboratories. The laboratories will communicate directly with the Project Manager regarding the analytical results and reporting and will be responsible for providing all labels, sample containers, trip blanks, temperature blanks, shipping coolers, and laboratory documentation.

QA Objectives for Data Management

New York State Analytical Services Protocol (ASP) Category B laboratory packages will be provided by the laboratory.

All analytical measurements will be made so that the results are representative of the media sampled and the conditions measured. Data will be reported in consistent dry weight units for solid samples (i.e., µg/kg and/or mg/kg). Tables 1A-1C present the proposed samples, sampling and analytical parameters, analytical methods, sample preservation requirements, containers, and QA/QC samples.

Quantitation Limits (QLs) are laboratory-specific and reflect those values achievable by the laboratory performing the analyses.

Data Quality Levels (DQLs) are those reporting limits required to meet the objectives of the program (i.e., program action levels, cleanup standards, etc.).

Data Quality Objectives (DQOs) define the quality of data and documentation required to support decisions made in the various phases of the data collection activities. The DQOs are dependent on the end uses of the data to be collected and are also expressed in terms of objectives for precision, accuracy, representativeness, completeness, and comparability.

The analytical methods to be used at this site provide the highest level of data quality and can be used for purposes of risk assessment, evaluation of remedial alternatives and verification that cleanup standards have been met. 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 and precision.

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.

For quantitation limits for parameters associated with soil samples, the laboratory will be required to attempt to meet or surpass the parameter-specific limits listed in 6 NYCRR Part 375 Unrestricted Use Criteria and Commissioner Policy 51 Tables 2 and 3 (CP-51).

For quantitation limits for parameters associated with groundwater samples, the laboratory will be required to attempt to meet or surpass the parameter-specific limits for groundwater from the NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values.

For quantitation limits for parameters associated with soil vapor, the laboratory will be required to use Method TO-15, which will provide detection limits of 0.20 micrograms per cubic meter for vinyl chloride, trichloroethene (TCE), cis-1,2-dichloroethene, 1,1-dichlorethene, and carbon tetrachloride, allowing for comparison with the lowest action levels for these compounds in the NYSDOH “Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York”, dated October 2006. All other compounds will have a detection limit of 1 microgram per cubic meter.

The QA objectives are defined as follows:

- ***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.

  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 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. Tables 2A, 2B, 2B-1 and 2C summarize the laboratory accuracy requirements.

- ***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. Precision is measured in a variety of ways including statistically, such as calculating variance or standard deviation.

  Precision in the field is assessed through the collection and measurement of field duplicates (one extra sample in addition to the original field sample). Field duplicates for soil, groundwater, and sediment samples will be collected at a frequency of one per twenty investigative samples per matrix per analytical parameter. Precision will be measured through the calculation of relative percent differences (RPDs). The resulting information will be used to assess sampling and analytical variability. 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.

Precision in the laboratory is assessed through the calculation of RPD for duplicate samples. For organic soil and groundwater analyses, laboratory precision will be assessed through the analysis of field duplicates.

- ***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.

  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.

- ***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. In addition, field duplicate samples will provide an additional measure of representativeness at a given location.

  Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the RI Work Plan (Work Plan) 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.

- ***Comparability*** 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 Work Plan 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 United Stated Environmental Protection Agency (USEPA) or equivalent analytical methods and the reporting of data in standardized units. Laboratory procedures are consistent with those used for previous sampling efforts.

Table 1A
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Soil and Sediment Samples

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[3]	Sample Container
Soil and Sediment	TCL and CP-51 VOCs	Grab	102	Duplicate: 1/20	8260D	Sealed in Terracore; Cool to ≤4° C	48 hours to extract: 2 Terracore samplers extruded in 5 mL DI water and freeze vials to <-7°C; 1 Terracore sampler extruded in 5 mL methanol and Cool to 40 C; 14 days to analysis	3 x 5 gram Terracore samplers
Soil and Sediment	TCL and CP-51 SVOCs (includes 1,4-dioxane[4])	Grab	102	Duplicate: 1/20	8270E	Cool to ≤4° C	14 days to extract	4 oz glass jar
Soil and Sediment	TAL Metals (includes cyanide and mercury)	Grab	102	Duplicate: 1/20	6010D/6020B 7471B Hg 9012B Cn	Cool to ≤4° C	Other metals: 180 days to analysis Cyanide:14 days Mercury: 28 days	2 oz glass jar
Soil and Sediment	Hexavalent Chromium	Grab	102	Duplicate: 1/20	7196A	Cool to ≤4° C	30 days to extract.	4 oz glass jar
Sediment	TOC	Grab	5	Duplicate: 1/20	9070	Cool to ≤4° C	14 days to extract	4 oz glass jar
Soil and Sediment	TCL Pesticides	Grab	102	Duplicate: 1/20	8081B	Cool to ≤4° C	14 days to extract	4 oz glass jar
Soil and Sediment	TCL Herbicides	Grab	102	Duplicate: 1/20	8151A	Cool to ≤4° C	14 days to extract	4 oz glass jar
Soil and Sediment	PCBs	Grab	102	Duplicate: 1/20	8082A	Cool to ≤4° C	14 days to extract	4 oz glass jar
Soil and Sediment	PFAS[5, 6]	Grab	44	Duplicate: 1/20	1633	Cool to ≤4° C	14 days to extract, 28 days to analyze (90days if stored at ≤ -20° C)	4oz or 2oz HDPE wide mouth jar (caps must not have Teflon liners)

Table 1A
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Soil and Sediment Samples

Sample Matrix	Analytical Parameter	Sample Type[1]	No. of Samples[2]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[3]	Sample Container

[1] A two-foot sampling interval is the targeted sample size; however, sample volume recovery, analytical method requirements, and field conditions can affect the actual sample interval size. For these reasons, the actual sampling interval may change in order to obtain adequate volume.

[2] Actual number of samples may vary depending on field conditions, sample material availability, and field observations.

[3] From date and time of sample collection

[4] The reporting limit for 1,4-dioxane is 0.1 mg/kg.

[5] NYSDEC 40 PFAS analytes

[6] The lab is able to achieve a reporting limit of 0.2 ug/kg for PFAS compounds.

Table 1B
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Groundwater Samples

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples[1]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[2]	Sample Container
Groundwater	TCL and CP-51 VOCs	Grab	21	Trip Blank[3]: as necessary (one per day, per cooler containing VOC groundwater samples) Duplicate: 1/20	8260D	pH<2 with HCl; cool to 4ºC; no headspace	14 days to analysis	3 40-mL glass vials
Groundwater	TCL and CP-51 SVOCs	Grab	17	Duplicate: 1/20	8270E	Cool to ≤4º C	14 days to analysis	2 1 L amber glass jar
Groundwater	TAL Metals (includes cyanide and mercury)	Grab	34	Duplicate: 1/20	6010D/6020B 7470A Hg 9012B Cn /	Cool, 4ºC pH < 2 w/ HNO_3; Cyanide: amber/NaOH>12	Metals: 180 days to analysis Cyanide: 14 days Mercury:28 days	1L plastic
Groundwater	Hexavalent Chromium	Grab	34	Duplicate: 1/20	SM3500 CrB	Cool to 4ºC	24 hours to extract	1L plastic

Table 1B
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Groundwater Samples

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples[1]	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[2]	Sample Container
Groundwater	TCL Pesticides	Grab	17	Duplicate: 1/20	8081B	Cool to ≤64º C	147 days to extract	2 1-L GTLC1L amber glass jar
Groundwater	TCL Herbicides	Grab	17	Duplicate: 1/20	8151A	Cool to ≤64º C	147 days to extract	2 1-L GTLC1L amber glass jar
Groundwater	TCL PCBs	Grab	17	Duplicate: 1/20	8082A	Cool to ≤64º C	147 days to extract	2 1-L GTLC1L amber glass jar
Groundwater	1,4-Dioxane[4]	Grab	17	Duplicate: 1/20	82670E	Cool to ≤6ºC4ºC	14 days to analysis	2 1-L GTLC1L amber glass jar
Groundwater	PFAS[5,6]	Grab	17	Duplicate: 1/20	1633	Cool to ≤6 ºC	28 days to analyze (90days if stored at ≤ -20º C)	500 mL HDPE[7] Bottles (CAPS MUST NOT HAVE Teflon Liners)

[1] Actual number of samples may vary depending on field conditions, sample material availability, and field observations.
[2] From date and time of sample collection
[3] Trip blank bottleware – 3 40-mL HCl-preserved glass vials
[4] The method detection limit for 1,4-dioxane is 0.0160 ug/L and the reporting limit is 0.35 ug/L.
[5] NYSDEC 40 PFAS analytes
[6] The reporting limit for PFAS compounds is 2 ng/L with the exception of N-ethylperfluoro-1-octanesulfonamidoacetic acid (N-EtFOSAA), 1H,1H,2H,2H-perfluorooctane sulfonate (6:2 FTS), 1H,1H,2H,2H-perfluorodecane sulfonate (8:2 FTS), and Perfluorobutanoic acid (PFBA). The reporting limit for these four PFAS range from 3 to 5 ng/L.
[7] HDPE – High density polyethylene

Table 1C
Analytical Parameters, Methods, Preservation, Holding Time, and Container Requirements for Soil Vapor Samples

Sample Matrix	Analytical Parameter	Sample Type	No. of Samples	No. of QA/QC Samples	EPA Analytical Method	Sample Preservation	Holding Time[1]	Sample Container
Soil Vapor	VOCs	Grab	14	None	TO-15	None	30 days to analysis	One 6-L Summa Canister

Soil Vapor	Methane	Grab	14	None	EPA Method 3C	None	30 days to analysis	One 6-L Summa Canister

[1] From date and time of sample collection

Table 2A
Laboratory Data Quality Objectives: Precision and Accuracy: Soil and Sediment Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
TCL and CP-51 VOCs	8260D	Soil and Sediment	Surrogates % Rec. 1,2-Dichloroethane-d4 56-154 Bromofluorobenzene 46-151 Toluene-d8 48-145 Dibromfluoromethane 48-156 Matrix Spikes: 20-150% recovery Laboratory Control Samples: 20-150% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤50	Field Duplicates: One per 20 soil samples
TCL and CP-51 SVOCs	8270E	Soil and Sediment	Surrogates % Rec. 2-Fluorophenol 38-9525-140 Phenol-d5 32-9127-146 2,4,6-Tribromophenol 10-10312-174 Nitrobenzene-d5 37-9416-159 2-Fluorobiphenyl 38-9529-145 Terphenyl-d14 24-10933-136 Matrix Spikes: 10-205% recovery Laboratory Control Samples: 10-205% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤50	Field Duplicates: One per 20 soil samples

Table 2A
Laboratory Data Quality Objectives: Precision and Accuracy: Soil and Sediment Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
TAL Metals	6010D/6020B	Soil and Sediment	Matrix Spikes: 75-125% recovery Laboratory Control Samples: LCS must recover within the QC Performance Acceptance Limits specified on the Certified Reference Material data sheet	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
Mercury	7471B	Soil and Sediment	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
Total Cyanide	SW 846-9012B	Soil and Sediment	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
TCL Pesticides	8081B	Soil and Sediment	Surrogates % Rec. TCMX 27-138 DCB 21-154 Matrix Spikes: 10-182% recovery Laboratory Control Samples: 80-120% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
TCL Herbicides	8151A	Soil and Sediment	Surrogates % Rec. Dcaa 10-160	Surrogates: All samples, standards, QC samples	Field Duplicates RPD ≤20	Field Duplicates:

Table 2A
Laboratory Data Quality Objectives: Precision and Accuracy: Soil and Sediment Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
			Matrix Spikes: 10-130% recovery Laboratory Control Samples: 10-130% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch		One per 20 soil samples
PCBs	8082A	Soil and Sediment	Surrogates % Rec. TCMX 13-171 DCB 10-186 Matrix Spikes: 10-220 recovery Laboratory Control Samples: 80-220% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples
PFAS	1633	Soil and Sediment	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤20	Field Duplicates: One per 20 soil samples

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
TCL and CP-51 VOCs[1]	8260D	Groundwater	Surrogates % Rec. 1,2-Dichloroethane-d4 81-123 Bromofluorobenzene 77-125 Toluene-d8 75-121 Dibromofluoromethane 82-120 Matrix Spikes: 10-225% recovery Laboratory Control Samples: 10-225% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤30	Field Duplicates: One per 20 groundwater samples

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[1] Results of analyses for VOCs will include all TCL VOCs and CP-51-listed VOCs. Included on the TCL and CP- 51 list are the 6 NYCRR Part 375-listed VOCs.

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
TCL and CP-51 SVOCs[2]	8270E	Groundwater	Surrogates % Rec 2-Fluorophenol 25-5810-131 Phenol-d5 14-3910-133 2,4,6-Tribromophenol 26-13920-180 Nitrobenzene-d5 51-10819-163 2-Fluorobiphenyl 45-10723-154 Terphenyl-d14 40-14830-184 Matrix Spikes: 10-216% recovery Laboratory Control Samples: 10-216% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates RPD ≤30	Method Blank/LCS/MS/MSD: 1 per preparation batch of 20 or fewer field samples.
TAL Metals (unfiltered)	6010C	Groundwater	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
Mercury (unfiltered)	7470A	Groundwater	Matrix Spikes: 80-120% recovery Laboratory Control Samples: 75-125% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples

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[2] Results of analyses for SVOCs will include all TCL SVOCs and CP-51-listed SVOCs. Included on the TCL and CP-51 list are the 6 NYCRR Part 375-listed SVOCs.

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
Total Cyanide	SW 846-9012B	Groundwater	Matrix Spikes: 75-125% recovery Laboratory Control Samples: 80-120% recovery	Matrix Spikes: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
TCL Pesticides	8081B	Groundwater	Surrogates % Rec. TCMX 12-137 DCB 13-160 Matrix Spikes: 80-120%22-159 recovery Laboratory Control Samples: 22-159% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
TCL Herbicides	8151A	Groundwater	Surrogates % Rec. Dcaa 46-145 Matrix Spikes: 10-130% recovery Laboratory Control Samples: 10-130% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
PCBs	8082A	Groundwater	Surrogates % Rec. TCMX 11-128 DCB 11-144 Matrix Spikes: 22-155 recovery Laboratory Control Samples: 22-155% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples

Table 2B
Laboratory Data Quality Objectives: Precision and Accuracy: Groundwater Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
1,4-Dioxane	8270E SIM	Groundwater	Surrogates % Rec 2-Fluorophenol 10-131 Phenol-d5 10-133 2,4,6-Tribromophenol 20-180 Nitrobenzene-d5 19-163 2-Fluorobiphenyl 23-154 Terphenyl-d14 30-184 Matrix Spikes: 70-13010-216% recovery Laboratory Control Samples: 10-216% recovery	Surrogates: All samples, standards, QC samples Matrix Spikes: One per 20 soil samples per laboratory analytical batch Laboratory Control Samples: One per 20 samples per laboratory analytical batch	Field Duplicates: RPD ≤20	Field Duplicates: One per 20 groundwater samples
PFAS	1633	Groundwater	Extracted Internal Standard (IDA): 25-150 Refer to Table 2B-I below for LCS & MS/MSD.	Extracted Internal Standard (IDA): Every field and QC sample. LCS/MS/MSD: one per extraction batch of no more than 20 samples. LCSD if not enough sample for MS/MSD.	LCS/LCSD or MS/MSD: RPD ≤30	LCS/LCSD or MS/MSD for each batch of no more than 20 field samples.

Table 2B-I
LCS & MS/MSD Accuracy Control Limits for PFAS

Analyte	LCS/MS/MSD % R	Analyte	LCS/MS/MSD % R
Perfluorobutanoic acid (PFBA)	70-140	Perfluorononanoic acid (PFNA)	70-150
Perfluoropentanoic acid (PFPeA)	65-135	Perfluorodecanoic acid (PFDA)	70-140
Perfluorohexanoic acid (PFHxA)	70-145	Perfluoroundecanoic acid (PFUnA)	70-145
Perfluoroheptanoic acid (PFHpA)	70-150	Perfluorododecanoic acid (PFDoA)	70-140
Perfluorooctanoic acid (PFOA)	70-150	Perfluorotridecanoic acid (PFTriA)	65-140
Perfluorotetradecanoic acid (PFTeA)	70-140	Perfluorodecanesulfonic acid (PFDS)	60-145
Perfluorobutanesulfonic acid (PFBS)	60-145	Perfluorooctane sulfonamide (FOSA)	70-145
Perfluorohexanesulfonic acid (PFHxS)	65-145	N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	70-145
Perfluoroheptanesulfonic acid (PFHpS)		N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	50-140
Perfluorooctanesulfonic acid (PFOS)		1H,1H,2H,2H-perfluorooctane sulfonate (6:2 FTS)	65-155
		1H,1H,2H,2H-perfluorodecane sulfonate (8:2 FTS)	60-150

Table 2B-II
Method Detection Limits (MDLs) and Reporting Limits (RLs) for PFAS

Matrix	Soil	Groundwater
Analyte	**MDL (ug/kg)**	**MDL (ng/L)**
Perfluorobutanoic acid (PFBA)	0.11	0.93
Perfluoropentanoic acid (PFPeA)	0.07	0.73
Perfluorohexanoic acid (PFHxA)	0.03	0.29
Perfluoroheptanoic acid (PFHpA)	0.05	0.5
Perfluorooctanoic acid (PFOA)	0.08	0.75
Perfluorononanoic acid (PFNA)	0.05	0.4
Perfluorodecanoic acid (PFDA)	0.07	0.62
Perfluoroundecanoic acid (PFUnA)	0.06	0.55
Perfluorododecanoic acid (PFDoA)	0.08	0.77
Perfluorotridecanoic acid (PFTriA)	0.09	0.79
Perfluorotetradecanoic acid (PFTeA)	0.1	0.76

Table 2B-II
Method Detection Limits (MDLs) and Reporting Limits (RLs) for PFAS

Matrix	Soil	Groundwater
Analyte	**MDL (ug/kg)**	**MDL (ng/L)**
Perfluorobutanesulfonic acid (PFBS)	0.07	0.66
Perfluoropentanesulfonic Acid (PFPeS)	0.1	1
Perfluorohexanesulfonic acid (PFHxS)	0.11	1.1
Perfluoroheptanesulfonic Acid (PFHpS)	0.1	0.98
Perfluorooctanesulfonic acid (PFOS)	0.05	0.43
Perfluorononanesulfonic Acid (PFNS)	0.14	1.4
Perfluorodecanesulfonic Acid (PFDS)	0.11	1.1
Perfluorododecane sulfonic acid (PFDoS)	0.05	0.4
4:2 Fluorotelomer Sulfonate (4:2 FTS)	0.28	2.3
6:2 Fluorotelomer Sulfonate (6:2 FTS)	0.1	0.91
8:2 Fluorotelomer Sulfonate (8:2 FTS)	0.19	1.5
Perfluorooctanesulfonamide (PFOSAm)	0.07	0.69
N-Methylperfluorooctane sulfonamide (NMeFOSA)	0.06	0.64
N-Ethylperfluorooctane sulfonamide (NEtFOSA)	0.05	0.53
N-Methyl perfluorooctane sulfonamido acetic acid (NMeFOSAA)	0.08	0.51
N-Ethyl perfluorooctane sulfonamido acetic acid (NEtFOSAA)	0.13	0.91
N-Methyl perfluorooctane sulfonamido ethanol (NMeFOSE)	0.28	2.8
N-Ethyl perfluorooctane sulfonamidoethanol (NEtFOSE)	0.73	3.8
Perfluoro-2-methyl-3-oxahexanoic acid (HFPO-DA)	0.18	1.8
4,8-dioxa-3H-perfluorononanoic Acid (ADONA)	0.12	1.2
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (F53B Major)	0.26	2.4
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F53B Minor)	0.18	1.8
3:3 Fluorotelomer carboxylic acid (3:3 FTCA)	0.24	2.4
2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)	0.62	7.1
3-Perfluoroheptylpropanoic acid (7:3 FTCA)	0.63	6.2
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	0.03	0.27
Perfluoro-3-methoxypropanoic Acid (PFMPA)	0.03	0.3
Perfluoro(4-methoxybutanoic) Acid (PFMBA)	0.06	0.56
Perfluoro-3,6-dioxaheptanoic acid (NFDHA)	0.13	1.3

Table 2B-II
Method Detection Limits (MDLs) and Reporting Limits (RLs) for PFAS

Matrix	Soil	Groundwater
Analyte	**MDL (ug/kg)**	**MDL (ng/L)**
Notes: Hampton Clarke is subcontracting PFAS analyses to SGS North America Inc (SGS). The laboratory SOP for PFAS analysis is included in Attachment A.		

Table 2C
Laboratory Data Quality Objectives: Precision and Accuracy: Soil Vapor Samples

Parameter	Method	Matrix	Accuracy Control Limits	Accuracy Frequency Requirements	Precision (RPD) Control Limits	Precision Frequency Requirements
VOCs	TO-15	Soil Vapor	LCS limits vary by analyte	Each batch or every 20 samples, whichever is less.	N/A	N/A
Methane	EPA Method 3C	Soil Vapor		Each batch or every 20 samples, whichever is less.	N/A	N/A
N/A – Not applicable						

Project Goals

The principal objectives of the Site Characterization (SC) are to complete the characterization of soil, groundwater, and soil vapor at the Site and confirm groundwater flow direction on the northern portion of the Site. The data obtained during the implementation of the SC will be utilized to determine whether the Site poses little or no threat to public health and the environment or if it poses a threat that requires further investigation. The SC may also obtain data useful for determining the remedial measures, if any, necessary for reopening the Site to the public.

Project Scope

In order to assess soil, groundwater, and soil vapor at the Site, the scope of work includes the advancement of soil borings; installation of temporary soil vapor probes and permanent and temporary groundwater monitoring wells; and the collection and laboratory analysis of soil vapor, soil, groundwater, and sediment samples.

Select soil/sediment and groundwater samples will be analyzed for TCL and NYSDEC CP-51-listed VOCs; TCL and NYSDEC CP-51-listed SVOCs including 1,4-dioxane; TAL metals including hexavalent chromium and cyanide, TCL pesticides, TCL herbicides, PCBs, and PFAS. Sediment samples will additionally be analyzed for TOC. Soil vapor samples will be analyzed for VOCs and methane.

Sampling Plan

Environmental sampling will include soil, groundwater, sediment, and soil vapor. Soil samples will be collected using disposable sampling equipment. Groundwater samples will be collected from permanent and temporary monitoring wells using peristaltic pumps and new dedicated high density polyethylene (HDPE) tubing. Sediment samples will be collected from approximately 0 to 0.5 feet below the sediment surface utilizing hand augers. Soil vapor samples will be collected from temporary soil vapor probes using dedicated sampling equipment.

Soil Sampling

Hand augers and a dolly-mounted direct push drill rig (Geoprobe) will be utilized to advance a total of 46 soil borings throughout the Site and in and adjacent to the former sherardizing building and former rail spurs. Soil samples will be collected in 3-, 4-, or 5-foot long 2-inch diameter macrocore samplers lined with acetate sleeves and/or hand augers. With the exception of soil collected for VOC analysis, the samples will be collected with a disposable scoop and placed in the sample bottles. Terracore® samplers will be used to collect soil samples for VOC analysis. Samplers will wear phthalate-free gloves such as nitrile (no latex will be used). Only clean instruments will be allowed to touch the sample.

Groundwater Sampling

Groundwater samples will be collected from two-inch diameter permanent wells and one-inch diameter temporary wells installed on the Site. Groundwater from each well will be purged via a peristaltic pump equipped with HDPE tubing until parameters have stabilized in accordance with USEPA Low-Stress (Low-Flow) sampling procedures. A turbidity level of 10 Nephelometric Turbidity Units (NTUs) or less is the well purging goal, but not an absolute value before sampling. Other field parameters including temperature, conductivity, pH, and dissolved oxygen (DO) will also be monitored. As practical, all field measurements will be taken from the flow-through cell and will be recorded during and after purging, and before sampling. Field parameters should generally be within ±10 percent for three consecutive readings prior to sampling.

A minimum of three well volumes will be purged prior to sample collection. During purging, the sampler will actively monitor and track the volume of water purged and the field parameter readings. Data will be recorded in the field logbook. For example, the sampler will record the running total volume purged from each well and note the readings for the corresponding field parameters.

Once groundwater conditions have stabilized and groundwater levels have recovered, samples will be collected. Sampling will be performed with the pump intake at the same location used for purging. Pumping rates for withdrawing the samples will be similar to those followed for well purging.

The samples will be collected in sample bottles (pre-preserved, if appropriate), placed in chilled coolers and removed from light immediately after collection. All bottles will be filled to avoid cascading and aeration of the samples, the goal being to minimize any precipitation of colloidal matter.

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. When sampling for PFAS in groundwater, specific modifications, in accordance with TRC's Standard Operating (SOP) for Groundwater Sampling dated November 2016, will be implemented. TRC's SOP for Groundwater Sampling is provided as Attachment A.

Soil Vapor Sampling

Soil vapor sampling will be conducted in accordance with the NYSDOH "Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006)" and ASTM Standard E 2600-22.

The soil vapor samples will be collected using a direct-drive rig (i.e., Geoprobe) that utilizes drive rods to advance the vapor probe to 5 feet bgs or one foot above the water table, whichever is shallower . In accordance with the NYSDOH vapor intrusion guidance, tracer gas (i.e., helium) will be used at each soil vapor sampling location to ensure that an adequate surface seal has been created.

The temporary vapor probe will then be purged using a photoionization detector (PID) to evacuate one to three volumes of soil vapor. During purging, the purge flow rate will not exceed 0.200 liters per minute (L/min). Maximum VOC concentrations will be recorded by the field technician. Each probe will be connected via Teflon tubing to a laboratory-supplied individually certified clean SUMMA canister with a 2-hour flow controller. Using a 0.05 L/min flow regulator, the sample collection time will be approximately 120 minutes.

QC Sample Collection

QC samples will include trip blanks for groundwater and field duplicates for soil, groundwater, and sediment samples. Refer to Tables 1A-1C for a summary of QC sample preservation and container requirements.

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

Field duplicates are an additional aliquot of the same sample submitted for the same parameters as the original sample. Field duplicates will be used to assess the sampling and analytical reproducibility. Field duplicates will be collected by alternately filling sample bottles from the source being sampled. Field duplicates will be submitted at a frequency of one per 20 samples for all matrices and all parameters. Refer to Tables 1A-1C for a summary of QC sample preservation and container requirements.

Sample Preservation and Containerization

The analytical laboratory will supply the containers for analytical samples. These containers will be cleaned by the manufacturer to meet or exceed all analyte specifications established in the latest USEPA'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 USEPA specifications. Soil and groundwater samples will be placed in chilled coolers immediately after collection

Equipment Decontamination

Re-usable sampling equipment shall be cleaned between each use in the following manner:

- Wash and scrub with Alconox and water mixture
- Tap water rinse
- Wash and scrub with biodegradable degreaser ("ZEP") if there is oily residue on equipment surface.
- Tap water rinse
- Distilled/deionized water rinse
- Air dry

As noted above, special care should be taken when sampling for PFAS. TRC will implement TRC's SOP ECR-010 Equipment Decontamination for PFAS-specific decontamination protocols. TRC's Equipment Decontamination SOP is provided in Attachment A.

Field Custody Procedures

Sample chain-of-custody and packaging procedures are summarized below. These procedures are intended to ensure that the samples will arrive at the laboratory with the chain-of-custody 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 sample collection, and type of analysis.

- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label because the pen would not function in wet weather.

- Samples will be accompanied by a properly completed chain-of-custody form. The sample numbers and locations will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage location. Chain of Custody Forms are provided in Attachment B.

- All shipments will be accompanied by the chain-of-custody 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 front right and back left of the cooler and covered with clear plastic tape after being signed by field personnel. The cooler will be strapped shut with strapping tape in at least two locations.

- If the samples are sent by common carrier, the air bill will be used. Air bills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.

- Samples remain in the custody of the sampler until transfer of custody is completed. This consists of delivery of samples to the laboratory sample custodian, and signature of the laboratory sample custodian on chain-of-custody document as receiving the samples and signature of sampler as relinquishing samples.

Data Management and Reporting

ASP Category B Laboratory Packages will undergo data validation. A NYSDEC Data Usability Summary Report (DUSR) will be prepared for each laboratory package. Note that waste characterization samples, if collected for laboratory analysis, will not undergo data validation.

ATTACHMENT A

Standard Operating Procedures – TRC and SGS

Title: **Groundwater Sampling**	Procedure Number: **ECR 009**
	Revision Number: **5**
	Effective Date: **March 2023**

Authorization Signatures

Technical Reviewer Chelsea Wenhardt	Date 03/27/2023	SOP Work Group Co-Lead Ryan Jorrey	Date 03/27/2023

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1.0 INTRODUCTION

1.1 Scope & Applicability

This Standard Operating Procedure (SOP) was prepared to provide TRC personnel with general guidance in performing groundwater sampling activities. This SOP details equipment and sampling procedures for low-flow sampling, multi-volume purge sampling and no-purge sampling methods from monitoring wells. Various regulatory agencies and project-specific work plans may have specific requirements (e.g., equipment/instrument, flow rate, stabilization criteria, etc.) that may be applicable and take precedence, depending on the program.

The objective of groundwater sampling is to obtain a representative sample of water from a saturated zone or groundwater-bearing unit (i.e., aquifer) with minimal disturbance of groundwater chemistry. This requires that the sample being collected is representative of groundwater within the formation surrounding the well bore as opposed to stagnant water within the well casing or within the filter pack immediately surrounding the well casing.

1.2 Summary of Method

There are three general approaches to groundwater purging/sampling that can be used to obtain a representative groundwater sample for analysis: 1) the low-flow or micropurge method where the mixing of water from the aquifer with stagnant water in the well casing is minimized using low-flow pumping rates during the collection of the groundwater sample; 2) the multiple well volume removal approach in which the stagnant water is removed from the well and the filter pack prior to sample collection; and 3) no-purge methods.

For low-flow and multiple well volume removal, there are various types of equipment available to perform groundwater sampling. The most common of these are the submersible pump, peristaltic pump, and bailer. However, the equipment selected, and the purge method used, if any, will depend on project goals, data quality objectives (DQOs), hydrogeologic conditions, and regulatory requirements. Care should be taken when choosing the sampling procedures and device(s), as some procedures have the potential to affect the representativeness of the sample more than others. For repeated monitoring events, the sampling methodology and operating equipment employed should be consistent to minimize potential variability due to sampling procedures. The type of sampling method utilized is dependent upon site-specific conditions and it is not within the scope of this document to recommend a specific methodology. For specialized sampling programs involving per- and polyfluorinated alkyl substances (PFAS), refer to Attachment C for further details. Information on applicability of sampling methods can be found on Interstate Technology & Regulatory Council (ITRC) and United States Environmental Protection Agency (EPA) websites.

1.3 Equipment

The following equipment is commonly used to collect groundwater samples from a monitoring well. Site-specific conditions may warrant the use of additional equipment or deletion of items from this list.

- Appropriate level of personal protective equipment (PPE) as specified in the site-specific Health and Safety Plan (HASP)

- Electronic water level indicator or oil/water interface probe capable of measuring to 0.01-foot accuracy
- Extra batteries for water level/interface probe
- Submersible pump (e.g., Grundfous, bladder pump, monsoon pump, etc.) with low-flow capabilities (less than 1 liter/min) constructed of inert materials (e.g., stainless steel or Teflon®), with sufficient quantity of bladders, o-rings, grab plates, etc.
- Peristaltic pump with sufficient silicone tubing
- Source of power for use with submersible or peristaltic pump (e.g., 12-volt battery, compressor, generator, compressed gas tanks, etc.)
- Flow controller for use with submersible pump (varies depending on type of pump used)
- Bottom-filling bailer constructed of inert materials (e.g., polyethylene, polyvinyl chloride [PVC], stainless steel or Teflon®)
- Bailer cord or wire (recommended Teflon®-coated, stainless steel cable; bailer wire; or contaminant-free rope with a Teflon®-coated stainless steel leader to connect bailer and rope)
- Tubing (Teflon®, Teflon®–lined polyethylene, low density polyethylene [LDPE], or high-density polyethylene [HDPE], type dependent upon project objectives)
- Silicone tubing (only used for peristaltic pump head and/or flow-through cell connections)
- Water quality meter(s) capable of measuring parameters, such as pH, temperature, specific conductivity (μS/cm), oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity (NTU)
- Flow-through cell
- T-connector
- Turbidity meter (if not included in water quality meter)
- Passive sampling device (and any device-specific accessories)
  - Passive diffusion bags (PDBs)
  - Tether (stainless steel cable or marine-grade polypropylene or polyethylene rope), well cap, and weights, unless already installed
  - Funnel (Fill kit)
  - PVC cable ties
  - Tool to cut cable ties adhering to TRC safety policies
  - PVC discharge tubes
  - Tether reel
- No-purge sampling device and any device-specific accessories (e.g., hydra-sleeve, snap sampler, etc.)
- Well lock keys
- Bolt cutters
- Appropriate tools for equipment and to open well box (e.g., socket wrench, pry bar, Road Box Keys, replacement bolts, etc.)
- Containers with lids for purge water (e.g., 5-gallon buckets, drums, etc.)
- Stopwatch or timer
- Graduated measuring container appropriately sized to measure flow rate
- Sample bottle labels

- Laboratory-grade water (can request from lab – for equipment blanks)
- Chain-of-custody (COC) forms
- Sample cooler(s)
- Photoionization detector (PID) or flame ionization detector (FID) for well head monitoring
- Sample containers (will be supplied by the laboratory): The proper containers should be determined in conjunction with the analytical laboratory in the planning stages of the project. If not included in sample containers provided by laboratory, sample preservatives will need to be kept with sample containers and added to sample containers prior to sample collection.
- Field book and/or Groundwater Field Data Record (multiple copies)
- Electronic device (e.g., tablet, smart phone, etc.) and charger if utilizing mobile data collection
- Filtration equipment
- In-line filter (0.45 micron [µm]) or as otherwise required by the project-specific work plan.
- Bubble wrap/Bubble wrap bags
- Lint-free, non-abrasive, disposable towels (e.g., Kimwipes®)
- Indelible marking pens
- Plastic bags (e.g., Ziploc®)
- Ice
- Teflon® tape
- Plastic sheeting or large trash bags which can be cut open
- Umbrella, tent, or equivalent for shading equipment (particularly the flow-through cell) from sunlight or blocking rain
- Equipment decontamination supplies (refer to SOP010)
- Container for bailing surface water out of water-filled road boxes or well vaults
- Map of well locations and well construction data
- Copy of field notes from previous sampling event for reference
- Project-specific work plan

1.4 Definitions

Bailer	A cylindrical device suspended from a rope or cable, which is used to remove water, non-aqueous phase liquid (NAPL), sediment or other materials from a well or open borehole. Usually equipped with some type of check valve at the base to allow water, NAPL, and/or sediment to enter the bailer and be retained as it is lifted to the surface.
Borehole	A hole drilled into the soil or bedrock using a drill rig or similar equipment.
Dense Non-aqueous Phase Liquid (DNAPL)	Separate-phase product that is denser than water and, therefore, sinks to the bottom of the water column.

Depth To Water (DTW)	The distance to the groundwater surface from an established measuring point.
Drawdown	The response to purging/pumping a well resulting in the lowering of groundwater within the water column in the well or in a water-bearing zone.
FID	An instrument that uses a flame to break down volatile organic compounds (VOCs) into ions that can be measured.
Flow-Through Cell	The container used to immerse the multi-parameter probes in well purge water during pre-sampling well purging. The flow-through cell is usually made of transparent acrylic and is connected to the end of the discharge tubing creating an in-line, sealed container in which purge water circulates around the measurement probes. The discharge from the pump prior to the flow-through cell may be fitted with a check valve or T-connector for collection of water for turbidity measurement.
Flush Mount	The type of well completion where the riser terminates at or below grade. Flush-mounted wells are typically completed with a "road box" which is an "at-grade" enclosure designed to protect the well riser.
Light Non-aqueous Phase Liquid (LNAPL)	Separate-phase product that is less dense than water and therefore floats on the surface of the water.
Monitoring Well	A well made from a polyvinyl chloride (PVC) pipe, stainless steel, or other appropriate material, with slotted screen installed across or within a saturated zone.
Negative Pressure Pump	A pump that uses suction or vacuum pressure to displace water from an elevation that is lower than that of the pump. A negative pressure pump will cause volatile constituents to be lost from the sample, lowering its apparent concentration and it therefore not recommended for sampling of VOCs.
PID	An instrument that uses an ultraviolet light source to break down VOCs into ions that can be measured.
Piezometer	A piezometer is similar to a monitoring well, except that it contains screen over a short interval at the base of the pipe. Piezometers are primarily installed to measure the potentiometric surface elevation.
Potentiometric Surface	A surface representing the hydraulic head of groundwater.

Protective Casing	The pipe installed around the well riser that sticks up from the ground (above-grade completions) or is flush with the ground (at-grade completions, e.g., curb box) in order to protect the well integrity. Protective casings are typically constructed of steel or aluminum and usually closeable with a locking cover/hasp to maintain well integrity between sampling events.
Positive Displacement Pump	A pump that relies on the use of a cylinder or piston arrangement with a foot valve to displace water. They are ideal for sampling at depths greater than 25 ft and for sampling VOCs as the entire sample train is under positive pressure and the pumps develop little heat.
Recharge Rate	The rate at which groundwater returns to the water column in the well.
Static Water Level	Level at which water resides in a well when the water level is at equilibrium with atmospheric pressure.
Well Cover	The cap or lid constructed at the end of the protective casing (above-grade completions) or flush-mounted curb box (ground surface completions) to secure access to the well. Well covers for stick-up wells are often equipped with a hasp to accommodate a padlock. Well covers for flush-mounted road boxes or vaults are opened and closed using a variety of closures (bolts, etc.) for security.
Well Filter Pack	A material composed of clean silica sand or sand and gravel of selected grain size and gradation that is placed in the annulus between the screened interval and the borehole wall in a well for the purpose of retaining and stabilizing the formation material.
Well Plug/Expansion Plug	The plug fashioned into a cap placed into the top of the well riser (e.g., J-Plug). Well plugs are usually designed with an expandable gasket that is activated by turning a locking wing nut or removable key latch, closing a snap cap or engaging a magnetic clutch cap to seal the well riser.
Well Riser	Sections of blank (non-slotted) pipe that extend from the well screen to or above the ground surface.
Well Screen	Pipe (typically PVC or stainless steel) used to retain the formation or filter pack materials outside of the well. The pipe has openings/slots of a uniform width, orientation, and spacing. The openings/slots can vary based on formation and filter pack material specifications.

1.5 Health & Safety Considerations

TRC personnel will be on-site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific HASP. TRC personnel will use the appropriate level of PPE as defined in the HASP.

The well head should be pre-screened using a PID/FID to avoid inhalation of contaminants venting from the well if elevated concentrations of VOCs are known or suspected/likely. If monitoring results indicate sustained elevated concentrations of organic contaminants, the level of PPE may need to be increased in accordance with the HASP.

When present, special care should be taken to avoid contact with LNAPL or DNAPL. The use of an air monitoring program, as well as the proper PPE designated by the site-specific HASP, can identify and/or mitigate potential health hazards.

Implementing this SOP may require the use of reagents and/or compressed gases for the calibration and operation of field equipment. These substances may be hazardous and TRC personnel must appropriately handle, store, and dispose of them at all times. Skin contact with liquid from preserved sample bottles must be avoided as they may contain strong acids or bases. When filling bottles pre-preserved with acid (e.g., hydrochloric acid, nitric acid, sulfuric acid), vapors may be released and should not be inhaled. Do not allow bottles with acid to be exposed to elevated atmospheric temperatures or sunlight as this will facilitate fumes from the acids.

1.6 Cautions and Potential Problems

The following sections highlight issues that may be encountered and should be discussed with the Project Manager prior to mobilization into the field. Special care in equipment selection and tubing materials should be taken when sampling for PFAS. Please refer to Attachment C for details.

1.6.1 Pre-Sampling Issues

(a) Selection of equipment for groundwater sampling should consider multiple factors, including: DTW, well specifications (e.g., depth and length of well screen intervals), aquifer type, desired flow rate, possible weather conditions, type and concentration of contaminant(s), and remoteness/accessibility to the site. The benefits and limits of each type of groundwater sampling equipment should be fully reviewed during project planning or prior to mobilization if the project-specific work plan does not identify the required equipment. For example, peristaltic pumps are incapable of withdrawing water in wells in which the depth to water is greater than approximately 20-25 feet below ground surface (bgs).

(b) If the screen or open borehole is greater than 10 feet in length, consult the project-specific work plans for the target sampling interval. Generally, pumps are either placed in the middle of the saturated zone if the water level is below the top of the screen or in the middle of the screen interval if the water level is above the top of the screen.

(c) The need for redevelopment of the monitoring wells should be evaluated periodically in accordance with the project-specific requirements. This is assessed by comparing the measured total depth of the well with the constructed depth. If the measured depth is less than the constructed depth, this may indicate siltation of the well and/or the presence of an obstruction in the well. If it is determined that redevelopment is necessary, it should be performed in accordance with ECR SOP 006. The time necessary for a well to restabilize after redevelopment will be determined on a project-specific basis and may depend on regulatory requirements.

(d) During the total well depth measurement, there is the potential for sediment, if present at the bottom of the well, to be disturbed, thereby increasing the turbidity of the groundwater.

Therefore, the total well depth measurement should be collected the day prior to collecting groundwater samples, if possible.

(e) Use caution if using compressed gas cylinders (e.g., nitrogen, carbon dioxide) for purging/sampling of groundwater. Check for leaks around regulator connections by spraying soapy water on the connections. If a leak is discovered, the connection to the regulator should be disassembled, wrapped with Teflon® tape, and reconnected to the cylinder. If the leak continues, the regulator should be replaced. It should be noted that Department of Transportation (DOT) regulations apply to the transportation and handling of compressed gas cylinders (see 49 Code of Federal Regulations [CFR] 171). Never transport cylinders with the regulator attached. Replace the cylinder valve cover on the compressed gas cylinder before transport.

(f) All field personnel must be made aware of the water level measurement reference point being used for each well at a site (i.e., must be clearly marked) in order to ensure collection of comparable data between events. This should be performed in accordance with ECR SOP 004.

(g) Bolt cutters may be necessary to remove rusted locks. Dipping rusted locks in a soapy solution may help with opening difficult locks. Oils and other products containing VOCs (e.g., WD-40) should not be used on locks as these compounds may cause contamination of water samples collected at the well. Replace cut locks and note in the field book.

(h) Prior to accessing the well, physical conditions around the well head should be assessed for situations that might result in cross-contamination or the introduction of foreign material/debris into the well. For example, flush-mounted wells may have water or road sand/salt/debris inside the curb box. Rodents and insects (e.g., bees, wasps, ants) have been known to construct nests within the protective casing of a well. If bees, wasps, or other insects are encountered, insecticides should be used with caution as the chemicals may cause contamination of water samples collected at the well. If water or foreign material is introduced into the well, the Project Manager should be immediately notified and included in sampling notes.

1.6.2 General Purging and Sampling Issues

(a) Prior to installation of a submersible pump into a well, ensure that the tubing is properly sealed to the pump to avoid losing the pump down the well and to prevent escape of air or water from the pump, which could result in poor pump performance and the aeration of the well water. Do not do this by tugging on tubing. Never lower pumps into the well using only tubing; instead, a security line attached to the pump is required to prevent potentially losing the pump down the well.

(b) A submersible pump should not be lowered to the bottom of the well to avoid stirring up any sediment at the bottom of the well and prevent the pump from getting stuck (fine sediment accumulation in the bottom of the well can create a strong suction with a flat bottom pump such as a bladder pump, which may require jetting to retrieve the pump).

(c) Start with the lowest pumping rate possible and increase until a sustainable rate is reached. Avoid high pumping rates (> 1 liter/min), as this could lead to damage of the well filter pack, if present. Where practical and/or possible, refer to previous sampling events to establish consistent flow rates.

(d) Some regulatory agencies may have concern about the use of peristaltic pumps when sampling for VOCs due to the potential for loss of VOCs during sampling and alteration of other water quality parameters such as pH and alkalinity. Samplers should review the requirements in the project-specific work plan and/or regulatory guidelines prior to performing the work. Explicit approval to use a peristaltic pump for the collection of VOCs may be required by the governing regulatory agency.

An option may be to use the "soda straw" method to collect the VOC sample which does not allow the water to go through the pump head:

(1) After purging the well with the peristaltic pump, collect all fractions except VOCs from the outlet side of the pump (i.e., VOCs will be collected last instead of first).
(2) Turn the pump off.
(3) Change into clean gloves.
(4) Disconnect the tubing coming out of the well from the inlet side of the pump and immediately put a finger over the end of this tubing to prevent water from draining out of the tubing.
(5) Retrieve tubing from the well, coiling it in one hand as it is being retrieved (maintain finger over end of tubing).
(6) Open VOC vials. Briefly remove finger from end of tubing to allow water to flow into vial. Replace finger on end of tubing to stop flow. Do this for remaining VOC vials.

(e) In the event that a well cannot be purged and sampled with a pump for various reasons, the alternative to pumping may be the use of a bottom-filling bailer. The applicable regulatory agency requirements and the Project Manager should be consulted if in doubt about the appropriateness of using a bailer at a site or during a particular sampling event.

(f) During purging and sampling, the tubing should remain filled with water (without entrained air) to minimize possible changes in water chemistry due to contact with the atmosphere. All flow-through cells should be shaded from direct sunlight to minimize the potential for off-gassing and temperature fluctuations.

(g) Ensure monitoring instruments (i.e., multi-parameter water quality instrument, turbidity meter, water level measuring device) are maintained in good condition and properly calibrated to ensure accurate readings. Be sure to have appropriate-sized extra batteries on hand.

(h) Adverse weather conditions may present challenges that need to be dealt with on a case-by-case basis. For example, air temperatures below 32°F may cause ice formation in the tubing, flow-through cell, and on the sampling equipment, or heavy rain could cause standing water issues with flush-mounted wells. Heavy rain can also impact electronic sampling equipment; preventative measures should be taken to keep electronic equipment dry.

(i) Observe and avoid any uncontrolled ambient/surrounding air conditions that could affect analytical results (e.g., truck/vehicle exhaust nearby, industrial building vents). Always ensure that vehicles are turned off during sampling to avoid introducing vehicle exhaust into the sample. If uncontrolled ambient/surrounding air conditions cannot be avoided, contact the Project Manager for further instruction; collection of a field blank sample may be warranted in this situation.

(j) Procedures should be established to minimize potential cross-contamination. For example:

- Wrap monitoring and sampling equipment with protective material (e.g., aluminum foil, polyethylene sheeting, Ziploc® bags) after decontamination and between sampling locations to minimize the potential for cross-contamination between well purging events at different locations.
- Use dedicated or disposable sampling equipment or new tubing at each sampling point when appropriate to minimize the need for decontamination.
- Protect sampling equipment and/or the open well head from blowing soil and dust by covering with plastic sheeting as needed.
- If a bailer and rope are used to purge and/or sample the well, then there is the possibility of contamination from the rope used to lower the bailer. New or dedicated rope should be used when appropriate. Alternatively, a decontaminated, Teflon®-coated stainless steel leader can be attached between the rope and the bailer. The leader acts as an extension to the rope and allows for the top of the bailer to enter the water column without immediately placing the rope into the water. It is important to keep the rope clean and not allow contact with the ground surface during bailing.

(k) Disposal of the groundwater collected during purging must be performed in accordance with all applicable regulations and the project-specific work plan.

(l) Clear tape should not be used to cover labels on containers used for certain analyses (e.g., 40-mL vials for VOC analysis) due to potential interference with analytical equipment at the laboratory.

(m) In cases where it is difficult to obtain sufficient sample volume for multiple analytical fractions as well as required quality control (QC) analyses (e.g., field duplicates, matrix spike/matrix spike duplicate [MS/MSD] analyses), discuss this situation with the Project Manager and laboratory prior to sample collection. Laboratories can often "make do" with less volume, especially for inorganic parameters, or increase the reporting/detection limit proportional to the sample volume obtained.

1.7 *Personnel Qualifications*

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained (e.g., OSHA 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response [HAZWOPER] and 8-hour annual refresher training). Project- and client-specific training requirements for samplers and other personnel on-site should be developed in project planning documents, such as the sampling plan or project-specific work plan.

2.0 PROCEDURES

Procedures for collecting groundwater samples from monitoring wells are described below. The project-specific work plan should also be consulted for specific details regarding sampling.

When possible, sampling should always begin at the monitoring well with the least contaminated groundwater and systematically proceed to the well with the most contaminated groundwater, including sites which may have nested wells.

2.1 Pre-sampling Activities

(a) It should be determined if there is the requirement to determine static water level measurements on all wells at the site prior to sampling, regardless if the well is being sampled.

(b) Prior to field activities, review historical groundwater sampling logs (if available) to maintain consistency for the current sampling event (e.g., equipment type, pump intake depth setting, flow rate, etc.).

(c) The sampling order of the wells should be pre-determined based on prior site experience, known contamination, soil sampling results, or well development characteristics in order to minimize the potential for cross contamination from one sample to another.

(d) Organize monitoring, purging, and sampling equipment taking care not to allow cross-contamination. This can be accomplished by laying new polyethylene sheeting near the well or using new buckets, etc.

(e) Calibrate (or perform a calibration check on) all field monitoring equipment on the same day before collecting groundwater samples. Refer to ECR SOP 011 and manufacturer's equipment calibration instructions. A calibration or calibration check may also be required during or at the end of each sampling day. Consult the project-specific work plan.

(f) Unlock the well cover on the well.

(g) Record the sample location, time, and date in the field book and/or on the Groundwater Field Data Record.

(h) On the Groundwater Field Data Record, note the physical condition of the well, including damage, deterioration, and signs of tampering, if any. Collect photographic documentation of serious damage to present to the Project Manager.

(i) Open the well cap and expansion plug (stay upwind of and not directly over the well). Note any unusual odors, sounds, or difficulties in opening the well and, if required, measure the organic vapor reading at the rim of the well with a suitable organic vapor screening device (e.g., PID or FID), and record the reading in the field book and/or on the Groundwater Field Data Record. If pressure or vacuum is noted or suspected in the well, allow sufficient time for the water level elevation in the well to equilibrate.

(j) Gently lower a clean, decontaminated water level measuring device into the well to determine the static water level. If appropriate for site conditions, check for the presence of LNAPL or DNAPL using an oil/water interface probe (refer to ECR SOP 004). If LNAPL or DNAPL is detected, contact the Project Manager before proceeding with purging and sampling activities. Record the information on depth to groundwater to the nearest 0.01 feet, depth to LNAPL or DNAPL, and/or thickness of NAPL in the field book and/or the Groundwater Field Data Record.

(k) If required in the project-specific work plan, measure the depth to the bottom of the well to assist in calculating the well volume. If possible, avoid making total well depth measurements on the same day as sampling due to the tendency to disturb sediment during this measurement.

If NAPL is suspected, use a decontaminated oil/water interface probe. If the measured depth is less than the constructed depth, this may indicate that the well needs to be redeveloped (see ECR SOP 006). Consult the project-specific work plan or Project Manager for further instructions.

2.2 Groundwater Purging Activities

Purging is conducted to ensure that representative groundwater is obtained from the water-bearing unit for analysis. The multiple-volume or low-flow purging approach may be used to remove water from the well and monitor the water in order to determine when a well has been adequately purged (i.e., stabilized); at a minimum, the pH, specific conductance and temperature of the groundwater removed during purging should be monitored and recorded in the field notes. Other parameters may be required in some regulatory jurisdictions (e.g., turbidity). Additionally, the purge volume should be monitored and recorded. In some instances, simply removing an adequate volume of water (e.g., three to five well volumes) may be suitable for adequate purging, and sampling can commence. Check with the project-specific work plan and appropriate regulatory guidance to determine any specific purging requirements.

If the well has been previously sampled consistent with this SOP, then the prior purging strategy (e.g., method, pump intake depth and the flow rates) should be followed during subsequent sampling events to maintain consistency and minimize potential variability due to the sampling procedure.

2.2.1 Multiple-Volume Purging Approach

The multiple-volume purging approach is typically performed using bailers or submersible or peristaltic pumps. In the multiple-volume purging approach, there are two measurements used to determine adequate purge volume removal prior to sample collection: 1) purge volume and 2) field parameter stabilization. The field parameters should be recorded at regular volumetric intervals. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the calculated purge volume is small, the measurements should be taken frequently enough (e.g., every three to five minutes) to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every five to ten minutes may be sufficient.

Purge Volume
Prior to purging a well, the amount of water inside the well riser and well screen (i.e., water column) should be determined, if possible. To do this, the diameter of the well should be determined and the water level and total depth of the well should be measured and recorded. The specific methodology for obtaining these measurements is included in ECR SOP 004.

Once this information is known, the well volume can be calculated using Equation 1:

Well Volume (V) = πr^2 h (cf)
where:
π = pi (3.14)
r = radius of well in feet (ft)
h = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3.

The volume in gallons/linear foot (gal/ft) and liters/linear foot (L/ft) for common-size wells are as follows:

Well Inside Diameter (inches)	Volume (gal/ft)	Volume (L/ft)
1	0.0408	0.1529
2	0.1631	0.6174
4	0.6524	2.4696
6	1.4680	5.5570

If the volumes for the common-size wells above are utilized, Equation 1 is modified as follows:

Well volume = (h)(f)
where:
h = height of water column (feet)
f = the volume in gal/ft or L/ft

Well Volume Including Filter Pack = $V_1 + V_2$
$V_1 = \pi(D_1/2)^2 H_1$
$V_2 = N\pi H_2[(D_3/2)^2 (D_2/2)^2]$
V_1 = volume of water in well
V_2 = volume of water in filter pack
N = porosity of filter pack
D_1 = inside diameter of well casing
D_2 = outside diameter of well casing
D_3 = diameter of borehole
H_1 = height of water column
H_2 = length of sand used in filter pack and fine sand filter pack seal or the height of the water column in water table observation wells
H_1 = height of water column
H_2 = length of filter pack or the height of the water column in water table observation wells
Note: There are 7.48 gallons per cubic foot

For volumetric purging, an adequate purge is typically achieved when three to five well volumes have been removed. The field notes should reflect the single-well volume calculations or determinations according to one of the above methods and a reference to the appropriate multiplication of that volume, (i.e., a minimum of three well volumes) clearly identified as a purge volume goal.

If removing a specified volume of water (e.g., three well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume. In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection. If, after three well volumes have been removed, the field parameters have not stabilized (see discussion in Section 2.2.3), additional well volumes (up to a total of five well volumes), should be removed. If the parameters have not stabilized within five well volumes, it is at the discretion of the Project Manager whether or not to collect a sample or to continue purging. If, after five well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level per work plan

DQO's, additional purging should be considered to obtain the best sample possible with respect to turbidity. The conditions of sampling should be noted in the field book.

2.2.2 Low-flow Purging Approach

The low-flow purging approach is typically performed using peristaltic pumps or submersible pumps. Low-flow purging (also referred to as low-stress purging, low-volume purging, or Micropurging®) is a method of well purging/sampling that minimizes the volume of water withdrawn from a well in obtaining a representative sample. The term low-flow refers to the low velocity with which water enters the pump intake during purging and sampling. The objective is to draw representative saturated zone water through the well screen to the pump intake while avoiding disturbance of the stagnant water above the pump intake through minimizing drawdown of the water column in the well. To achieve this, the flow rate should be adjusted to less than 1 L/min (usually, this will be a rate less than 500 mL/min and may be as low as 100 mL/min). Once drawdown stabilizes, the sampled water is isolated from the stagnant water in the well casing, thus eliminating the need for its removal. Horizontal flow is induced to the pump intake with no/minimal vertical mixing. Water entering the pump can be considered representative of water in the formation after drawdown and indicator parameters have stabilized.

When performing low-flow purging and sampling, it is recommended that the pump intake be set in the center of the well screen interval (or center of the water column within the well screen if the water level is below the top of the well screen) to help prevent disturbance of any sediment at the bottom of the well. If known, the pump can be placed adjacent to the areas with the highest hydraulic conductivity or highest level of contaminants. Dedicated pumps can be utilized to minimize disturbance of the water column. Subsequent sampling events should duplicate as closely as possible the pump intake depth and the stabilized flow rate from the previous events.

To begin purging, the pump should be started at the lowest pressure/power flow rate setting (e.g., 100 mL/min) and then slowly increased until water begins discharging. Monitor the water level and slowly adjust the pump speed until there is little or no drawdown or drawdown has stabilized. The pump pressure/power may need to be increased for discharge to occur.

The stabilization of drawdown should be documented. Measure and record the flow rate and water level every three to five minutes during purging. The flow rate should be reduced if drawdown is greater than 0.3 feet over three consecutive three to five minute interval readings. Note any flow rate adjustments on the Groundwater Field Data Record. Once an appropriate purge rate has been achieved (i.e., drawdown is <0.3 feet between measurements), record this information, continue purging until water quality indicator parameters have stabilized (see Section 2.2.3), and then sample the well.

Attempts should be made to avoid pumping a well dry. If drawdown cannot be maintained at less than 0.3 feet and the falling water level is approaching the top of the screened interval (or the pump intake for sampling that began with the water level below the top of the screen), perform the following steps:

1. Reduce the flow rate, or turn the pump off and allow for recovery. (The pump must have a check valve to prevent backflow if it is shut off).
2. Begin pumping again at a lower flow rate.

3. If the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, turn the pump off and allow the water level to recharge.
4. The well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated sample containers.
5. If this procedure is used, this should be recorded in the field book and/or on the Groundwater Field Data Record.

2.2.3 Field Parameter Stabilization During Purging

Stabilization criteria may depend on project objectives or regulatory-specific requirements. Generally, an adequate purge with respect to the ground water chemistry is achieved when stability for at least three consecutive measurements is as follows:

- pH ± 0.1 standard unit (SU)
- specific conductance within 3%
- turbidity within 10% for values greater than 10 nephelometric turbidity units (NTUs). If three turbidity readings are less than 10 NTUs, the values are considered as stabilized
- DO within 0.2 mg/L or 10% saturation, whichever is greater
- ORP within 10 mV

DO measurements should be conducted using either a flow-through cell or an over-topping cell to minimize or reduce potential oxygenation of the sample.

Because groundwater temperature is generally not very sensitive in distinguishing between stagnant casing water and formation water and is subject to rapid changes during purging, its usefulness is subject to question for the purpose of determining parameter stability. Even if temperature is not used to determine stability during well purging, it is still advisable to record the sample temperature, along with the other groundwater chemistry parameters, during well purging, as it may be needed to interpret other parameter results. If used for stabilization, typical stabilization goals for temperature are within 3%.

ORP is not always used as a stabilization parameter since it may also be subject to rapid changes during the purging process; however, it may be measured and recorded during well purging. If used for stabilization, typical stabilization goals for ORP are ± 10 millivolts (mV).

Turbidity measurements during groundwater sampling are recommended to be <10 NTUs for at least three consecutive measurements to ensure a stable/representative groundwater sample. Obtaining a groundwater sample with low turbidity is especially important when sampling for PFAS. While a low turbidity level (<10 NTUs) may not always be feasible at every well, there are several BMPs that are recommended to help reduce the turbidity in groundwater samples. Please refer to Attachment D for further details regarding BMPs to manage turbidity in groundwater samples being analyzed for PFAS.

General Considerations

- Minimize presence of particulates through the use of low-flow groundwater sampling.
- Modify (typically decrease) purge rate as this may help reduce turbidity.
- Change pump intake depth if turbidity is not decreasing (but be sure to remain within the prescribed sampling interval for the well, e.g., within the screened interval).
- Ideally, collect a PFAS sample when turbidity is <10 NTUs.

- Consider no-purge samplers such as HydraSleeves™; the use of these samplers may depend on site-specific conditions (e.g., light non-aqueous phase liquid [LNAPL]) and local regulations.

2.2.4 Special Considerations During Purging

Wells Purged Dry/Purge Adequacy
For wells with slow groundwater recovery, attempts should be made to avoid purging the well dry. This may be accomplished by slowing the purge rate. As water enters a well that has been purged dry, the water may cascade down the sand pack and/or the well screen, potentially stripping VOCs that may be present, changing the oxidation state of the water, and/or potentially mobilizing soil fines into the re-accumulating water column.

However, even with slower purge rates, in some situations, a well may be pumped or bailed dry (evacuated) during the purging process. In these situations, evacuation generally constitutes an adequate purge and the well may be sampled following sufficient recovery (enough volume to allow filling of all sample containers). **It is not necessary that the well be evacuated three times before it is sampled unless required by the project planning documents.** Purging parameters should be measured and recorded during sample collection to serve as the measurements of record for the sampling event.

It is particularly important that wells be sampled as soon as possible after purging to maintain sample representativeness. If adequate volume is available upon completion of purging, the well should be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. If possible, sampling of wells that have a slow recovery should be scheduled so that they can be purged and sampled in the same day after adequate volume has recovered. Wells of this type should, unless it is unavoidable, not be purged at the end of one day and sampled the following day.

Temporary Monitoring Wells
Procedures used to purge temporary groundwater monitoring wells may differ from permanent wells, because samples collected from temporary wells have different DQOs to allow for immediate sample acquisition. Wells of this type may include standard well screens and risers placed in boreholes created by hand augering, power augering, or by drilling. Alternatively, they may consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15/16 sampler, or a Hydropunch® sampler.

Purging to address stagnant water may not necessarily apply to temporary wells, because stagnant water is not typically present. It is important to note, however, that the longer a temporary well is in place and not sampled, the more stagnant the water column may become, and the more appropriate it may be to apply, to the extent possible, standard permanent monitoring well purging criteria.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing saturated conditions, resulting primarily in increased turbidity. Therefore, the goal of purging, if conducted, may be to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low-stress purging techniques using variable-speed peristaltic pumps.

Sampling from temporary wells could result in groundwater samples with higher turbidity and could have the following consequences:

- Results may not be representative.
- Results for PFAS, metals, and certain PAHs may be biased high from high turbidity levels.
- Due to adsorption, turbid samples compared to clear samples can result in detection of different PFAS compounds (e.g., perfluorosulfonic acids [PFSAs] such as perfluorohexanesulfonic acid [PFHxS] and perfluorooctanesulfonic acid [PFOS] are more likely to be detected in a turbid sample).

Data collected from temporary wells are best used for screening level analyses and/or source characterization. Consider, in certain circumstances, collecting both a filtered and unfiltered sample from the temporary well for comparison. There would be no downside for the client – dissolved samples are likely more representative for temporary wells.

If possible, it is recommended to speak with the regulatory or governing agency and request permission to decant groundwater prior to sampling and/or have the laboratory handle the turbid sample in a manner which eliminates particulates.

2.2.5 Equipment Considerations for Purging

Monitoring well purging is accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. The pump of choice is usually a function of the purging approach (e.g., multiple-volume vs. low-flow), well diameter, the DTW, the total depth of the well, the amount of water that is to be removed during purging, the specific analytical testing program for the well, and the equipment previously used during purging and sampling of the well. A peristaltic pump is appropriate for purging whenever the head difference between the sampling location and the water level is less than the limit of suction (approximately 25’ to 30’) and the volume to be removed is reasonably small. For wells where the water level is below the limit of suction, and/or where there is a large volume of water to be purged, the variable-speed electric submersible pump, adjustable-rate bladder pumps, or positive displacement pumps would be appropriate. Bailers may also be used for purging in appropriate situations (e.g., shallow wells with small purge volumes); bailers are not suitable for low-flow purging.

The following subsections describe well evacuation devices that are most commonly used. Other devices are available but are not discussed in this SOP due to their limited use. Site-specific operating procedures should be developed in the case that an uncommon purge device is used.

2.2.5.1 Purging with a Suction Pump

There are many different types of suction pumps. They commonly include: centrifugal, peristaltic and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low-volume pump that incorporates a roller to squeeze flexible tubing, thereby creating suction. This tubing can be dedicated to a well for re-use or discarded. It is recommended that 1/4 inch or 3/8 inch (inner diameter) tubing be used to help ensure that the sample tubing remains filled with water and to prevent water from being aerated as it flows through the tubing. Purging procedures are as follows.

(a) Determine the volume of water to be purged as described in Section 2.2.1 or follow the low-flow approach described in Section 2.2.2 (applicable to peristaltic pumps only).

(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of pumps, tubing or other purging/sampling equipment with foreign materials.

(c) Assemble the pump, tubing and power source, if necessary, in accordance with manufacturer's specifications.

(d) Ensure that the pump tubing is set at the pre-determined pump intake depth as described in Section 2.2.2.

(e) Connect the discharge line from the pump to the flow-through cell for parameter measurements. Use a T-connection or valve prior to the flow-through cell to allow for collection of water for turbidity measurements, if necessary. Direct the discharge line from the flow-through cell to a five-gallon bucket (or equivalent) to contain the purge water for proper disposal. Verify the end of the tubing is not submerged in the purge bucket. Manage purge water as specified in the project-specific work plan.

(f) Measure the flow rate of the pump with a graduated container and stop watch. The pump pressure may need to be increased for discharge to occur. Record the volume of water collected for a period of one minute and calculate the flow rate as follows.

$$Flowrate\,(mL / min) = \frac{volume\ collected\ (mL)}{1\ minute}$$

(g) Measure the water level and record the flow rate and the water level. This should be performed every three to five minutes during purging. For low-flow purging, the flow rate should be adjusted to result in a rate between 100 to 500 mL/min; however, if drawdown of the well is observed, a slower flow rate may be necessary. If using a bladder pump, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL volatile organic analysis (VOA) vial, if possible.

(h) Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, adjust the rate accordingly or, if consistent with the purging and sampling objectives, lower the tubing further into the well and continue pumping.

(i) Using the water quality meter, take an initial reading of the required indicator parameters. All measurements, except turbidity, must be obtained using a transparent flow-through cell unless an unforeseen situation makes this impractical or inadvisable. Initially, turbidity may be elevated. Once turbidity has decreased to a measurable range, begin monitoring indicator parameters at approximately three to five minute intervals. Please note that flow-through cell size should be taken into account in conjunction with the flow rate to determine the length of time between water quality parameter readings. At least one flow-through cell volume should be turned over between readings. For example, if the flow through cell size is 500 mL and the flow rate is 100 mL/min, then it would be appropriate to measure water quality parameters every five minutes.

(j) Record the readings on the Groundwater Field Data Record. The monitoring probes must be submerged in water at all times. Record the indicator parameters, along with the water level, as described in Step (g) above. If removing a specified volume of water (e.g., three to five well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume. In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection. Stabilization criteria are discussed in Section 2.2.3.

Particulate build-up in the flow-through cell may impact indicator parameters. If the cell must be cleaned during pumping operations, continue pumping and disconnect the cell for cleaning, then reconnect and continue monitoring. Record the start and stop times, and describe the cleaning steps in the field book.

If indicator parameter stabilization is required and parameters have not stabilized after a pre-determined length of time, one of three options may be taken after consultation with the Project Manager:

1) continue purging until stabilization is achieved;

2) discontinue purging, do not collect any samples, and record in the field book and/or on the Groundwater Field Data Record the stabilization conditions and steps taken to attempt to achieve stabilization; or,

3) discontinue purging, collect samples and document attempts to achieve stabilization.

NOTE: If parameters do not stabilize, or turbidity remains greater than 10 NTU within the project-determined time range (refer to EPA or state-specific guidance), contact the Project Manager to develop a modified sampling approach.

(k) Record the volume of water purged on the Groundwater Field Data Record. Record the disposal method used for purge water in the field book.

(l) Once the required volume of water is removed (typically three to five well volumes) from the well and/or parameters are stabilized to the satisfaction of the project-specific work plan, proceed to Section 2.3, Post-purging Groundwater Sample Collection.

2.2.5.2 Purging with a Submersible Pump

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas. Electric pumps can be powered by a 12-volt DC rechargeable battery, or a 110- or 220-volt AC power supply. Those units powered by compressed gas (e.g., bladder pump) normally use a small electric controller that also needs a 12-volt DC battery or 110-volt AC power. They may also utilize compressed gas from bottles. Pumps differ according to the depth and diameter of the monitoring wells and the height of the potentiometric surface/water table (e.g., pressure head). It is recommended that 1/4-inch or 3/8-inch (inner diameter) tubing be used to help ensure that the sample tubing remains filled with water and to prevent water from being aerated as it flows through the tubing. Purging procedures are as follows.

(a) Follow steps (a) through (c) from Section 2.2.5.1.

(b) Non-dedicated purge/sampling vs. dedicated purge/sampling systems.

Dedicated systems: Pump has already been installed. Refer to historical monitoring well information and record the depth of the pump intake in the field book and/or on the Groundwater Field Data Record.

Non-dedicated systems: Determine the target depth of the pump intake as described in Section 2.2.2. Slowly lower the pump, safety line, and tubing into the well. The tubing should be cut to the desired length to assist in installing the pump. Measure the depth of the pump intake while lowering the tubing/pump into location. Record the pump intake depth in the field book and/or on the Groundwater Field Data Record. For deeper wells and large diameter wells, two staff members may be necessary to accomplish this task.

(c) Proceed to steps (e) through (j) in Section 2.2.5.1.

NOTE: Prior to recording the water quality indicator parameters, a minimum of one tubing volume should be purged. Note that this includes the volume of the flow-through cell.

2.2.5.3 Purging with a Bailer

(a) Determine the volume of water to be purged as described in Section 2.2.1.

(b) Take necessary precautions (e.g., laying plastic sheeting around the well) to prevent contamination of tubing or other purging/sampling equipment with foreign materials.

(c) Use a well-dedicated bailer (i.e., used exclusively for that well only), a decontaminated bailer or an unused, disposable bailer.

(d) Attach an appropriate length of (a) bailing line; (b) Teflon®-coated bailing wire; or (c) rope with Teflon®-coated stainless steel leader to reach the bottom of the well. Secure a knot or series of knots to the top of the bailer. Be sure to have additional length of line to facilitate handling of the bailer at the surface (typically 10 ft).

(e) Lower the bailer gently into the well until it reaches the water column and fills with water from the bottom. **Note:** It is recommended that the bailer be lowered into the water to a depth that prevents the water from entering the top of the bailer. This is done to prevent excess turbulence caused by filling from the bottom and the top simultaneously. Controlling the line attached to the bailer as it is lowered into the well is also important to prevent degassing of the water as the bailer impacts the water. For wells of greater depths it is common to utilize a hand-over-hand (windmill) approach using both hands to control longer lengths of line and prevent the loops in the line from tangling with one another. This procedure is simple to learn and saves a good deal of time by preventing tangles. Do not allow the bailing line or rope to become contaminated by surface soil.

(f) Once the bailer is full of water, gently withdraw the bailer from the well until it comes out of the top of the well. Be sure to control excess line in your hands to prevent the rope and bailer from touching the ground, and then grasp the bailer as it appears at the top of the well.

(g) Immediately pour the water into a vessel for water quality measurements and record the measurements in the field book or on the Groundwater Field Data Record (at the project-required frequency). Otherwise, pour water into a five-gallon bucket or other vessel to track the volume purged. As a general rule, standard two-inch bailers are able to hold about one liter of water when full. This process will have to be repeated several times to complete adequate purging of the well (i.e., three to five well volumes).

(h) Record the volume of water purged on the Groundwater Field Data Record. Record the disposal method used for purge water in the field book.

(i) Once the required volume of water is removed (typically three to five well volumes) from the well and/or parameters are stabilized to the satisfaction of the project-specific work plan, proceed to Section 2.3, Post-purging Groundwater Sample Collection.

2.3 Post-purging Groundwater Sample Collection

(a) New, disposable gloves should be donned immediately prior to sample collection and should be changed at any point that their cleanliness becomes compromised during sample collection.

(b) If using a submersible or peristaltic pump, maintain the same flow rate as used during purging. Disconnect the pump tubing from the flow-through cell or sample from the T-connector, if used. Samples must be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. This is critically important to avoid cross-contamination between wells.

(c) If using bottom-filling bailers,

- Slowly lower the bailer into the well until it is submerged to the point where water does not enter the top (i.e., bottom-filling).
- Retrieve the bailer. The first bailer recovered after well purging must be used for sample collection.

2.3.1 Sample Collection Order

Fractions of the groundwater sample should be collected in the following order (i.e., decreasing volatility) unless otherwise specified in the project-specific work plan:

1. VOCs;
2. Semi volatile organic compounds (SVOCs);
3. Other organic parameters;
4. Unfiltered inorganic constituents (e.g., total metals);
5. Filtered inorganic constituents (e.g., dissolved metals); and
6. Other constituents.

During sample collection, allow the water to flow directly down the side of the sample container without allowing the tubing to touch the inside of the sample container or lid in order to minimize aeration and turbulence and maintain sample integrity. The tubing should remain filled with water.

2.3.2 VOC Sample Collection

<u>Collection of VOCs/Volatile Petroleum Hydrocarbons (VPH):</u> Samples for VOCs will be collected first unless they are being collected by the "straw" method described in Section 1.6.2 (d), and the sample vial must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken to not flush any preservative out of the vial when topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected. Note: Extra VOC vials should be obtained prior to the sampling event in case this situation occurs.

NOTE: When using a bladder pump, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 ml VOA vial, if possible.

When acid preservation is used for the collection of VOCs, the acid must be added to the vials before sample collection; however, in most cases 40-ml VOA vials come pre-preserved. If a pre-preserved vial effervesces upon the addition of sample, the acid preservative can be rinsed out of the vial with sample water and then used to collect the sample. The laboratory should be made aware that the affected sample will not be acid-preserved as this may affect the sample holding time. Note effervescence in the field book for future reference.

2.3.3 Non-VOC Sample Collection

Completely fill the remaining sample containers for all non-VOC analyses.

Preserve the non-VOC samples in accordance with method and project-specific requirements following sample collection if the sample containers are not pre-preserved.

NOTE: Pre-preserved vials may be supplied by the laboratory, depending on the program.

2.3.4 Field Filtering

Depending upon project and regulatory requirements, field filtering may be performed for non-VOC analyses. An in-line filter should be fitted at the end of the discharge tubing and the sample should be collected after the filter. Pre-rinse the in-line filter by allowing a minimum of 0.5 to 1 liter of groundwater from the well to pass through the filter prior to sampling. Ensure the filter is free of air bubbles prior to collecting samples. Preserve the filtered water sample immediately or directly fill pre-preserved containers (if provided). Clearly note "filtered" or "dissolved" on sample label and COC document.

2.4 Groundwater Sample Collection Without Purging (Passive Sampling)

Passive sampling can be defined as the free flow of contaminants from the media being sampled to a receiving phase in a sampling device. Depending upon the sampler, the receiving phase can be a solvent (e.g., water), chemical reagent, or porous adsorbent (e.g., activated carbon). While there are many different types of passive samplers, most have a barrier between the medium being sampled and the receiving phase. The barrier determines the sampling rate that contaminants are collected at a given concentration and can be used to selectively permit or restrict various classes of chemicals from entering the receiving phase.

There are three generic forms of passive (no purge) samplers: thief (grab) samplers, diffusion (equilibrium) samplers, and integrating (kinetic) samplers; however, this SOP focuses on the more commonly used diffusion (equilibrium) samplers.

Passive samplers are deployed down a well to the desired depth within the screened interval or open borehole to obtain a discrete sample without using pumping or a purging technique. Most samplers are able to be stacked to obtain samples at multiple depths. Some samplers can also be used to measure contaminants in groundwater as it enters a surface water body.

Diffusion, or equilibrium, samplers are devices that rely on diffusion of the analytes to reach equilibrium between the sampler fluid and the well water. Samples are time-weighted toward conditions at the sampling point during the latter portion of the deployment period. The degree of weighting depends on analyte and device-specific diffusion rates. Typically, conditions during only the last few days of sampler deployment are represented. Depending upon the contaminant of concern, equilibration times range from a few days to several weeks. Diffusion samplers are less versatile than grab samplers as they are not generally effective for all chemical classes.

Both the diffusion and integrating samplers depend upon permeation or diffusion through barriers that hold the receiving phase. This diffusion process is chemical and barrier specific. Diffusion samplers are commonly known as PDBs or rigid porous polyethylene (RPP) samplers. PDBs may be used to sample for VOCs, and RPPs may be used to sample for various organic and inorganic constituents. PDBs must be allowed to remain in the well for a sufficient period of time to allow the deionized water in the sampler to come into equilibrium with the constituents in the ambient groundwater.

Some regulatory agencies allow groundwater samples to be collected without purging the well. This may be accomplished by suspending a passive sampler in the well for a period of time appropriate for the type of passive sampler being used. It is important to confirm that the chosen sampler is compatible with the contaminants of concern including all VOCs of interest at the site.

The procedure for diffusion passive samplers is as follows:

(a) Passive samplers are deployed at a predetermined depth across the well screen. Typically, the initial sampling event may deploy multiple passive samplers across five-foot intervals of saturated well screen to observe any potential stratification. Long-term sampling depths typically target a zone of higher concentration, if present.

(b) New passive samplers are attached via PVC cable ties to a tether (a pre-made marine-grade polyethylene rope or stainless steel cable with a weight at the bottom) that is then suspended within the well. There should be sufficient well screen saturation within the well to completely cover the passive sampler. For VOCs, it is recommended that there should be several feet of groundwater above the top of the PDB.

(c) The passive sampler should be allowed to equilibrate with groundwater for an appropriate period of time (e.g., at least two weeks for PDB samplers). Longer equilibration times may be necessary in lower permeability formations. Once sufficient time for equilibration has passed, the PDB samplers can be retrieved when convenient.

(d) Raise the passive sampler to the surface using a tether reel. Examine the surface of the passive sampler for evidence of algae, iron, or other coatings, and for tears to the membrane. Note observations in the field book. If tears are present and water is leaking out, the sample is not considered viable. Contact the Project Manager.

(e) Detach the passive sampler from the tether.

(f) Remove excess beaded water from the passive sampler with a clean gloved hand, running top to bottom; this is to minimize the contact of beaded water with water in the passive sampler.

(g) Use a small diameter discharge tube (<0.15 inch diameter to reduce volatilization) and pierce near the bottom, allowing water to smoothly flow into the VOA vial. Tilting the passive sampler will control the flow rate. The VOA vials must be filled within the first several minutes of passive sampler retrieval. **Note**: sample vials should be prepared and opened on a stable surface or holding device such as a foam pack. Decanting sample from passive samplers into containers requires techniques that may require some practice and patience. Refer to Section 2.3.2 for special circumstances regarding the filling of VOA vials.

(h) A small amount of water may remain within the passive sampler after filling the VOA vials and can be used for field parameter measurements if required.

(i) Dispose of the passive sampler after use.

2.5 Post-sampling Activities

(a) Cease pumping and, if system is non-dedicated, disassemble and decontaminate the purging and sampling equipment. Verify the end of the tubing is not submerged in the purge bucket prior to turning off the pump.

(b) Dispose of the bailer (if disposable) and/or rope and/or other disposable equipment in accordance with the project-specific work plan or store the bailer in a plastic bag for transport to the site decontamination area.

(c) Dispose of the empty passive sampler and/or rope and/or other disposable equipment in accordance with the project-specific work plan, or store the empty passive sampler in a plastic bag for transport to the site decontamination area.

(d) Replace the well cap and well cover on the well and lock the outer casing (if present).

(e) Label each sample. If the labels are covered with clear tape, ensure this is not performed for VOA vials.

(f) Place all samples in a cooler with ice.

(g) Ensure samples are delivered to the laboratory well before the required holding time expires.

(h) Consult the project-specific work plan to determine if a calibration check is required at the end of the day for the water quality parameters.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager.

Each project must consider investigation-derived waste disposal methods and have a plan in place prior to performing the field work. Provisions must be in place as to what will be done with investigation-derived waste. If investigation-derived waste cannot be returned to the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The collection of QC samples is dependent upon the DQOs, not all QC samples will be required for all projects. Project-specific work plans should be consulted to determine the required frequency of QC sample collection.

4.1 Field Duplicates

The following procedures should be used for collecting field duplicates of groundwater samples:

(a) For QC purposes, each duplicate sample will be typically submitted to the laboratory as a “blind” duplicate sample, in that a unique sample identification not tied to the primary sample identification will be assigned to the duplicate (e.g., DUP-01). Standard labeling procedures used for groundwater sampling will be employed; however, a sample collection time will not be included on the sample label or the COC form. The actual source of the duplicate sample will be recorded in the field book and/or on the Groundwater Field Data Record.

(b) Each duplicate sample will be collected simultaneously with the actual sample by alternately filling sample and duplicate bottles. Following the order of collection specified for each set of containers (VOCs, SVOCs, other organic parameters, unfiltered inorganic constituents, and filtered inorganic constituents), the duplicate sample containers will be alternately filled with groundwater for each parameter.

(c) All collection and preservation procedures outlined for groundwater sampling will be followed for each duplicate sample.

4.2 Equipment Blanks

Equipment blanks include reagent water that is run through the bailer (if not disposable), rope, leader line, decontaminated pump, a representative section of the pump’s tubing, or any other piece of sampling equipment that may have come in contact with the sample. The equipment blanks are collected and preserved in the same sample containers as field samples. If dedicated or disposable systems are used, equipment blanks are not required, although an initial blank could be performed to demonstrate that the dedicated equipment is clean prior to use. If only dedicated tubing is used, the equipment blank will include only the pump in subsequent sampling events. A passive sampler is considered a dedicated device and no equipment blank is required.

Ideally, the reagent water should come from the laboratory and be certified clean. If not certified and/or if not from the laboratory performing the analyses, a separate water blank that has not run through the sampling equipment should be sent to the laboratory for analysis.

4.3 Trip Blanks

Trip blanks will be used to check for potential contamination of VOCs via migration during storage and shipping. Trip blanks typically consist of two to three 40 mL VOA vials filled with analyte-free water and preserved with hydrochloric acid (HCl) to pH <2 SU. Trip blank containers are usually supplied pre-filled by the laboratory. Trip blanks are typically submitted to the laboratory at a frequency of one per cooler for coolers that contain samples for VOC and/or VPH analysis. Trip blanks are analyzed by the laboratory for VOCs and/or VPH, depending on field sample analyses.

4.4 Field Blanks

Field blanks consists of analyte free water exposed to the atmosphere during field sample collection. The water is containerized in an appropriate bottle and preservative for the analytical suite and shipped to the laboratory with the other field samples. The results are used to assess whether or ambient/surrounding air conditions may have influenced analytical results.

4.5 MS/MSDs and MS/Duplicates

MSs are an additional analysis of a sample spiked by the laboratory with a subset or all of the target analytes and are used to demonstrate the accuracy of analytical methods for a given matrix. MSDs are an additional analysis of a sample spiked with a subset or all of the target analytes and are also used to demonstrate the accuracy of analytical methods for a given matrix. MS/MSDs also provide a measure of analytical precision for a given matrix. Duplicates are an additional analysis of a sample and are used to demonstrate the precision of analytical methods for a given matrix.

Triplicate volumes of a field sample must be collected in order for the laboratory to have enough volume to perform the MS/MSD analyses for organic parameters. Duplicate volumes of a field sample must be collected in order for the laboratory to have enough volume to perform MS/Duplicate analyses for inorganic parameters. The sample designated for MS/MSD or MS/Duplicate analyses should be noted in the Comments column of the COC document.

4.6 Temperature Blanks

Temperature blanks consist of a sample container filled with non-preserved water (potable or distilled) and typically are included in all coolers that contain samples that require temperature preservation. These may be added to the coolers by the field team if not provided by the laboratory. Temperature blanks must remain inside the coolers on ice during the sampling process.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

Record the sample location, sample identification, and date and time of collection in the field book and/or the Groundwater Field Data Record. The Groundwater Field Data Record (Attachment A) should be used to record the following information:

- Volume of each sample
- Sample identification number
- Sample location (sketch of the sample point)
- Time and date sample was collected
- Personnel performing the task
- Volume of water removed
- Purging time
- Flow rate during purging and sampling
- Weather conditions during sampling (e.g. temperature, wind)
- Field parameters such as water level, pH, temperature, conductivity, turbidity, ORP, and DO
- Sample collection equipment and method used
- Decontamination procedures
- Analytical parameters
- Preservation method and amount of preservative

All sample numbers must be documented on the COC form that accompanies the samples during shipment. Any deviations from the records management procedures specified in the project-specific work plan must be approved by the Project Manager and documented in the field book.

For projects using TRC's Environmental Data Management System (EDMS), the project team's Data Manager can assist in planning sampling events to prepopulate bottle labels and chain of custody forms and keep track of COC forms and laboratory EDDs generated for the project. The TRC EDMS system has a completeness report that can track the samples collected and the analyses performed as data are received from the laboratory.

TRC's EDMS includes an approved electronic mobile field data collection system (e.g., EQuIS Collect, Fulcrum, or esri Collector). A TRC Data Manager must be assigned for coordination and setup of the respective application to be used by the project team. The details and specifications of the sampling event should be discussed with the TRC Data Manager during the project kickoff meeting. The TRC Data Manager will work with the TRC project team and field personnel on configuring the system for efficient use in the field with pre-populated, project-specific menus following TRC's best practices for sample ID naming conventions compatible with TRC's EDMS.

For projects that do not use electronic mobile field data collection systems field notes containing sample IDs, sample date, sample matrix, sample start depth, sample end depth, sample method, sample event task code, and sample purpose, along with GPS coordinates for each sample location ID should be transcribed into TRC's standard Location and Field Sample EDDs for import into TRC's EDMS as soon as the groundwater sampling event is completed, preferably the same day in order to get data into the EDMS in as near real time as possible.

6.0 REFERENCES

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USEPA. May 2002. *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. EPA/542-S-02-001. USEPA Office of Solid Waste and Emergency Response.

USEPA. September 2004. Field Sampling Guidance Document #1220: Groundwater Well Sampling. USEPA Region 9 Laboratory Richmond, California.

USEPA. April 22, 2014. Passive (No Purge) Samples. http://www.clu-in.org/characterization/technologies/default.focus/sec/Passive_%28no%20purge%29_Samplers/cat/Overview/

USEPA, September 19, 2017. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells*. USEPA Region 1, Rev. 4.

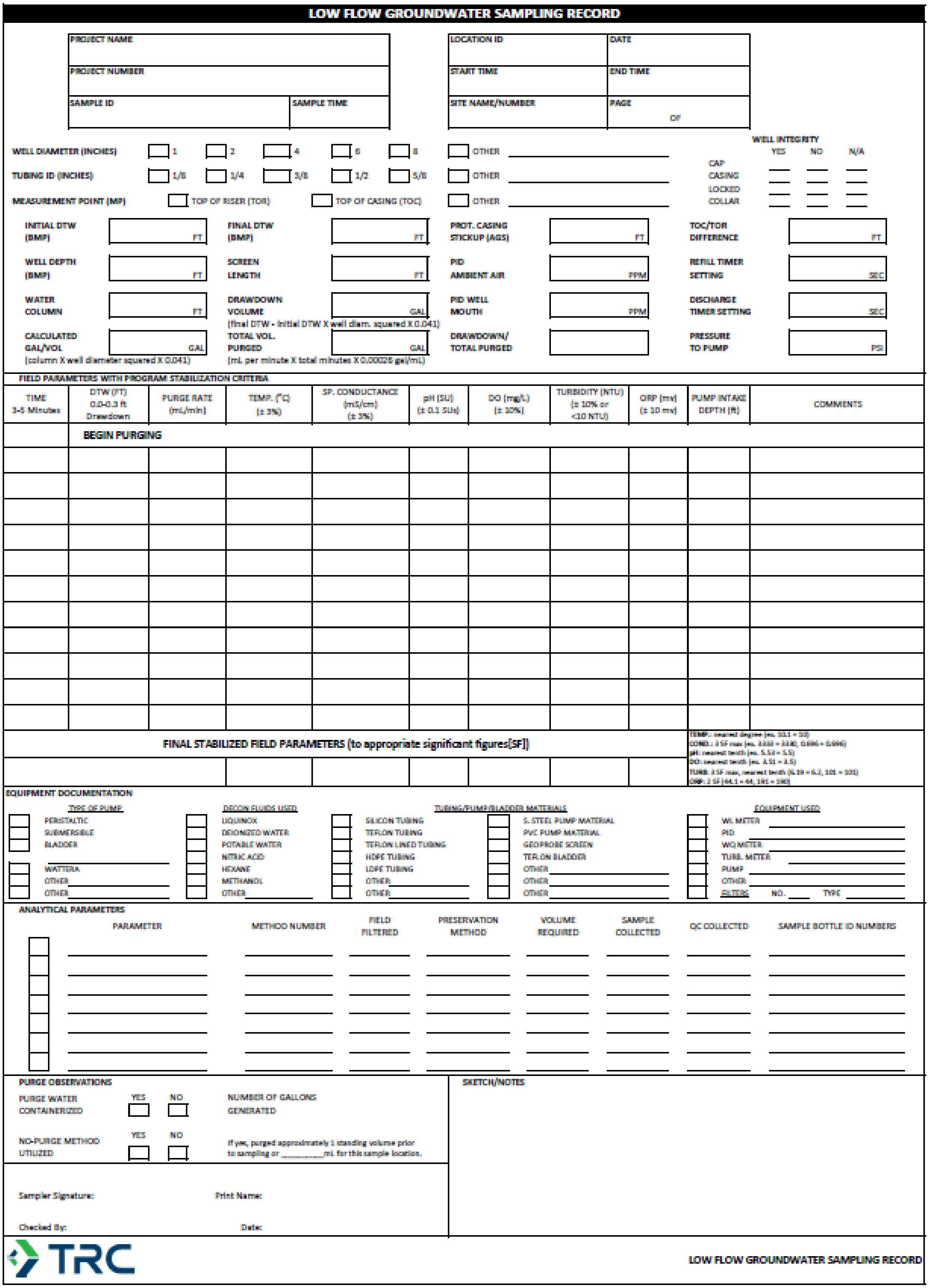
USEPA. April 26, 2017. *Groundwater Sampling.* SESDPROC-301-R4. USEPA Region 4, Science and Ecosystem Support Division. Athens, Georgia.

7.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
0	AUGUST 2014	NOT APPLICABLE
1	JULY 2016	ADDED ATTACHMENT D TO ACCOMMODATE SOP MODIFICATIONS REQUIRED WHEN SAMPLING FOR PFCS; CHANGED NAMING CONVENTION FOR SOP FROM RMD TO ECR.
2	NOVEMBER 2016	ADDED ADDITIONAL INFORMATION REGARDING PFAS.
3	JANUARY 2020	TRC RE-BRANDING; ADDED FIELD BLANKS TO SECTION 4
4	AUGUST 2020	ADDITIONAL PFAS-SPECIFIC INFORMATION INCLUDED
5	MARCH 2022	ADDED ADDITIONAL INFORMATION REGARDING PFAS AND TURBIDITY. EDITED PROCEDURES FOR CONSISTENCY WITH UPDATED EPA LOW-FLOW SAMPLING PROCEDURES. REMOVED ATTACHMENT A (SELECT STATE REQUIREMENTS).

Attachment A:

Example Groundwater Field Data Records



LOW FLOW GROUNDWATER SAMPLING RECORD

PROJECT NAME		LOCATION ID	DATE
PROJECT NUMBER		START TIME	END TIME
SAMPLE ID	SAMPLE TIME	SITE NAME/NUMBER	PAGE OF

WELL DIAMETER (INCHES) ☐ 1 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ OTHER ____________

TUBING ID (INCHES) ☐ 1/8 ☐ 1/4 ☐ 3/8 ☐ 1/2 ☐ 5/8 ☐ OTHER ____________

MEASUREMENT POINT (MP) ☐ TOP OF RISER (TOR) ☐ TOP OF CASING (TOC) ☐ OTHER ____________

WELL INTEGRITY	YES	NO	N/A
CAP	___	___	___
CASING	___	___	___
LOCKED	___	___	___
COLLAR	___	___	___

INITIAL DTW (BMP)	FT	FINAL DTW (BMP)	FT	PROT. CASING STICKUP (AGS)	FT	TOC/TOR DIFFERENCE	FT
WELL DEPTH (BMP)	FT	SCREEN LENGTH	FT	PID AMBIENT AIR	PPM	REFILL TIMER SETTING	SEC
WATER COLUMN	FT	DRAWDOWN VOLUME (final DTW - initial DTW X well diam. squared X 0.041)	GAL	PID WELL MOUTH	PPM	DISCHARGE TIMER SETTING	SEC
CALCULATED GAL/VOL (column X well diameter squared X 0.041)	GAL	TOTAL VOL. PURGED (mL per minute X total minutes X 0.00026 gal/mL)	GAL	DRAWDOWN/ TOTAL PURGED		PRESSURE TO PUMP	PSI

FIELD PARAMETERS WITH PROGRAM STABILIZATION CRITERIA

TIME 3-5 Minutes	DTW (FT) 0.0-0.3 ft Drawdown	PURGE RATE (mL/min)	TEMP. (°C) (± 3%)	SP. CONDUCTANCE (mS/cm) (± 3%)	pH (SU) (± 0.1 SUs)	DO (mg/L) (± 10%)	TURBIDITY (NTU) (± 10% or <10 NTU)	ORP (mv) (± 10 mv)	PUMP INTAKE DEPTH (ft)	COMMENTS
	BEGIN PURGING									
FINAL STABILIZED FIELD PARAMETERS (to appropriate significant figures[SF])									TEMP.: nearest degree (ex. 10.1 = 10) COND.: 3 SF max (ex. 3333 = 3330, 0.696 = 0.696) pH: nearest tenth (ex. 5.53 = 5.5) DO: nearest tenth (ex. 3.51 = 3.5) TURB: 3 SF max, nearest tenth (6.19 = 6.2, 101 = 101) ORP: 2 SF (44.1 = 44, 191 = 190)	

EQUIPMENT DOCUMENTATION

TYPE OF PUMP
☐ PERISTALTIC
☐ SUBMERSIBLE
☐ BLADDER
☐ WATTERA
☐ OTHER ____________
☐ OTHER ____________

DECON FLUIDS USED
☐ LIQUINOX
☐ DEIONIZED WATER
☐ POTABLE WATER
☐ NITRIC ACID
☐ HEXANE
☐ METHANOL
☐ OTHER ____________

TUBING/PUMP/BLADDER MATERIALS
☐ SILICON TUBING
☐ TEFLON TUBING
☐ TEFLON LINED TUBING
☐ HDPE TUBING
☐ LDPE TUBING
☐ OTHER ____________
☐ OTHER ____________
☐ S. STEEL PUMP MATERIAL
☐ PVC PUMP MATERIAL
☐ GEOPROBE SCREEN
☐ TEFLON BLADDER
☐ OTHER ____________
☐ OTHER ____________
☐ OTHER ____________

EQUIPMENT USED
☐ WL METER ____________
☐ PID ____________
☐ WQ METER ____________
☐ TURB. METER ____________
☐ PUMP ____________
☐ OTHER ____________
☐ FILTERS NO. ____ TYPE ____________

ANALYTICAL PARAMETERS

	PARAMETER	METHOD NUMBER	FIELD FILTERED	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	QC COLLECTED	SAMPLE BOTTLE ID NUMBERS
☐								
☐								
☐								
☐								
☐								
☐								
☐								

PURGE OBSERVATIONS

PURGE WATER CONTAINERIZED YES ☐ NO ☐ NUMBER OF GALLONS GENERATED

NO-PURGE METHOD UTILIZED YES ☐ NO ☐ If yes, purged approximately 1 standing volume prior to sampling or ________mL for this sample location.

SKETCH/NOTES

Sampler Signature: Print Name:

Checked By: Date:

TRC LOW FLOW GROUNDWATER SAMPLING RECORD

Groundwater Sampling Record for Organics (For Wells with Passive Diffusion Bags)

Project Name/No:

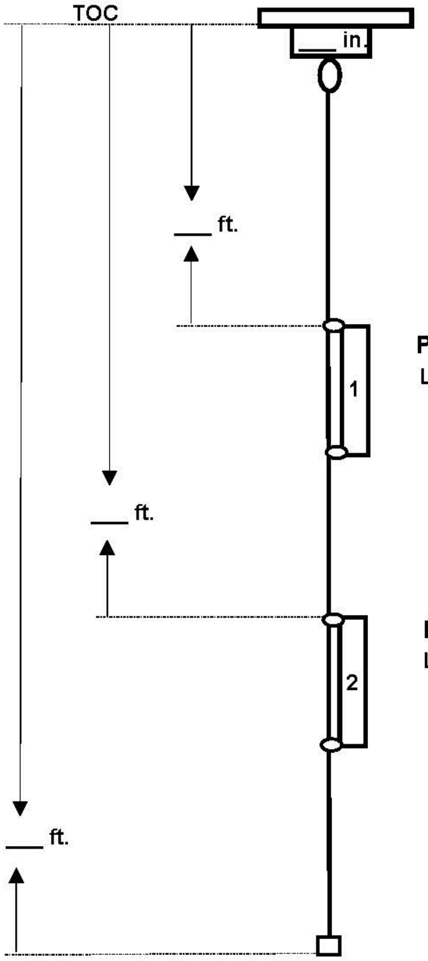
Well ID:

Installation of PDBs:

TRC Personnel: ______________________
Date: ______________________
Time: ______________________
DTW (ft): ______________________

Sampling of PDBs:

TRC Personnel: ______________________
Date: ______________________
DTW (ft): ______________________



PDB #1
Length: ___ in.

Sample ID: ______________________
Sample Time: ______________________
Evidence of algae, iron or other coatings?: ____________

PDB #2
Length: ___ in.

Sample ID: ______________________
Sample Time: ______________________
Evidence of algae, iron or other coatings?: ____________

Measured well depth during tether installation: ___ ft.

Field Notes:

Rev: April 2014

Attachment B: SOP Fact Sheet

PURPOSE AND OBJECTIVE

The objective of groundwater sampling is to obtain a representative sample of water from a saturated zone or groundwater-bearing unit (i.e., aquifer) with minimal disturbance of groundwater chemistry. This requires that the sample being collected is representative of groundwater within the formation surrounding the well bore as opposed to stagnant water within the well casing or within the filter pack immediately surrounding the well casing.

There are three general approaches to groundwater purging/sampling that can be used to obtain a representative groundwater sample for analysis: 1) the low-flow or micropurge method where the mixing of the stagnant water is minimized using low-flow pumping rates during the collection of the groundwater sample; 2) the multiple well volume removal approach in which the stagnant water is removed from the well and the filter pack prior to sample collection; and 3) the passive sampler procedure where water quality equilibration with the surroundings is achieved through deployment of the passive sampler for a sufficient amount of time prior to sampling. All three approaches are summarized in this document.

WHAT TO BRING

- Site-specific HASP and field book
- Project-specific work plan
- Figure or site map showing well locations and table showing well construction details
- Field data sheets from previous sampling event
- Well wrenches, ratchet set, and turkey baster to remove standing water from flushmount manholes
- Bolt cutters, padlocks and keys
- Water level meter of sufficient length
- Decontaminated pump, control box, power source (i.e., battery, generator, etc.)
- Tubing (Teflon®, Teflon®–lined polyethylene, or HDPE, type dependent upon project objectives)
- Multi-parameter instrument and flow-through cell (typically should include: pH, temperature, conductivity, ORP, and DO)
- Turbidity meter
- Equipment decontamination supplies (refer to ECR SOP 010, *Equipment Decontamination*)
- Appropriate PPE
- Field book
- Sample bottleware, labeled cooler, ice, temperature blank and blank COC forms; may also need field blank bottles and reagent-grade water
- Zip-loc® plastic bags
- Groundwater field data records
- Graduated cylinder and stop-watch
- Rope for tying off pump at desired intake
- Indelible marking pens
- Bubble wrap
- 5-gallon bucket(s)

<u>As Needed:</u>

- Calibrated PID or FID for well mouth readings
- Oil/water interface probe of sufficient length
- Drums for purge water, grease pen and adhesive drum labels; appropriate crescent or socket wrench
- Filtration equipment, if required (0.45 micron filters, or as otherwise required for the project)
- Other non-routine PPE such as Tyvek coveralls or respirators
- Traffic cones
- Field calibration sheets and calibration solutions

OFFICE

- Prepare/update the site-specific HASP; make sure the field team is familiar with the most recent version.
- Review the project-specific work plan with the Project Manager and/or the field team leader. Discuss the following:
  - Communication procedures;
  - Sampling order and designation;
  - Collection and sample method;
  - Analytical parameters, holding times and turn-around times;
  - Laboratory (contact/shipping info, COC, billing references);
  - Purge water management (Drums? Discharge to ground?);
  - QC sample collection; and
  - Decontamination procedures.
- Verify that monitoring wells will be accessible and/or coordinate to have a site contact available to assist.
- Make sure that monitoring well sample designations and QC sample designations/frequency are understood.
- Confirm that all necessary equipment is available in-house or has been ordered. Rental equipment is typically delivered the day before fieldwork is scheduled. Prior to departure or mobilization to site, test equipment and make sure it is in proper working order. Have rental equipment supplier contact information available for use in field.
- Review sample bottle order for accuracy and completeness and damaged bottles.
- Discuss specific documentation and containerization requirements for investigation-derived waste disposal with the Project Manager

ON-SITE

- Review the HASP with all field personnel, sign acknowledgement form and conduct Health & Safety tailgate meeting. Check in security, site contact, or designated person per project-specific work plan or Project Manager.
- Make sure appropriate PPE is worn by all personnel and work area is safe (i.e., utilize traffic cones; minimize interference with on-site activities and pedestrian traffic, etc.)
- Calibrate equipment (if applicable) and record all rental equipment serial numbers in the field book.
- Open wells to allow equilibration and collect full round of water level gauging before sampling is started (unless otherwise noted in project-specific work plan). Record the following:
  - Well mouth PID/FID reading (if necessary);
  - Depth to product and water;
  - Total well depth (not required if free product is measured unless otherwise noted in project-specific work plan); and
  - Condition of wells (i.e., lid broken, pad cracked, rusted lock) and collect photographs if site allows camera use.

SAMPLING PROCEDURES: PRE-PURGE

- Decontaminate pump.
- Take water level measurements prior to pump installation.
- Connect sampling tubing to pump outlet and lower to sample depth; **ALWAYS USE ROPE TO SECURE PUMP TO SURFACE.**
- The pump intake depth(s) for each well should be specified in the project-specific work plan (either specific depth or mid-point of saturated well screen).
- For wells with screened or open borehole intervals greater than 10 feet in length, sampling of multiple intervals may be required.
- If samples are to be collected from multiple depths from an individual well, always collect a sample from the shallowest depth first and leave enough extra tubing coiled at the surface so the pump can be lowered to the next interval; always try to cover excess tubing present at the surface to prevent the air temperature from influencing the measurements and exposure to contaminants on the ground;
- Be careful not to let the pump hit the bottom of the well.
- If using Teflon®-lined tubing, be sure that the lining does not bunch up around the connection. This will restrict water flow and make the pump work harder than it has to.
- Calibrate (or perform a calibration check on) all field monitoring equipment on the same day before collecting groundwater samples. Refer to TRC SOPs and manufacturer's equipment calibration instructions. A calibration check may also be required during or at the end of each sampling day. Consult the project-specific work plan.

SAMPLING PROCEDURES: MULTIPLE-VOLUME PURGING

- The multiple-volume purging approach is typically performed using bailers or submersible or peristaltic pumps. In the multiple-volume purging approach, there are two measurements used to determine adequate purge volume removal prior to sample collection: 1) purge volume and 2) field parameter stabilization.
- The field parameters should be recorded at regular volumetric intervals. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters.
- Prior to purging a well, the amount of water inside the well riser and well screen (i.e., water column) should be determined, if possible. Once this information is known, the well volume can be calculated using the following equation:

  Well Volume (V) = πr2 h
- For volumetric purging, an adequate purge is typically achieved when 3 to 5 well volumes have been removed.
- For volumetric purging, it is suggested that field readings are collected every ½ well/well screen volume after an initial 1 to ½ well volumes are purged. The volume removed between readings can be adjusted as well-specific information is developed.
- If removing a specified volume of water (e.g., 3 well volumes) has been determined to be suitable for purging, sampling can commence immediately upon achieving the required purge volume.
- In other cases, where specified in the project-specific work plan, stabilization of field parameters must be documented prior to sample collection.
- If, after 3 well volumes have been removed, the field parameters have not stabilized, additional well volumes (up to a total of 5 well volumes), should be removed.
- If the parameters have not stabilized within five well volumes, it is at the discretion of the Project Manager whether or not to collect a sample or to continue purging.

SAMPLING PROCEDURES: LOW-FLOW PURGING

- The low-flow purging approach is typically performed using peristaltic pumps or submersible pumps. Low-flow purging (also referred to as low-stress purging, low-volume purging, or Micropurging®) is a method of well purging/sampling that minimizes the volume of water withdrawn from a well in obtaining a representative sample.
- When performing low-flow purging and sampling, it is recommended that the pump intake be set in the center of the well screen interval to help prevent disturbance of any sediment at the bottom of the well.
- To begin purging, the pump should be started at the lowest pressure/power flow rate setting (e.g., 100 mL/min) and then slowly increased until water begins discharging. Monitor the water level and slowly adjust the pump speed until there is little or no drawdown or drawdown has stabilized. The pump pressure/power may need to be increased for discharge to occur.
- The stabilization of drawdown should be documented. Measure and record the flow rate and water level every 3 to 5 minutes during purging. The flow rate should be reduced if drawdown is greater than 0.3 feet over three consecutive 3 to 5 minute interval readings.
- Attempts should be made to avoid pumping a well dry

FIELD PARAMETER STABILIZATION DURING PURGING

- Generally, an adequate purge with respect to the groundwater chemistry is achieved when stability for at least three consecutive measurements is achieved. See stability requirements in Appendix A of this SOP.

POST-PURGE GROUNDWATER SAMPLE COLLECTION

- New, disposable gloves should be donned immediately prior to sample collection and should be changed at any point that their cleanliness becomes compromised during sample collection.
- If using a submersible or peristaltic pump, maintain the same flow rate as used during purging. Disconnect the pump tubing from the flow-through cell. Samples must be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. This is critically important to avoid cross-contamination between wells.
- If using bottom-filling bailers, slowly lower the bailer into the well until it is submerged to the point where water does not enter the top (i.e., bottom-filling). Retrieve the bailer. The first bailer recovered after well purging must be used for sample collection.
- Collect groundwater samples in the following order:
  - VOCs;
  - SVOCs;
  - Other organic parameters;
  - Unfiltered inorganic constituents; and
  - Filtered inorganic constituents.
- Note that sample vials for VOCs must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, see Section 2.3.2 of this SOP.
- Preserve the non-VOC samples in pre-preserved vials supplied by the laboratory or if the sample containers are not pre-preserved, preserve the non-VOC samples in accordance with method and project-specific requirements.
- Depending upon project requirements, filtering may be performed. See procedures listed in Section 2.3.4 of this SOP. Clearly note "filtered" on the sample label and the COC.
- Make sure all sample bottles are appropriately labeled.
- Package the samples with bubble wrap and/or organic absorbent, as necessary. Place into shipping container and cool to 4°C and complete the COC.
- Decontaminate non-disposable sampling equipment between uses.

PASSIVE SAMPLING

- There are three generic forms of passive (no purge) samplers: thief (grab) samplers, diffusion (equilibrium) samplers, and integrating (kinetic) samplers. However, this SOP focuses on the more commonly used diffusion (equilibrium) samplers. Be aware of sample holding times, and arrange for samples to be in the laboratory's possession accordingly.
- Passive samplers are deployed at a predetermined depth across the well screen. Typically, the initial sampling event may deploy multiple passive samplers across 5-foot intervals of saturated well screen to observe any potential stratification. Long-term sampling depths typically target a zone of higher concentration, if present.
- New passive samplers are attached via PVC cable ties to a tether (pre-made marine-grade polyethylene rope or stainless steel cable with a weight at the bottom) that is then suspended within the well.
- The passive sampler should be allowed to equilibrate with groundwater for an appropriate period of time (e.g., at least 2 weeks for PDB samplers).
- Raise the passive sampler to the surface using a tether reel. Examine the surface of the passive sampler for evidence of algae, iron, or other coatings, and for tears to the

membrane. Note observations in the field book. If tears are present and water is leaking out, the sample is not considered viable. Contact the Project Manager.

- Detach the passive sampler from the tether.
- Remove excess beaded water from the passive sampler with a clean gloved hand, running top to bottom; this is to minimize the contact of beaded water with water in the passive sampler.
- Use a small diameter discharge tube (<0.15 inch diameter to reduce volatilization) and pierce near the bottom, allowing water to smoothly flow into the VOA vial. The VOA vials must be filled within the first several minutes of passive sampler retrieval.
- A small amount of water may remain within the passive sampler after filling the VOA vials and can be used for field parameter measurements if required.
- Dispose of the passive sampler after use.
- Note that sample vials for VOCs must be filled so a meniscus forms over the mouth of the vial. This ensures no air bubbles or headspace will be formed after it has been capped. Ensure the lack of air bubbles and headspace by turning the vial upside down and tapping it lightly. If any bubbles are observed, see Section 2.3.2 of this SOP.
- Make sure all sample bottles are appropriately labeled.
- Package the samples with bubble wrap and/or organic absorbent, as necessary. Place into shipping container and cool to 4ºC and complete the COC.

DOS AND DO NOTS OF GROUNDWATER PURGING AND SAMPLING

DOs:

- DO have the following items when going into the field: site-specific work plan; site-Specific HASP; appropriate PPE (steel-toed boots, safety glasses, etc.) as required by the Site-Specific HASP; field book and a water-proof ball-point pen; business cards; nitrile gloves; well keys; copies of well installation forms and field data forms from previous sampling event.
- DO make sure that the equipment is set up properly and the bottleware is nearby and ready to be filled. There is little time between taking parameters.
- DO look at the water quality parameters from the previous round of sampling. If there is a large deviation from the previous round's measurements, make sure the meters are properly calibrated and the parameter units are the same. Otherwise, consult the Project Manager or field team leader.
- DO fill sample bottles slowly to make sure that they are not overfilled and that preservative does not become diluted. If collecting filtered samples, fill all non-filtered first, then fill filtered samples - if water is very silty, more than one filter might be required to fill sample bottles.
- DO record the time that purging begins and ends. "Purge Stop" and sample start time are the same.
- DO call your Project Manager or field team leader if unexpected conditions are encountered or at least daily to update them. It is also recommended to call when sampling is winding down for the day to make sure that the project-specific work plan has been fully implemented and there are no additional tasks to complete. Provide shipping tracking numbers to the Project Manager and laboratory contact.
- DO have the numbers for laboratory, vehicle rental and equipment rental providers readily available while in the field.
- DO record sample locations and parameters in the field book and the Groundwater Field Data Records as you purge.
- DO check on the purging setup frequently to make sure proper equipment function is maintained.
- DO bring ice to the site in the morning so that samples are kept cool throughout the entire event. Storing samples in a warm cooler can invalidate sample results and may result in re-sampling on your own time.

DO NOTs:

- DO NOT sign anything in the field. This includes disposal documentation, statements, etc.; call the Project Manager if this is an issue.
- DO NOT allow the pump or sampling equipment to hit the bottom of the well - If the pump hits the bottom of the well, it can stir up mud. Remember, the goal of low-flow sampling is to collect non-turbid samples.
- DO NOT use non-indelible ink to label samples or record field notes – if the field book gets wet, notes become illegible.
- DO NOT leave air bubbles in VOA vials.
- DO NOT pour any extracted water back down into the well.
- DO NOT lean over wells with pens, keys, cell phones, tools, etc. in your pocket.
- DO NOT use clear tape to cover labels on certain analyses (e.g., 40-mL vials for VOC analysis) due to potential interference with analytical equipment.

Attachment C: SOP Modifications for PFAS

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross-contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. The following table highlights the required modifications to this SOP when sampling for PFAS.

PFAS Sampling Protocols	
SOP Section Number	**Modifications to SOP**
1.3	• Do not use equipment utilizing Teflon® or low density polyethylene (LDPE)[1] during sample handling or mobilization/demobilization. This includes bailers, tubing, bladders, bailer cord/wire, waterproof/resistant paper products, certain personal protective equipment (PPE) (see below), and Teflon® tape. High density polyethylene (HDPE) or silicone tubing should be used in lieu of Teflon® or Teflon®-lined tubing. • Passive diffusion bags (PDBs) should not be used due to the presence of LDPE material in PDBs. • Blue Ice® (chemical ice packs) must not be used to cool samples or be used in sample coolers. Regular ice in Ziploc® bags can be used. • Do not use LDPE or glass sample containers or containers with Teflon-lined lids. HDPE or polypropylene containers are acceptable for sample storage. HDPE or polypropylene caps are acceptable. • Do not use aluminum foil. • Field notes should be recorded on loose paper field forms maintained in aluminum or Masonite clipboards. Waterproof field books, plastic clipboards and spiral bound notebooks should not be used. • Do not use Post-It Notes during sample handling or mobilization/demobilization. • Refer to TRC's SOP ECR-010 Equipment Decontamination for PFAS-specific decontamination protocols. Ensure that PFAS-free water is used during the decontamination procedure.
1.5	Always consult the Site Specific Health and Safety Plan prior to conducting field work. The following considerations should be made with regards to field preparation during PFAS sampling: • Tyvek® suits should not be worn during PFAS sampling events. Cotton coveralls may be worn. • Boots and other field clothing containing Gore-Tex™ or other waterproof/resistant material should not be worn. This includes rain gear. Boots made with polyurethane and polyvinyl chloride (PVC) are acceptable. • Stain resistant clothing should not be worn. • Food and drink should not be allowed within the exclusion area. Pre-wrapped food or snacks should not be in the possession of sampling personnel during sampling. Bottled water and hydration drinks (e.g., Gatorade®) may be consumed in the staging area only. • Personnel involved with sample collection and handling should wear nitrile gloves at all times while collecting and handling samples or sampling equipment. Avoid handling unnecessary items with nitrile

PFAS Sampling Protocols	
SOP Section Number	**Modifications to SOP**
	gloves. A new pair of gloves must be donned prior to collecting each sample. • Wash hands with Alconox or Liquinox and deionized water after leaving vehicle before setting up to sample a well.
1.6.1	• Avoid wearing clothing laundered with fabric softeners. • Avoid wearing new clothing (recommended 6 washings since purchase). Clothing made of cotton is preferred. • Avoid using cosmetics, moisturizers, hand creams, or other related products as part of cleaning/showering on the day of sampling. • Avoid using sunscreens or insect repellants that are not natural or chemical free.
1.6.2	• Consider collecting samples for total suspended solids which will become important for fate and transport and treatment considerations. Floc accumulates high concentrations of PFAS and specifically some of the longer-chain PFAS; when this floc settles out, concentrations can decrease by an order of magnitude. • Low-flow sampling is preferred for PFAS sampling. Bailers should be avoided due to the potential for PFAS to accumulate at the air/water interface. If bailers need to be used, purging of at least one well volume should be performed to remove static surface conditions. • If sampling for parameters other than PFAS, perform PFAS sampling first. Schedule PFAS sampling at the beginning of the work day to avoid other sources of contamination.
2.0	• Monitoring wells should always be sampled from the lowest contamination to the highest contamination, when possible. In source areas, if deep wells are anticipated to be less contaminated, the deep wells should be sampled prior to sampling the shallow wells to avoid cross-contamination from sampling equipment.
2.2.3	Solids present in groundwater samples may or may not be included in the extraction for PFAS analysis. Sample extraction procedures of aqueous samples containing suspended solids can vary amongst laboratories. • Work with the laboratory prior to sampling to understand their procedures for handling high turbidity PFAS samples. • If data quality objectives (DQOs) require an aqueous-only analysis, request that the laboratory centrifuge the sample when suspended solids content is observed by the chemist to be visually high and likely to clog the solid phase extraction cartridge (this is recommended by State of Wisconsin guidance [WDNR 2019].) ○ Extracting and analyzing the solid phase of the sample as well may or may not be necessary depending on the DQOs for the project. There is the potential that the total PFAS sample concentration will be biased low if solids are excluded. ○ However, analyzing only the aqueous phase provides an aqueous concentration result that may be more representative of drinking water, for example. • Regardless of the approach, it is important to 1) have clear communication with the laboratory to understand if the reported

PFAS Sampling Protocols	
SOP Section Number	**Modifications to SOP**
	concentrations are total or only the aqueous phase concentrations and 2) ensure the proper documentation of laboratory procedures. • If sampling groundwater for source delineation, remedial design, or risk assessment, consider a total measurement – the aqueous phase concentration after centrifuging/decanting/extraction and the solid phase concentration after extraction, presented either individually or summed (ITRC 2022). •
2.2.5	Tubing used to purge and sample groundwater for PFAS must not be LDPE or Teflon®. HDPE and silicone are acceptable.
2.3 and 2.3.3	LDPE and/or glass containers should not be used for sampling. Teflon®-lined caps should also not be used during sample collection. Instead, HDPE or polypropylene containers are acceptable for sample storage. HDPE or polypropylene caps are acceptable.
2.4	Due to LDPE material in PDBs, PDBs cannot be used for PFAS sampling.
2.5 (e)	Avoid using waterproof labels for sample bottles. The use of paper labels covered with clear tape or placed in Ziploc® bags to avoid moisture on the sample label is acceptable.
2.5 (f)	Samples for PFAS analysis must be shipped at <10°C. Standard coolers are acceptable. Keep high-concentration PFAS samples in separate coolers from low-concentration PFAS samples.

Notes:

[1] – PFAS have been used as an additive in the manufacturing of LDPE to smooth rough surfaces and, in the case of LDPE tubing, to allow for less turbulent flow along the surface of the tubing.

Attachment D: Best Management Practices (BMPs) to Manage Turbidity in Groundwater Samples

Attachment D: Best Management Practices (BMPs) to Manage Turbidity in Groundwater Samples Being Analyzed for PFAS

Turbidity measurements during groundwater sampling are recommended to be <10 Nephelometric Turbidity Units (NTUs) for at least 3 consecutive measurements (along with other parameters; see Section 2.2.3 in GW ECR SOP 009) to ensure a stable/representative groundwater sample. Obtaining a groundwater sample with low turbidity is especially important when sampling for PFAS. Since PFAS (especially longer-chain and sulfonate PFAS) tend to adsorb to particulates, a turbid groundwater sample can overestimate the PFAS concentrations and may not be representative of the concentrations or signature in groundwater (as discussed below, this may also be dependent on how the laboratory handles the sample during the extraction process.) While a low turbidity level (<10 NTUs) may not always be feasible at every well, there are several BMPs that are recommended to help reduce the turbidity in groundwater samples.

General Considerations

- Minimize presence of particulates through the use of low-flow groundwater sampling.
- Modify (typically decrease) purge rate as this may help reduce turbidity.
- Change pump intake depth if turbidity is not decreasing (but be sure to remain within the prescribed sampling interval for the well, e.g., within the screened interval).
- Ideally, collect a PFAS sample when turbidity is <10 NTUs.
- Consider no-purge samplers such as HydraSleeves™; the use of these samplers may depend on site-specific conditions (e.g., light non-aqueous phase liquid [LNAPL]) and local regulations.

Permanent Well Construction for PFAS Sampling

- Use excavation by hand, air-vacuum extraction, drilling, or similar excavation techniques to remove soil from the surface and grout a protective steel outer casing in-place at the intended boring location. The outer casing should be set a minimum of 2-feet below ground surface (bgs) and a minimum of 6-inches below any surface soil organic layer, whichever is greater. Additionally, if applicable, the outer casing should be set a minimum of 6-inches below the local frost line. This practice will minimize the potential for any impacted soil at the surface to inadvertently cross-contaminate the deeper borehole from soil falling into the opening during borehole advancement, soil sample collection, and construction and sampling of a monitoring well.
- Installation of permanent monitoring wells with a full sand pack is recommended.
- Consider redevelopment or replacement of the well if turbidity <25 NTUs cannot be obtained.

Temporary Wells

- Sampling from temporary wells could result in groundwater samples with higher turbidity and could have the following consequences:
    - Results may not be representative.
    - PFAS results may be biased high from high turbidity levels.
    - Due to adsorption (see discussion above), turbid samples compared to clear samples can result in detection of different PFAS compounds (e.g., perfluorosulfonic acids [PFSAs] such as perfluorohexanesulfonic acid [PFHxS] and perfluorooctanesulfonic acid [PFOS] are more likely to be detected in a turbid sample).

- Data collected from temporary wells are best used for screening level analyses and/or source characterization.
- Consider, in certain circumstances, collecting both a filtered and unfiltered sample from the temporary well for comparison.
    - There would be no downside for the client – dissolved samples are likely more representative for temporary wells.
- If possible, it is recommended to speak with the regulatory or governing agency and request permission to <u>decant</u> groundwater prior to sampling and/or have the laboratory handle the turbid sample in a manner which eliminates particulates (see below for additional information).

Risk Assessment

For usability of data in risk assessment, the US EPA Office of Solid Waste and Emergency Response (OSWER) recommends:

- Stable turbidity levels as low as possible (<10 NTUs) (USEPA 2014).
- Unfiltered data for calculating the exposure point concentration (USEPA 1989).
- In the rare situations where filtered data are needed, prior agreement from site team recommended (USEPA 2014).

Laboratory Analysis

Solids present in groundwater samples may or may not be included in the extraction for PFAS analysis. Sample extraction procedures of aqueous samples containing suspended solids can vary amongst laboratories.

- Work with the laboratory prior to sampling to understand their procedures for handling high turbidity PFAS samples.
- If data quality objectives (DQOs) require an aqueous-only analysis, request that the laboratory centrifuge the sample when suspended solids content is observed by the chemist to be visually high and likely to clog the solid phase extraction cartridge (this is recommended by State of Wisconsin guidance [WDNR 2019].)
    - Extracting and analyzing the solid phase of the sample as well may or may not be necessary depending on the DQOs for the project. There is the potential that the total PFAS sample concentration will be biased low if solids are excluded.
    - However, analyzing only the aqueous phase provides an aqueous concentration result that may be more representative of drinking water, for example.
- Regardless of the approach, it is important to 1) have clear communication with the laboratory to understand if the reported concentrations are total or only the aqueous phase concentrations and 2) ensure the proper documentation of laboratory procedures.
- If sampling groundwater for source delineation, remedial design, or risk assessment, consider a total measurement – the aqueous phase concentration after centrifuging/decanting/extraction and the solid phase concentration after extraction, presented either individually or summed (ITRC 2022).

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Authorization Signatures

		Elizabeth Denly	
Technical Reviewer	Date	Environmental Sector Quality Director	Date
Cory Yates	4/29/21	Elizabeth Denly	4/29/21

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ATTACHMENTS

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1.0 INTRODUCTION

1.1 Scope & Applicability

This Standard Operating Procedure (SOP) was prepared to direct TRC personnel in the procedures needed for decontamination of equipment used in the field during environmental investigations (e.g., sediment, soil, groundwater investigations). Other state or federal requirements may be above and beyond the scope of this SOP and will be followed, if applicable. The actual procedures used should be documented and described in the field notes. Preventing or minimizing potential cross-contamination of samples is important for the collection of representative samples, avoiding the possible introduction of sampling error into sample results, and for protecting the health and safety of site personnel.

Removing or neutralizing potential contaminants that may have accumulated on equipment and vehicles ensures protection of personnel, reduces or eliminates potential transfer of contaminants to clean areas, and minimizes the likelihood of sample cross-contamination.

The use of dedicated or disposable sampling equipment (e.g., disposable liners, plastic spoons, plastic or aluminum bowls) should be considered as an alternative to equipment decontamination and the subsequent generation of decontamination fluids.

1.2 Summary of Method

Equipment decontamination is used to remove potential contaminants from a sampling device or piece of field equipment prior to and between the collection of samples. It is also used to limit personnel exposure to residual contamination that may be present on used field equipment.

Contaminants can be physically removed from equipment or deactivated by sterilization or disinfection. Gross contamination of equipment requires physical decontamination, including abrasive and nonabrasive methods. These may include the use of brushes, air and wet blasting, or high-pressure water, followed by a wash/rinse process using appropriate cleaning solutions. A solvent rinse may be required when organic contamination is present, and an acid rinse may be required when metals are parameters of interest. Equipment decontamination procedures can vary depending on the media being sampled and the type of sampling equipment being used. Disposal of decontamination fluids will be handled on a project-specific basis and will be conducted in accordance with the applicable regulations.

1.3 Equipment

The following equipment may be utilized when decontaminating equipment. Project-specific conditions or requirements may warrant the use of additional equipment or deletion of items from this list. For specialized sampling programs involving per- and polyfluoroalkyl substances (PFAS), refer to Attachment B for further details.

- Appropriate level of personal protective equipment (PPE) as specified in the site-specific Health and Safety Plan (HASP)

- Alconox®, Liquinox® or other non-phosphate, concentrated, laboratory-grade soap
- Simple Green® or other nontoxic biodegradable cleaner
- Deionized, distilled, organic-free, or potable water as appropriate as determined by the Project Manager. Water may be supplied by the laboratory or purchased from commercial vendors depending on project requirements.
- Pump sprayer
- Pressure sprayer
- Squeeze bottle filled with hexane (option for organic analyses)
- Squeeze bottle filled with methanol as appropriate (option for organic analyses)
- Squeeze bottle filled with isopropanol as appropriate (option for organic analyses)
- Squeeze bottle filled with 10 percent nitric acid (option for metals analyses and stainless-steel equipment)
- Squeeze bottle filled with 1 percent nitric acid (option for metals analyses)
- Container (squeeze bottle to 5-gallon bucket) filled with appropriate grade water and a non-phosphate, laboratory-grade soap (approximately 1 tablespoon of soap to 5 gallons of water)
- Extra quantities of above listed liquids
- Containers, such as buckets or wash basins (the type and number of containers is dependent on the procedure)
- Scrub brushes
- Small wire brush
- Aluminum foil
- Polyethylene sheeting
- A container for decontamination of pumps and associated tubing

1.4 Health & Safety Considerations

TRC personnel will be on site when implementing this SOP. Therefore, TRC personnel and/or subcontractors shall follow the site-specific HASP. TRC personnel and/or subcontractors will use the appropriate level of PPE as defined in the HASP.

Sampling equipment or materials that have come in contact with chemical contaminants may be handled during implementation of this SOP. Certain decontamination fluids, including solvents and/or acids, are considered hazardous materials, and TRC employees will always handle and store them appropriately. Hazardous substances may be incompatible or may cause dangerous chemical reactions, including the production of heat, violent reactivity, or produce toxic vapors or other byproducts. Some hazardous substances may be incompatible with clothing or equipment and can permeate or degrade protective clothing or equipment. Also, hazardous substances may pose a direct health hazard to workers through inhalation, skin contact, or if a combustible material is exposed to heat/flame. Safety data sheets (SDS) for chemicals handled by TRC personnel should be maintained in a designated location at the project site.

1.5 Cautions and Potential Problems

Special care should be taken when decontaminating equipment used for sampling for PFAS. Please refer to Attachment B for details.

- The use of deionized, distilled, or organic-free water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment, provided that it has been certified by the vendor as analyte-free and/or meets the project-specific requirements.

- Alconox®, Liquinox®, or other non-phosphate, concentrated, laboratory-grade soap may contain trace quantities of perchlorate or 1,4-dioxane.

- Avoid using an excessive amount of soap during decontamination procedures, as this could result in difficulty rinsing the soap residue off of the equipment. Typically, the soap solution is prepared using 1 tablespoon of soap to 5 gallons of water.

- Use sufficient amounts of decontamination fluid (e.g., acid or solvent rinses) so that the fluid flows over the equipment and runs off. Spraying the equipment with a minimal amount of decontamination fluid that does not run off is ineffective.

- Spent decontamination solutions are considered investigation-derived waste (IDW) and must be managed as directed by the site-specific field program. Project and regulatory requirements, chemical compatibility, ambient conditions, and professional judgment should be used to determine the appropriate decontamination process with respect to combining and/or segregating decontamination fluids. Section 3 of this SOP provides more guidance on the disposal procedures.

- Several procedures can be established to minimize the potential for cross-contamination or analytical interference by decontamination fluids. For example:

    - The use of methanol in the decontamination procedure may not be appropriate if methanol is a contaminant of concern.

    - Isopropanol may be used as a substitute for methanol but may not be appropriate when collecting samples for volatile organic compound (VOC) analyses. Residual isopropanol on the equipment may cause substantial interferences in subsequent VOC analyses and may result in unnecessary dilutions and/or false positive results if isopropanol is not removed in subsequent decontamination steps. It should also be noted that the application of isopropanol to hot metal surfaces (e.g., a steam-cleaned split spoon) may cause oxidation of the isopropanol to acetone.

    - If hexane is used in the decontamination procedure, caution should be used to ensure that the hexane is completely volatilized and the equipment is subsequently rinsed when samples are to be analyzed for VOCs and volatile petroleum hydrocarbons (VPH).

Residual hexane on equipment could interfere with the VOC and VPH analyses and may result in unnecessary dilutions and/or false positive results.

- Cover monitoring and sampling equipment with protective material (i.e., aluminum foil, polyethylene sheeting, or Ziploc® bags) to minimize potential re-contamination after decontamination.

- Use dedicated or disposable sampling equipment when appropriate to minimize the need for decontamination. Although disposable sampling tools are encouraged in order to minimize the generation of decontamination fluids, it should be noted that plastic tools may not be appropriate for collection of samples to be analyzed for semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). Potential phthalate contamination may cause significant interferences in the subsequent analyses and may result in unnecessary dilutions and/or false positive results.

- After decontamination, equipment should be handled only by personnel wearing clean disposable, powder-free, nitrile gloves to prevent recontamination.
- Following decontamination, the equipment should be moved away (preferably upwind) from the decontamination area to prevent recontamination.
- Equipment that is not decontaminated properly may result in potentially high, biased results in field samples. **Note:** Equipment blank collection may be appropriate after decontamination of equipment used to collect highly contaminated samples.

1.6 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Project and client-specific training requirements for samplers and other personnel on site should be developed in project planning documents, such as the sampling plan or project work plan. These requirements may include:

- Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety Training for Hazardous Waste Operations and Emergency Response (HAZWOPER) workers; and
- 8-hour annual HAZWOPER refresher training.

2.0 PROCEDURES

Refer to the site-specific sampling plan and/or Quality Assurance Project Plan (QAPP), if applicable, for site-specific procedures. Other state or federal requirements may be above and beyond the scope of this SOP and will be followed if applicable. The actual procedures used should be documented and described in the field notes.

2.1 General

Personnel, sample containers, and equipment leaving the contaminated area of a site must be decontaminated. Various decontamination methods will either physically remove contaminants by abrasive and/or washing actions, inactivate contaminants by disinfection or sterilization, or both. Decontamination procedures should be documented in the field book.

2.2 Physical Decontamination Procedures

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques appropriate for equipment decontamination can be grouped into two categories: abrasive methods and nonabrasive methods. In general, heavy equipment decontamination is conducted by drilling and construction subcontractors and not by TRC personnel. However, TRC personnel will typically need to document such decontamination efforts as part of project work. Special care should be taken during decontamination procedures following sampling for PFAS; please refer to Attachment B for details.

ABRASIVE CLEANING METHODS APPROPRIATE FOR DRILLING EQUIPMENT (DRILLING RIGS, ETC.)

Abrasive cleaning methods involve rubbing and wearing away the top layer of the surface containing the contaminant. The following abrasive methods are available but are not commonly used:

- *Mechanical:* Mechanical cleaning methods use metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of brushing time, and degree of brush contact.

- *Air Blasting:* Air blasting is used for cleaning large equipment, such as bulldozers, drilling rigs, or auger bits. The equipment used in air blasting employs compressed air to force abrasive material through a nozzle at high velocities. The distance between the nozzle and the surface cleaned, as well as the pressure of air, the time of application, and the angle at which the abrasive material strikes the surface, determines cleaning efficiency. Air blasting has several disadvantages, including its inability to control the amount of materials removed, it can aerate contaminants, and it generates large amounts of waste.

- *Wet Blasting:* Wet blasting, also used to clean large equipment, involves use of a suspended fine abrasive delivered by compressed air to the contaminated area. The amount of materials removed can be carefully controlled by using very fine abrasives. One disadvantage of this method is the generation of a large amount of waste.

NONABRASIVE CLEANING METHODS APPROPRIATE FOR FIELD EQUIPMENT (DRILLING AUGERS AND RIGS, ETC.)

Nonabrasive cleaning methods involve forcing the contaminant off a surface with pressure. In general, less of the equipment surface is removed using nonabrasive methods. The following nonabrasive methods are available:

High-pressure Potable Water: This method consists of a high-pressure pump, an operator-controlled directional nozzle, and a high-pressure hose. Flow rates typically range from 20 to 140 liters per minute (approximately 5 to 37 US gallons per minute). This procedure is used the majority of the time and is more appropriate for equipment with painted surfaces.

Ultrahigh-Pressure Potable Water: This system produces a pressurized water jet. The ultrahigh-pressure spray removes tightly adhered surface film. The water velocity ranges from 500 meters per second (m/sec) to 900 m/sec (approximately 1,640 to 2,953 feet per second). Additives can enhance the method. This method is not applicable for hand-held sampling equipment. This procedure is not commonly used but would be appropriate for carbon steel drilling rods and augers.

Steam Cleaning: This method consists of a high-pressure hot water cleaner capable of generating a pressure of at least 2,500 pounds per square inch (psi) and producing hot water and/or steam (at least 200 degrees Fahrenheit), and is typically equipped with a soap compartment. Due to the high temperatures associated with this method, steam cleaning should not be used for polyvinyl chloride (PVC) or plastic equipment.

2.3 Procedure for Sampling Equipment

Sampling equipment, such as split-spoon samplers, shovels, hand augers, trowels, spoons, spatulas, bailers, tethers, dippers, and pumps, will be cleaned using the following procedure. Special care should be taken during decontamination procedures following sampling for PFAS; please refer to Attachment B for details. **Note:** The overall number of containers needed for collection of decontamination fluids may vary depending on chemical compatibilities, project and regulatory requirements, and ultimate disposal methods for these fluids.

1. Lay out sufficient polyethylene sheeting on the ground or floor to allow placement of the necessary number of containers (e.g., plastic wash basins or buckets) and an air-drying area. The number of decontamination steps and designated containers should be determined prior to field sampling based on the site-specific sampling plan. At a minimum, one container should be designated for the detergent wash. A second container should be designated for water rinsing. A third container may be designated for non-water rinsing. If more than one, the non-water rinsate fluids may need to be separated. Non-water rinsate fluids should not be combined with the detergent wash during decontamination. Place the containers on the polyethylene sheeting. The decontamination line should progress from “dirty” to “clean”.

   Note: In instances where acid or solvent rinses are required, additional containers may be needed to manage collection and subsequent disposal of the spent decontamination fluids.

2. Fill the first container with potable water. Add sufficient non-phosphate, concentrated, laboratory-grade soap to cause suds to form. Do not use an excessive amount of the soap (approximately 1 tablespoon of soap to 5 gallons of water) or rinsing the soap residue off the equipment will be difficult.

3. Disassemble the equipment, as appropriate.

4. Brush any visible dirt off sampling equipment into a designated area before getting equipment wet.

5. Using a clean, coarse scrub brush, submerge and wash the sampling equipment in the soap solution in the first container, removing all dirt and/or visible hydrocarbons. Allow excess soap to drain off the equipment into the container when finished.

6. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

7. Rinse the equipment with appropriate water over an appropriate container, using a coarse scrub brush or pressure sprayer to aid in the rinse if necessary. If an additional acid or solvent rinse is not required, proceed to Step 10.

8. **If sampling for metals and if required by the project, rinse the equipment with nitric acid over an appropriate container. Consider using a container dedicated to acidic solutions to minimize the volume of liquid that needs to be neutralized later. A 10 percent nitric acid solution is used on stainless steel equipment. A 1 percent nitric acid solution is used on all other equipment. If not required, this step may be omitted.

9. **If sampling for organic parameters and if required by the project, rinse the equipment over an appropriate container using methanol or isopropanol (see Cautions and Potential Problems). If oily, a hexane rinse should follow the methanol/isopropanol rinse, or as an alternative, Simple Green® can be used if approved by the Project Manager. Consider using an appropriate container dedicated to volatile solvents to minimize the volume of liquid that subsequently needs to be managed as IDW. If not required, this step may be omitted.

   Allow the equipment to completely air dry prior to proceeding to the next step.

   **** Steps 8 and 9 are optional and may be used on a site-specific basis. The site-specific sampling plan or QAPP, if available, should be consulted. In the absence of a sampling plan or QAPP, the Project Manager will decide upon the necessity of these steps.**

10. Rinse the equipment over an appropriate container using deionized, distilled or organic-free water after each step. If cleaning a pump that is not completely disassembled, run the submerged pump in the container long enough to allow sufficient contact time with the internal components of the pump.

11. Allow the equipment to completely air dry on a clean surface (e.g., polyethylene sheeting or a clean container) (See*NOTE).

    ***NOTE** that if temperature or humidity conditions preclude air drying equipment, sufficient spares, as applicable and if possible, should be available so that no item of sampling equipment need be used more than once. If an ample amount of spare equipment is not available and the equipment will not completely air dry, additional rinses with deionized, distilled or organic-free water should be used. The inability of equipment to air dry and the usage of additional rinses should be recorded in the field book or on the appropriate form.

12. Reassemble equipment, if necessary, and wrap completely in clean, unused, protective material. Reuse of equipment on the same day without wrapping in protective material is acceptable.
13. Spent decontamination fluids are considered IDW and must be managed as directed by the site-specific field program.
14. Record the decontamination procedure in the field book or on the appropriate form.
15. Decontamination solution and rinse water should be refreshed at regular intervals as appropriate to meet project quality objectives.

2.4 Procedure for Measuring Equipment

Measuring equipment, such as pressure transducers, water level indicators, oil/water interface probes, and soil moisture/pH meters will be cleaned using the following procedure, unless it conflicts with the manufacturer's recommendations. Special care should be taken during decontamination procedures following sampling for PFAS; please refer to Attachment B for details.

1. Fill two clean containers (e.g., plastic wash basins or buckets) with potable water.
2. Add sufficient nonphosphate, concentrated, laboratory-grade soap to one container to form a thin layer of soap suds. If oily residues are apparent, the use of Simple Green® may be required.
3. Brush any visible dirt off measuring equipment before getting the equipment wet.
4. Either spray rinse the device with the soap solution over the first container, or for heavily soiled equipment, immerse the device in the container containing soap and gently agitate. Scrub device if it is soiled. Do not submerse any electrical controls or take-up reels. Submerse only that portion of the device that came in contact with potential contaminants.
5. Immerse the device in the container containing the potable water and gently agitate. Do not submerse any electrical connectors or take-up reels. Submerse only that portion of the device that came in contact with potential contaminants.
6. Spray rinse equipment with deionized, distilled, or organic-free water over the last container used.
7. Allow the equipment to air dry if time allows.
8. Record the decontamination procedure in the field book or on the appropriate form.

3.0 INVESTIGATION-DERIVED WASTE DISPOSAL

Field personnel should discuss specific documentation and containerization requirements for IDW disposal with the Project Manager.

Each project must consider IDW disposal methods and have a plan in place prior to performing field work. Provisions must be in place regarding what will be done with IDW. If IDW must be removed from the site, consider material containment, such as a composite drum, proper labeling, on-site storage by the client, testing for disposal approval of the materials, and ultimately the pickup and disposal of the materials by appropriately licensed vendors.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

One type of quality control sample specific to the field decontamination process is the equipment blank. The equipment blank provides information about the effectiveness of the decontamination process employed in the field. An equipment blank can detect contamination that may arise from potentially contaminated equipment or equipment that has not been decontaminated effectively.

Equipment blanks consist of a sample of analyte-free (i.e., deionized, distilled, organic-free) water that is poured over and through a decontaminated sampling device and placed in a clean sample container. Ideally, the reagent water should come from the laboratory and be certified as clean. If the blank water is not certified as clean and/or not supplied by the laboratory performing the analyses, a separate water blank that has not run through the sampling equipment should also be sent to the laboratory for analysis.

Equipment blanks are typically collected for all parameters of interest at a minimum rate of 1 per day per matrix; however, the frequency of equipment blank collection will vary from project to project, depending upon the data quality objectives and/or regulatory requirements, and will be specified in either the site-specific sampling plan or QAPP. Equipment blanks are typically not required if dedicated sampling equipment is used.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

All reagents used must be documented in the field book or on the appropriate form. Any deviations from the decontamination procedures specified in the sampling plan or QAPP must be approved by the Quality Assurance Officer and Project Manager and documented in the field book. The lot number and vendor of each reagent used should be documented in the field book. Refer to ECR SOP 001 for field documentation procedures.

Planning for the collection of equipment blank samples can be tracked in the TRC Environmental Data Management System (EDMS). This can ensure the field teams are reminded by the mobile data collection app to collect equipment blank samples per the sampling plan or QAPP. Data quality checks for equipment blank samples can be automatically run by the TRC EDMS and highlight any non-conformities to the QAPP or concentrations detected in the equipment blank samples when data are loaded. Discuss with your EDMS data manager to have this automated report configured for your project site.

6.0 REFERENCES

USEPA. December 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001.

USEPA. January 1991. *Compendium of ERT Groundwater Sampling Procedures*. OSWER Directive 9360.4-06. PB91-9211275.

USEPA. November 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance*. EPA/530-R-93-001. USEPA Office of Solid Waste.

USEPA. January 1999. *Compendium of ERT Groundwater Sampling Procedures*. EPA/540/P-91/007. OSWER Directive 9360.4-06. PB91-921275.

USEPA. June 22, 2020. *Field Equipment Cleaning and Decontamination*. LSASDPROC-205-R4. Region 4. Laboratory Services and Applied Science Division. Athens, Georgia.

7.0 SUSTAINABLE RECOMMENDATIONS

Sustainable practices should be incorporated wherever practical. Items to consider for equipment decontamination are as follows:

- Utilize Alconox® soap when appropriate due to its biodegradable nature;
- Utilize a reusable container such as a carboy for decontamination water;
- Utilize reusable decontamination equipment such as plastic spray bottles, plastic brushes, etc., when appropriate;
- Utilize recycled plastic sheeting to contain decontamination rinsate, if available; and,
- Send decontamination rinsate to a wastewater treatment facility for water reuse/recycling when practical.

8.0 SOP REVISION HISTORY

REVISION NUMBER	REVISION DATE	REASON FOR REVISION
1	DECEMBER 2016	ADDED ATTACHMENT B TO ACCOMMODATE SOP MODIFICATIONS REQUIRED WHEN SAMPLING FOR PFAS; CHANGED NAMING CONVENTION FOR SOP FROM RMD TO ECR.
2	JANUARY 2020	TRC RE-BRANDING
3	APRIL 2021	REVIEWED AND REVISED SOP

Attachment A: SOP Fact Sheet

EQUIPMENT DECONTAMINATION

PURPOSE AND OBJECTIVE

Removing or neutralizing potential contaminants that may have accumulated on equipment and vehicles ensures protection of personnel, reduces or eliminates potential transfer of contaminants to clean areas, and minimizes the likelihood of sample cross-contamination. Preventing or minimizing potential cross-contamination of samples is important for the collection of representative samples, avoiding the possible introduction of sampling error into sample results, and for protecting the health and safety of site personnel.

WHAT TO BRING

- Field book
- Appropriate PPE
- Site-specific HASP
- Alconox®, Liquinox® or other nonphosphate, concentrated, laboratory-grade soap
- Simple Green® or other nontoxic biodegradable cleaner
- Deionized, distilled, organic-free water, or potable water as appropriate as determined by the Project Manager
- Pump or pressure sprayer
- Squeeze bottles filled with appropriate decontamination chemicals (e.g., organic solvents, nitric acid)
- Containers, such as buckets or wash basins (type and number is dependent on the procedure)
- Scrub brushes and/or small wire brush
- Aluminum foil
- Polyethylene sheeting
- A container for decontamination of pumps and associated tubing

OFFICE

- Prepare/update the site-specific HASP; make sure the field team is familiar with the latest version.
- Review site-specific sampling plan/QAPP for decontamination procedures and procedures for management of investigation-derived waste (IDW) (e.g., used decontamination solutions).
- Confirm all required decontamination supplies are in stock or order as needed.

ON-SITE

- Verify project HASP including safety data sheets for decontamination chemicals used on site.
- Conduct daily Health & Safety tailgate meetings, as appropriate.
- Establish a designated equipment and personnel decontamination area.
- Provide for the proper collection and management of all IDW.
- Verify that appropriate PPE is worn by all site personnel (including subcontractors) and the work area is safe.

SAMPLING EQUIPMENT DECONTAMINATION - PROCEDURES

Sampling equipment, such as split-spoon samplers, shovels, hand augers, trowels, spoons, spatulas, bailers, tethers, dippers, and pumps, will be cleaned using the following procedure. **A more simplified procedure for decontamination of measuring equipment is presented in the SOP.** Note: The overall number of containers needed for collection of decontamination fluids may vary depending on chemical compatibilities, project and regulatory requirements, and ultimate disposal methods for these fluids.

1. Lay out sufficient polyethylene sheeting on the ground or floor to allow placement of the necessary number of containers (e.g., plastic wash basins or buckets) and an air-drying area. At a minimum, one container should be designated for the detergent wash. A second container should be designated for water rinsing. A third container may be designated for nonwater rinsing. Nonwater rinsate fluids should not be combined with the detergent wash during decontamination. The decontamination line should progress from "dirty" to "clean".
   Note: In instances where acid or solvent rinses are required, additional containers may be needed to manage collection and subsequent disposal of the spent decontamination fluids.
2. Fill the first container with potable water. Add sufficient nonphosphate concentrated laboratory-grade soap to cause suds to form. Do not use excessive amount of the soap (approximately 1 tablespoon of soap to 5 gallons of water) or rinsing the soap residue off the equipment will be difficult.
3. Brush any visible dirt off of the sampling equipment into a designated area before getting equipment wet.
4. Using a clean, coarse scrub brush, submerge and wash the sampling equipment in the soap solution in the first container, removing all dirt and/or visible hydrocarbons.

EQUIPMENT DECONTAMINATION

5. Rinse the equipment with appropriate water over an appropriate container, using a coarse scrub brush or pressure sprayer to aid in the rinse if necessary. If an additional acid or solvent rinse is not required, proceed to Step 8.
6. **If sampling for metals and if required by the project, rinse the equipment with nitric acid over an appropriate container. Consider using a container dedicated to acidic solutions to minimize the volume of liquid that needs to be neutralized later. A 10 percent nitric acid solution is used on stainless steel equipment. A 1 percent nitric acid solution is used on all other equipment. If not required, this step may be omitted.
7. **If sampling for organic parameters and if required by the project, rinse the equipment over an appropriate container using methanol or isopropanol (see Caution and Potential Problems). If oily, a hexane rinse should follow the methanol/isopropanol rinse, or as an alternative, Simple Green® can be used if approved by the Project Manager. Consider using an appropriate container dedicated to volatile solvents to minimize the volume of liquid that subsequently needs to be managed as IDW. If not required, this step may be omitted.
   Allow the equipment to completely air dry prior to proceeding to the next step.
   ** Steps 6 and 7 are optional and may be used on a site-specific basis. The site-specific sampling plan or QAPP, if available, should be consulted. In the absence of a sampling plan or QAPP, the Project Manager will decide upon the necessity of these steps.
8. Rinse the equipment over an appropriate container using deionized, distilled or organic-free water after each step.
9. Allow the equipment to completely air dry on a clean surface (e.g., polyethylene sheeting or a clean container).
   *NOTE that if temperature or humidity conditions preclude air drying equipment, sufficient spares, if possible, should be available so that no item of sampling equipment need be used more than once. If an ample amount of spare equipment is not available and the equipment will not completely air dry, additional rinses with deionized, distilled or organic-free water should be used. The inability of equipment to air dry and the usage of additional rinses should be recorded in the field logbook or on the appropriate form.
10. Reassemble equipment, if necessary, and wrap completely in clean, unused, protective material. Reuse of equipment on the same day without wrapping in protective material is acceptable.
11. Spent decontamination fluids are considered IDW and must be managed as directed by the site-specific field program.
12. Decontamination solution and rinse water should be refreshed at regular intervals as appropriate to meet project quality objectives.

INVESTIGATION DERIVED WASTE (IDW) DISPOSAL

Field personnel should review the project work plan and ensure project-specific IDW management documentation and containerization requirements are specified or discussed with the Project Manager before going to the project site.

DATA MANAGEMENT AND RECORDS MANAGEMENT

All reagents used must be documented in the field book or an appropriate field form. Any deviations from the decontamination procedures specified in the work plan, sampling plan or QAPP must be approved by the Quality Assurance Officer and Project Manager and documented in the field book. The lot number and vendor of each reagent used should be documented in the field logbook. Refer to ECR SOP 001 for field documentation procedures.

DOS AND DO NOTS OF EQUIPMENT DECONTAMINATION

DOs:

- DO call the Project Manager or field team leader if unexpected conditions are encountered or at least daily to update them on site work.
- DO manage and collect IDW in accordance with project requirements.
- DO use deionized, distilled or analyte free water that is provided by the laboratory, is certified analyte-free, and/or meets project requirements.
- DO use sufficient amount of decontamination fluids so that the fluid flows over the equipment and runs off.
- DO use new wrapped disposable dedicated sampling equipment when appropriate to minimize the need for decontamination.

DO NOTs:

- DO NOT use an excessive amount of soap during decontamination.
- DO NOT sign anything in the field unless authorized in writing by client. This includes waste disposal documentation, statements, etc.; call the Project Manager if this issue arises.

Attachment B: SOP Modifications for PFAS

Due to the pervasive nature of PFAS in various substances routinely used during sampling and the need to mitigate potential cross-contamination or sampling bias to ensure representative data are collected, special care should be taken when sampling for PFAS. The following table highlights the required modifications to this SOP when sampling for PFAS.

PFAS Equipment Decontamination Protocols	
SOP Section Number	**Modifications to SOP**
1.3	• Use only Alconox® or Liquinox® soap; do not use Decon 90. • Use new plastic buckets for wash and rinse water. • Ensure that PFAS-free water is used during the decontamination procedure. • Do not use aluminum foil.
1.5	Always consult the Site-specific Health and Safety Plan prior to conducting field work. The following considerations should be made with regards to decontamination procedures: • Tyvek® suits should not be worn. Cotton coveralls may be worn. • Boots and other field clothing containing Gore-Tex™ or other waterproof/resistant material should not be worn. This includes rain gear. Boots made with polyurethane and polyvinyl chloride (PVC) are acceptable. • Food and drink should not be allowed within the decontamination area. Bottled water and hydration drinks (e.g., Gatorade®) may be consumed in the staging area only. • Personnel involved with decontamination should wear a new pair of nitrile gloves after each decontamination procedure when handling equipment to avoid re-contamination. Avoid handling unnecessary items with nitrile gloves. • Do not store on or cover equipment with aluminum foil after decontamination. Use of polyethylene sheeting is acceptable. • Avoid wearing clothing laundered with fabric softeners. • Avoid wearing new clothing (recommended six washings since purchase). Clothing made of cotton is preferred. • Avoid using cosmetics, moisturizers, hand creams, or other related products as part of cleaning/showering the morning of sampling and decontamination field work.
2.2	• New nylon or metal bristle brushes should be used for mechanical cleaning methods. • If high-pressure water is used, it must be tested prior to use for the presence of PFAS.
2.3	• Ensure that PFAS-free water is used during the last step of the decontamination procedure.
2.4	• Ensure that PFAS-free water is used during the last step of the decontamination procedure.

LAB SUPERVISOR: ______________________

QA OFFICER: ______________________

EFFECTIVE DATE: 03/21/2024

TITLE: ANALYSIS OF PER- AND POLYFLUORINATED ALKYL SUBSTANCES (PFAS) IN AQUEOUS AND SOLID SAMPLES BY LC/MS/MS

REFERENCES: EPA METHOD 1633, January 2024

REVISED SECTIONS: references, 2.1, 15.1, Table 6.

ADDED SECTIONS: NONE

1.0 SCOPE AND APPLICATION

1.1 This method is used to determine the concentrations of select Per- and Polyfluorinated Alkyl Substances (PFAS) in aqueous, solid (soil, sediment, biosolids), and tissue matrices utilizing an HPLC equipped with a tandem mass spectrometer (MS/MS).

1.2 Analytes that may be reported under this method are listed in TABLE 1. Translations between analytes names and acronyms used in EPA 1633 versus the laboratory report and raw data are listed in TABLE 4.

1.3 This method is "performance-based," meaning that modifications may be made without additional EPA review to improve performance (e.g., overcome interferences, or improve the sensitivity, accuracy, or precision of the results) provided that all performance criteria in this method are met.

2.0 SUMMARY OF METHOD

2.1 This method is adapted from EPA Method 1633 for the analysis of environmental water and soil samples. This SOP is not designed to be used to analyze aqueous and solid samples by the laboratory's in-house LCMSMS method.

2.2 Samples are received, stored, and extracted within the appropriate holding times.

2.3 Sample preparation is performed following SGS-Dayton SOP EOP040 and EOP041.

2.4 Samples known to be high in PFAS (such as AFFF or AFFF impacted waters) should be screened by serial dilution and direct injection onto the LC/MS/MS in order to determine the appropriate subsample size. High level water and soil samples require that a smaller sample aliquot be used so that the analytes fall within the instrument calibration range. For definitive analysis AFFF samples must be subcontracted to a laboratory certified for AFFF analysis by QSM 5.4.

2.5 Per- and Polyfluorinated Alkyl Analytes are separated, detected and quantitated using an LC/MS/MS. After HPLC separation and ionization, the specific Perfluorinated compound is isolated in the first mass spectrometer and transferred to a collision cell for fragmentation.

The resulting fragments are introduced into the second mass spectrometer where they are detected and quantified.

2.6 Per- and Polyfluorinated Alkyl Analytes may exist in branched and/or linear form. Fluorotelomer production results in linear isomers only but electrochemical fluorination results in branched and linear isomers. The branched isomers may account for up to 30% of the total analyte. The branched isomers will elute just before the linear isomer. A qualitative branched/linear RT standard with additional branched isomers is used to help establish transition windows.

2.7 Manual integrations are performed in accordance with SOP EQA044.

3.0 REPORTING LIMIT AND METHOD DETECTION LIMIT

3.1 The Lower Limit of Quantitation (LLOQ) or Reporting limits (RL) are based on the extraction procedure and the lowest calibration standard. LLOQs may vary depending on matrix complications and volumes. LLOQs for this method are 0.002-0.050 ug/l for aqueous samples and 0.2-50 ug/kg for solid samples. Solid matrices are reported on a dry weight basis.

3.2 **MeFOSA, EtFOSA, MeFOSE, and EtFOSE** tend to recover erratically by SPE cartridge. These analytes may also be lost during the evaporative step. Data for these analytes should be reviewed carefully.

3.3 The Method Detection Limit (MDL). Experimentally determine MDLs using the procedure specified in 40 CFR, Part 136, Appendix B, Revision 2. Experimental MDLs must be determined in accordance with SGS SOP EQA075

3.4 Compounds detected at concentrations between the LLOQ and MDL are quantitated and qualified as estimated values and reported with a "J" qualifier. Some program or project specifications may require that no values below the LLOQ be reported.

4.0 DEFINITIONS

4.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or 12 hours whichever comes first.

4.2 Blank Spike (BS): An analyte-free matrix spiked with a known number of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

4.3 Low Level Blank Spike (LLBS): An analyte-free matrix spiked with a known number of analyte(s) at 2x LLOQ, processed simultaneously with the samples through all the steps of the analytical procedure. Low-Level Blank Spike Recoveries are used to document laboratory performance at the LLOQ for a given method. This may also be called a Low Level Laboratory Control Sample (LLLCS) or the Low-Level Ongoing Precision And Recovery Standard (LLOPR).

4.4 Extracted Internal Standards (EIS): A standard containing isotopically labelled versions of the native target analytes. These isotopes are usually labelled with C13, d2, or O18 atoms. Isotope Dilution Standards are used to measure the extraction efficiency and to correct the concentrations of the native analytes based on the recovery of their isotopically labelled analogs.

4.5 Field Blank (FB): An aliquot of reagent water that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FB is to determine if method analytes or other interferences are present in the field environment.

4.6 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and are still considered valid.

4.7 Matrix Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

4.8 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

4.9 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike duplicate recoveries are used to document the precision and bias of a method in a given sample matrix.

4.10 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

4.11 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

5.0 HEALTH & SAFETY

5.1 The analyst must follow normal safety procedures as outlined in the SGS Laboratory Safety Manual which includes the use of Safety glasses, gloves and lab coats. In addition, all acids are corrosive and must be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor.

5.2 Safety Data Sheets (SDS) are available for all reagents and solvents used in the lab. Technicians should review the SDS prior to using any new reagents or solvents.

5.3 Methanol is an inhalation hazard. Use in well ventilated area.

5.4 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical must be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level. The laboratory maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of data handling sheets is available to all personnel involved in these analyses.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIME

6.1 Collection

6.1.1 Aqueous samples should be collected in 500mL high density polyethylene bottles (HDPE). Caps must not have Teflon liners. Alternate size bottles may be used depending on project requirements. Additional bottles should be provided for solids determination, dilutions, and pre- screening of samples.

6.1.2 All containers must demonstrate to be PFAS-free at or above the MDLs for the target analytes by testing one or more representative containers from each lot.

6.1.3 Solid samples shall be collected in 4oz or 2oz HDPE wide mouth jars. Caps must not have Teflon liners.

6.1.4 The samples must be chilled to ≤ 6°C from the time of collection until arrival at the laboratory.

6.2 Storage

6.2.1 Samples may be stored in the dark at either ≤ 6°C or ≤ -20°C.

6.2.1.1 Issues were observed with MeFOSE, EtFOSE, MeFOSAA and EtFOSAA after 7 days when stored at ≤ 6°C. These issues are more likely to elevate the observed concentrations of other PFAS compounds via the transformation of these precursors if they are present in the sample.

6.2.2 The extracts should be stored in the dark at ≤ 6°C. All extracts must be allowed to come to room temperature and vortexed just prior to transfer to the autosampler vials.

6.3 Holding Time

6.3.1 Aqueous and solid samples must be extracted and analyzed within 28 days of collection if stored at ≤ 6°C.

6.3.2 Aqueous and solid samples must be extracted and analyzed within 90 days of collection if stored at ≤ -20°C.

6.3.3 Leachates must be leached within 28 days of collection and extracted and analyzed within 28 days from leaching date.

7.0 APPARATUS AND MATERIALS

7.1 HPLC – Agilent Technologies 1260 or 1290

7.1.1 Suitable HPLC equipped with an autosampler, pump, and column compartment. System may have a membrane degasser if shown to not adversely affect the analysis.

7.2 MS/MS – Agilent Technologies 6470A or 6495B

7.2.1 LC/MS/MS must be capable of negative ion electrospray ionization near the required flow rate of the HPLC Column. The system must be capable of performing MS/MS to produce unique precursor and product ions for the PFAS method analytes within the specified retention time segments. A minimum of 10 scans across each peak is required to ensure adequate precision.

7.3 Data System – Agilent Technologies Mass Hunter B10.0x

7.3.1 A computer system interfaced to the HPLC/MS/MS that allows for the continuous acquisition and storage of all data obtained throughout the duration of the chromatographic program.

7.3.2 The software must allow for the viewing of the specific MS/MS Spectra acquired over the analytical run. Comparisons can then be made between spectra from standards and samples.

7.3.3 Data is archived to a backup server for long term storage.

7.4 Columns: Agilent Poroshell 120 EC C18 2.7um, 100 x 2.1 mm ID or equivalent

7.5 Delay Columns: Agilent Poroshell or Eclipse C18 50 x 4.6 mm ID or equivalent

7.6 Disposable polyethylene transfer pipettes

7.7 15ml Centrifuge tubes

7.8 HDPE or Polypropylene screw cap and autosampler vials

7.9 Volumetric Pipettors and volumetric “plasticware” for dilutions of standards and extracts.

7.10 Class A volumetric flasks.

7.11 HDPE bottles – various sizes, shown to be PFAS free.

8.0 STANDARDS AND REAGENTS

8.1 Acetonitrile – HPLC grade or equivalent (Eluent A)

8.2 Water – HPLC grade or equivalent

8.3 Ammonium Acetate – LCMS grade or equivalent (Replace 2 Years after opening date)

8.4 Ammonium Hydroxide – Fisher A669-212 or equivalent (28-30% Aqueous Ammonia(replace 2 years after opening date).

8.5 Eluent A - Acetonitrile

8.6 Eluent B – 2mM Ammonium Acetate in 95:5 Water: Acetonitrile
Dissolve 0.154 grams of ammonium acetate in 950ml of water and 50ml of acetonitrile. Store at room temperature, and discard after two months.

8.7 Dilution Mix - Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid

Add ammonium hydroxide (3.3ml of 30%), reagent water (1.7ml) and acetic acid (0.625ml) to methanol (92ml). Store at room temperature, replace after 1 month.

8.8 Nitrogen – various grades

8.9 Per fluorinated Alkyl Substances stock standards – Traceable to Certificate of Analysis.

8.10 Qualitative Identification Standards- br-PFNA and T-PFOA from Wellington Laboratories.

8.11 Bile salt interference check standard- Taurodeoxycholic Acid (TDCA) or Sodium taurodeoxychloate hydrate – (Sigma Aldrich 580221-5GM, or equivalent). Prepare solution at a concentration of 1 µg/mL in the Acetonitrile.

8.12 Mass labeled – Non-Extracted Internal Standards

$^{13}C_3$-PFBA	$^{13}C_4$-PFOA	$^{13}C_2$-PFDA	$^{13}C_4$-PFOS
$^{13}C_2$-PFHxA	$^{13}C_5$-PFNA	$^{18}O_2$-PFHxS	

8.13 Mass labeled – Extracted Internal Standards

$^{13}C_4$-PFBA	$^{13}C_9$-PFNA	$^{13}C_3$-PFBS	$^{13}C_2$-8:2 FTS	D_5-NEtFOSAA
$^{13}C_5$-PFPeA	$^{13}C_6$-PFDA	$^{13}C_3$-PFHxS	$^{13}C_8$-PFOSA	D_7-NMeFOSE
$^{13}C_5$-PFHxA	$^{13}C_7$-PFUnA	$^{13}C_8$-PFOS	D_3-NMeFOSA	D_9-NEtFOSE
$^{13}C_4$-PFHpA	$^{13}C_2$-PFDoA	$^{13}C_2$-4:2 FTS	D_5-NEtFOSA	$^{13}C_3$-HFPO-DA
$^{13}C_8$-PFOA	$^{13}C_2$-PFTeDA	$^{13}C_2$-6:2 FTS	D_3-NMeFOSAA	

9.0 INTERFERENCES

9.1 Data from all blanks, samples, and spikes must be evaluated for interferences. Method interferences may be caused by contaminants in solvents, reagents, or glassware. The analytes in this method can also be found in many common laboratory supplies and equipment, such as PTFE (polytetrafluoroethylene) or Teflon products, HPLC solvent lines, methanol, aluminum foil, SPE transfer lines, bottle caps, etc. All materials must be demonstrated to be free from interferences.

9.2 Contact with glass containers, pipettes, or syringes should be minimized since the Perfuorinated compounds can potentially adsorb to glass surfaces.

9.3 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the sample. Humic and/or fulvic material can be co-extracted during SPE and high levels can cause enhancement and/or suppression in the electrospray ionization source or low recoveries on the SPE sorbent. Total organic carbon (TOC) is a good indicator of the humic content of the sample. High levels of iron have been shown to reduce the d5-EtFOSAA recoveries.

9.4 When establishing the chromatographic conditions, it is important to consider the potential interference of bile salts during analyses of tissue samples. A standard containing TDCA should be injected to ensure that TDCA does not coelute with any of the target analytes, EIS, or NIS standards. Analytical conditions must be set to allow a separation of at least 1 minute between the bile salts and PFOS.

9.5 SPE cartridges can be a source of interferences. The analysis of field and method blanks can provide important information regarding the presence or absence of such interferences. Brands and lots of SPE devices must be tested to ensure that contamination does not preclude analyte identification and quantitation.

9.6 Water and containers used for equipment blanks or field blanks must be tested prior to use. For smaller sampling events DI water will be provided in the same type of bottle used for sample collection. For larger sampling events four-liter HDPE containers should be used. Containers should be filled with DI water and allowed to sit for several hours before testing. If the bottles are from the same lot and filled with DI on the same day, then one analysis per 10 containers should suffice. The DI water and container blanks must be free of any analytes of interest or interferences below the MDL.

9.7 A field blank should be collected with each set of samples. Each field blank consists of 4 bottles. Two bottles are filled with DI water at the lab and the other two bottles are empty. At the sampling site the sampler should open then two empty bottles and transfer the DI water from the full bottles into them. Cap the bottles, label as field blanks, and return them to the laboratory along with the samples for analysis.

10.0 PROCEDURE

10.1 Standards Preparation. **Standards and sample extracts must be brought to room temperature and vortexed prior to aliquoting into an instrument vial.**

10.1.1 Standards are prepared from commercially available certified neat or reference standards. All standards must be logged in the HPLC Standards Logbook. All standards shall be traceable to their original source. The standards must be stored at ≤ 6°C, or as recommended by the manufacturer. Calibration levels, spike and isotope dilution standard concentrations, preparation information, and vendor part numbers can be found in the LCMS STD Summary in the Active SOP directory. A summary of the calibration concentrations can be found in Table 3.

10.2 Stock Standard Solutions

10.2.1 Stock standards are available from some commercial vendors. All vendors must supply a "Certificate of Analysis" with the standard. The certificate will be retained by the lab. Hold time for unopened stock standards is until the vendor's expiration date. Once opened, the hold time is reduced to one year or the vendor's expiration date (whichever is shorter).

10.3 Intermediate Standard Solutions

10.3.1 Intermediate standards are prepared by quantitative dilution of the stock standard with methanol. The hold time for intermediate standards is six months or the vendor's expiration date (whichever is shorter). Intermediate standards may need to be remade if comparisons to other standards indicate analyte degradation or concentration changes. Intermediate standards should be prepared using the dilution mix and stored in polyethylene vials.

10.4 Calibration Standards

10.4.1 Calibration standards for Perfluorinated analytes are prepared at a minimum of six concentration levels through quantitative dilutions of the intermediate standard. Calibration standards are prepared in methanol. The low standard is at a concentration at or below the RL and the remaining standards define the working range of the detector. Calibration standards should be prepared using the dilution mix and be stored in polyethylene vials. See Table 3 for levels.

10.4.2 Calibration standards concentrations for the sulfonates may need to be corrected for the molecular weight of the cation in the salt. Check the vendor's Certificate of Analysis to see if their nominal concentration is based on the acid or salt.

$$\mathrm{Mass}_{acid} = \mathrm{Mass}_{salt} \mathbf{X} \mathrm{MW}_{acid}/\mathrm{MW}_{salt}$$

MW_{acid} = Molecular weight of PFAA
MW_{salt} = Molecular weight of the salt

NOTE: Per fluorinated analytes may exist in branched and/or linear form. If a branched form is commercially available, then the calibration standards must contain the branched and linear form. The Quantitative standards must contain PFHxS, PFOS, PFOSA, NMeFOSAA, NEtFOSAA NMeFOSA, NEtFOSA, NMeFOSE, NEtFOSE, PFOA and PFNA which are currently available in mixes of branched and linear isomers.

10.4.3 Calibration standard concentrations are verified by the analysis of an initial calibration verification (ICV) standard.

10.5 HPLC/MS/MS Conditions

10.5.1 HPLC Conditions

10.5.1.1 6-10ul autosampler injection
10.5.1.2 Gradient Program
10.5.1.3 Eluent A – Acetonitrile
10.5.1.4 Eluent B – 2mM ammonium acetate in 95:5 water: acetonitrile
10.5.1.5 Column temperature – 50.0 °C

Time (min)	A (%)	B (%)	Flow (mL/min)
0.20 min	10.0 %	90.0 %	0.350 mL/min
4.00 min	30.0 %	70.0 %	0.350 mL/min
7.00 min	55.0 %	45.0 %	0.350 mL/min
9.00 min	75.0 %	25.0 %	0.350 mL/min
10.00 min	95.0 %	5.0 %	0.400 mL/min
10.30 min	95.0 %	5.0 %	0.400 mL/min
10.40 min	2.0 %	98.0 %	0.400 mL/min
11.80 min	2.0 %	98.0 %	0.400 mL/min
13.00 min	2.0 %	98.0 %	0.350 mL/min

10.5.2 MS/MS Conditions

Parameter	Value	Parameter	Value
Gas Temp C	250	Sheath Gas Flow (l/min)	10
Gas Flow (l/min)	10	Capillary (V)	3500
Nebulizer (psi)	50	V Charging	500
Sheath Gas Heater	300	Ionization Mode	Neg ESI
Collision Cell Gas (psi)	40	Collision Cell Gas	UHP N2

Fragmentation voltages and collisions energies are optimized for each analyte and are stored in the instrument method. Precursor ions and transition masses are listed in Table 2.

LC/MS/MS conditions are optimized for each instrument. Actual conditions may vary slightly from those listed above.

10.6 Sample Preparation

10.6.1 Low Level Aqueous Samples

10.6.1.1 A 500ml aliquot of sample (entire bottle) is extracted utilizing a solid phase extraction cartridge. The cartridge is eluted with basic methanol. The extract is carbon cleaned, filtered and the final volume is adjusted to 5.0ml, and then transferred to a centrifuge tube for storage. Refer to SOP EOP041.

10.6.2 Solid Samples

10.6.2.1 A 5-gram aliquot sample is extracted with basic methanol utilizing vortex mixer and a shaker table. The extract is carbon cleaned, SPE cleaned, filtered and the final volume is adjusted to 5.0ml, and then transferred to a centrifuge tube for storage. Refer to SOP EOP040.

10.7 HPLC/MS/MS Analysis

Instrument calibration consists of four major sections:

Mass Tuning and Calibration Transition Window Selection Initial Calibration Procedures Continuing Calibration Verification

10.7.1 Mass Calibration and Transition Window Selection

The instrument must have a valid mass calibration prior to any sample analysis. The mass calibration must be updated as needed. (i.e. QC failures, ion masses showing large deviations from known masses, or after major instrument maintenance is performed). It is recommended that the mass calibration be verified weekly through the analysis of a Check Tune. The Agilent Check Tune Masses range from 112.99 to 2233.91 amu for MS1 and 69.00 to 2233.91 for MS2.

The Check Tune Report may show both Positive and Negative ESI Results. Only the Negative results need to be evaluated. Unit resolution is demonstrated when the value of the peak width at half-height is within 0.5 ± 0.1 amu of the true value.

MS1 (UNIT)	MS2 (UNIT)
	69.00
112.99	112.99
302.00	302.00
601.98	601.98
1033.99	1033.99
1633.95	1633.95
2233.91	2233.91

Since masses greater than 1033.99 amu are not used for this method, the 1633.95 and 2233.91 amu masses must be present but do not need to be within 0.1 amu of the true value.

The Branched/Linear RT Check and mid-point calibration standard are used to check the analyte retention times. These retention times are used to update the transition windows. The windows must be wide enough to ensure that the branched and linear isomer PFAS analytes are completely within the transition window. The branched isomers will elute just prior to the linear isomer. If they are partially cut off, adjust the retention time of the linear isomer or the width of the transition window. Use a similar size window for the other analytes that do not have a branched standard. Later eluting peaks are broader and require a slightly wider transition windows because of peak broadening.

10.7.2 Initial Calibration Procedures

Before samples can be run, the LC/MS/MS system must be calibrated. The calibration must be performed every time after taking an action that changes the chromatographic conditions or when either ICV/CCV or Instrument Sensitivity check don’t meet acceptance criteria. The signal to noise ratio must be >= 3:1 for analytes with both a quant and confirmation ion and >= 10:1 for analytes with no confirmation ion.

10.7.2.1 Isotope Dilution Standard (Extracted Internal Standard) Calibration

A minimum 6-point calibration curve is created for the native PFAS compounds using an Isotope Dilution or Extracted Internal Standard technique. SGS - Dayton routinely performs an 8-point calibration to maximize the calibration range and to allow for quadratic fits. See Table 3.

The calibration standards for PFHxS, PFOS, PFOA, PFNA, PFOSA, NMeFOSAA, NEtFOSAA NMeFOSA, NEtFOSA, NMeFOSE, and NEtFOSE must consist of both branched and linear isomers. The branched isomer elutes just prior to the linear isomer. These 9 PFAS are currently being reported as the sum of the branched and linear isomers so both the branched and linear isomers in the calibration standards must be integrated.

Response factors (RF) for each analyte at each calibration level are determined as follows:

$RF = (A_{analyte}\ C_{ids})/(A_{ids} \mathbf{X}\ C_{analyte})$ $A_{analyte}$

= area of the analyte
A_{ids} = area of the isotope dilution standard $C_{analyte}$
= concentration of the analyte
C_{ids} = concentration of the isotope dilution standard.

The mean RF and standard deviation of the RF are determined for each analyte and EIS. The percent relative standard deviation (%RSD) of the response factors is calculated for each analyte as follows:

%RSD = (Standard Deviation of RF X 100) / Mean RF

If the %RSD $\leq$ 20%, linearity through the origin can be assumed and the mean RF can be used to quantitate target analytes in the samples.

Alternatively, a weighted linear regression or non-linear regression may be used. If used, the regression must be weighted inversely proportional to concentration and must not be forced through zero. The correlation coefficient (r value) must be $\geq$ 0.995 or ±0.99 (for r^2 value) for each compound to be acceptable. If a linear or non-linear regression is used, then the Relative Standard Error (%RSE) must be calculated.

Calculation of Relative Standard Error (%RSE)

$$RSE = 100 \times \sqrt{\sum_{i=1}^{n}\left[\frac{x_i' - x_i}{x_i}\right]^2 \Big/ (n-p)}$$

x’i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or *concentration units.*

p = Number of terms in the fitting equation. (average = 1, linear = 2, quadratic = 3)

n = Number of calibration points.

If Relative Standard Error (%RSE) ≤ 20%, then the curve can be used to quantitate target analytes in the samples.

NOTE: If any EIS was removed from a specific calibration point to meet the acceptance criteria for the initial calibration, then corresponding native compound in that calibration point must be also removed.

10.7.2.2 Initial Calibration Verification (ICV)

The validity of the initial calibration curve must be verified through the analysis of an initial calibration verification (ICV) standard. The ICV must be prepared from a second source at a mid-range concentration.

NOTE: Second source standards may consist of linear isomers only.

The %D for the compound of interest must be ≤ ±30% (70-130% of True Value). If the ICV does not meet criteria, a fresh standard must be prepared. If this ICV meets criteria, proceed with sample analysis. If the ICV still does not meet criteria, make fresh calibration standards. Recalibrate the instrument.

NOTE: Analyze the branched/linear standard to identify the branched isomers. This is a qualitative standard only. Currently it should contain branched isomers of PFOA and PFNA. This standard is loaded into LIMS as an ICV.

10.7.2.3 Bile Salt Interference Check and Branched/Linear Retention Time Check.

The separation between Taurodeoxycholic Acid (TDCA) and PFOS must be verified with each ICAL.

For QSM 5.4 the separation between Taurodeoxycholic Acid (TDCA) and PFOS must be verified daily.

Inject a mid-level PFAS standard that has been fortified with 1 ug/ml TDCA. The standard may also contain Taurochenodeoxycholic Acid (TCDCA) and Tauroursodeoxycholic Acid (TUDCA) as well.

TDCA must be separated by at least 1 minute from all branched and linear isomers of PFOS.

10.7.2.4 Branched/Linear RT Check. Analyze

The branched/linear RT standard to identify the branched isomers. This is a qualitative standard only. Currently, it should contain branched isomers of PFOA and PFNA. This standard is loaded into LIMS as an RT Check.

10.7.2.5 Highest Standard and Instrument Blank

Analyze an instrument blank (IBLK) immediately following the highest standard analyzed. The highest standard analyzed may be analyzed as part of the calibration curve or following the calibration curve. The highest standard may be at or above the concentration of highest level of calibration. It cannot be used to extend the calibration range.

The instrument blank must be analyzed immediately following the highest standard. The instrument blank must be free of any analytes of interest or interferences at or below the MDL to be acceptable.

If the acceptance criteria is not met, the concentration of the standard should be lowered and another blank analyzed.

The highest standard and instrument blank pair are used only to document the highest concentration at which carryover does not occur. If a sample concentration exceeds this range and the sample(s) following have reportable detections for that analyte, then they must be reanalyzed.

10.7.2.6 Retention Time Windows

The retention time of each analyte and extracted internal standard must fall within **0.4 minutes** of the predicted retention times from the daily calibration verification or from the midpoint standard of the ICAL (on days when an ICAL is performed).

Establish the center of the retention time window for each analyte and surrogate by using the absolute retention time for each analyte and extracted internal standard from the calibration verification standard at the beginning of the analytical shift. For samples run during the same shift as an initial calibration, use the retention time of the mid-point standard of the initial calibration.

Initial peak identification is based on the retention time of a peak falling within the retention time window for a given analyte. Time reference peaks (extracted internal standards) are used to correct for run-to-run variations in retention times due to temperature, flow, or injector fluctuations. HPLC retention times tend to shift more than GC retention times.

The retention time of the target analyte must fall within **0.1 minutes** of the associated isotope dilution standard (for analytes that have an exact isotopic counterpart).

10.7.2.7 Ion Ratios and Signal to Noise

A minimum of two transition ions are monitored for each target analyte except for those analytes in Table 2 which only have a single transition ion.

The ratio of the primary and secondary transition masses should be updated from the initial calibration. They may be updated from the midpoint standard or from an average of all levels. Additionally, the ion ratio may be updated from the opening daily CCV.

Isotope Ratio criteria is still being developed for EPA method 1633. The MassHunter software calculates the ratio as the response of the primary transition mass divided by the response of the secondary transition mass times 100. It is set to flag the analyte if the ratio of these ions is not within ± 50% of the expected, (e.g., if the ion ratio is expected to be 50% in the standard, the ion ratio in the corresponding sample must be between 25 and 75%).

Primary and secondary transition masses must maximize within ± 2 seconds.

The signal to noise ratio for the primary transition mass must be at least 3 times that of the background and the secondary transition mass must be at least 3 times that of the background.

10.7.3 Daily Calibration and Carryover Verifications

10.7.3.1 Continuing Calibration Verification (CCV)

Continuing calibration verification standards for the Perfluorinated compounds are prepared at low and mid-range concentration. CCV standards are prepared from the same stock as the initial calibration standards.

A low level CCV (Instrument Sensitivity check) must be analyzed at the beginning of each analytical sequence (prior to sample analysis) and at least once every 24 hours during the sequence to ensure accuracy at the LOQ.

The CCV must be analyzed at the beginning and end of each run to verify that the initial calibration is still valid. Additionally, the mid-point CCV must be analyzed after every 10 samples.

The percent difference (%D) for each analyte of interest will be monitored. The |%D| must be ≤ 30% for the target analytes and EIS in each CCV.

If the first continuing calibration verification does not meet criteria, a second standard may be injected. If the second standard does not meet

criteria, the system must be recalibrated. If the second standard meets criteria, then a third standard must be analyzed. If the third standard also meets criteria, then the system is considered in control and results may be reported.

If the |%D| is outside the control limits, then documented corrective action is necessary. This may include recalibrating the instrument and reanalyzing the samples, performing instrument maintenance to correct the problem and reanalyzing the samples, or qualifying the data. Qualifying the data should only be done if the sample cannot be reanalyzed. Under certain circumstances, the data may be reported,
i.e. The CCV failed high, the associated QC passed, and the samples were ND.

NOTE: Any target analytes that are detected in the samples must be bracketed by an acceptable initial calibration curve and acceptable CCV standards; otherwise, the samples must be reanalyzed, or the data must be qualified.

10.7.3.2 Carryover Verification

A high standard and an instrument blank (IBLK) must be analyzed each day prior to the analysis of samples. The high standard may be at or above the concentration of highest level of the calibration.

The instrument blank must be analyzed immediately following the high standard. The instrument blank must be free of any analytes of interest or interferences at or below the MDL to be acceptable.

If the acceptance criteria are not met, the concentration of the standard should be lowered, and another blank analyzed.

The highest standard and instrument blank pair are used only to document the highest concentration at which carryover does not occur. If sample concentrations exceed this range and the sample(s) following exceed this acceptance criteria (>1/2 LOQ), they must be reanalyzed.

10.7.3.3 Continuing Calibration Blank (CCB)

An additional blank must be analyzed after each CCV to ensure no carryover from the standard. The instrument blank must be free of any analytes of interest or interferences at ½ the required LOQ to be acceptable. The CCB is loaded into LIMS as "ICCB".

If the acceptance criteria are not met, the system should be checked. Any samples bracketed by the failing CCB must be reanalyzed.

Review the data to see if there was a high sample prior to the CCV/CCB pair that may have contaminated the system? If so, clean the system and run additional blanks to see if the system is in control.

10.7.3.4 Bile Salt Interference Check.

Inject a mid-level PFAS standard that has been fortified with 1 ug/ml TDCA. The standard may also contain Taurochenodeoxycholic Acid (TCDCA) and Tauroursodeoxycholic Acid (TUDCA) as well.

TDCA must be separated by at least 1 min relative to all of the branched and linear isomers of PFOS.

10.7.3.5 Branched.Linear RT Check

Analyze the branched/linear RT standard daily to identify the branched isomers. This is a qualitative standard only. Currently, it should contain branched isomers of PFOA and PFNA. This standard is loaded into LIMS as an RT Check

10.7.4 Sample Extract Analysis

10.7.4.1 Samples are analyzed in a set referred to as an analysis sequence or batch. A batch consists of the following:

Initial Calibration Standards
ICV
Carryover Check Standard
Instrument Blank (IBLK)
Bile Salt Interference Check
Branched/Linear RT
CCV Standards:
    Low-Level (LOQ)- Instrument Sensitivity check
    Mid-Level

QC Extracts
Sample Extracts
Bracketing CCV
Bracketing CCB

10.7.4.2 Six to ten microliters (same amount as standards) of extract is injected into the HPLC by the autosampler. The data system then records the resultant peak responses and retention times.

10.7.4.3 Tentative identification of an analyte occurs when the peak from the sample extract falls within the retention time window of the target compound.

10.7.4.4 Positive identification is confirmed by comparing the ion ratio in the sample to the ion ratio of the standards. For the linear isomer, the primary and secondary transition masses must both be present. For the branched isomers the primary and secondary transition masses should both be present. In rare circumstances a particular branched peak may only exhibit the primary transition ion. These should be omitted from the quantitation.

The MassHunter software is set to flag the analyte if the ratio of these ions is not within ± 30% of the expected, (e.g., if the ion ratio is expected to be 50% in the standard, the ion ratio in the corresponding sample must be between 20 and 80%).

The signal to noise ratio for the primary transition mass must be at least 3 times that of the background and the secondary transition mass must be at least 3 times that of the background.

10.7.4.5 Some of the PFASs may have multiple chromatographic peaks due to the presence of linear and branched isomers. This is prevalent in PFHxS and PFOS. The areas of all the linear and branched isomers peaks must be included and the concentrations reported as a total for each of these analytes.

NOTE: The branched isomers for PFOA and PFNA must be included in the quantitation even if the calibration is based on just the linear isomer.

10.7.4.6 If the compound identification does not confirm, then the result should be reported as ND.

10.7.4.7 If the analyte response exceeds the linear range of the system, the extract must be diluted and reanalyzed. It is recommended that extracts be diluted so that the response falls into the middle of the calibration curve.

Dilutions for this method are performed differently depending on the concentration of the target analytes in the extract. For dilutions in the 2x to 10x range, the extract is diluted with the dilution mix. No additional EIS nor NIS are added. NIS concentrations in the diluted samples are normalized by multiplying calculated concentration by dilution factor.

If the responses for each EIS in the diluted extract meet the S/N requirements in Section 10.7.2 and retention time requirements in Section 10.7.2.6, and the EIS recoveries from the analysis of the diluted extract are greater than 5%, then the compounds associated with those EISs may be quantified using isotope dilution.

Use the EIS recoveries from the original analysis to select the dilution factor, with the objective of keeping the EIS recoveries in the dilution above that 5% lower limit (i.e., if the EIS recovery of the affected analyte in the undiluted analysis is 50%, then the sample cannot be diluted more than 10:1; if the if the EIS recovery of the affected analyte in the undiluted analysis is 30%, then the sample cannot be diluted more than 6:1).

For dilutions greater than 10-fold, a smaller aliquot should be extracted for soil samples. The estimated analyte concentration from below can be used to determine the best aliquot size. The method requires the collection of a smaller sample size for aqueous samples in such cases (i.e., 125 mL). If aliquoting of an aqueous sample is necessary, the client must be notified prior to subsampling.

If no additional sample is available, then additional EIS and NIS are added, and the sample re-analyzed. The theoretical concentration of the isotope dilution standards in the extract will need to be entered into MassHunter so that the software can correctly calculate the native analyte concentration. This result is estimated based on an internal standard approach. The results should be footnoted as such.

10.7.4.8 If peak identification is prevented by the presence of interferences, further cleanup may be required, or the extract must be diluted so that the interference does not mask any analytes.

10.8 Maintenance and Trouble Shooting

10.8.1 All instrument maintenance must be documented in the appropriate “Instrument Repair and Maintenance” log. The log will include such items as problem, action taken, correction verification, date, and analyst.

10.8.2 Repairs performed by outside vendors must also be documented in the log. The analyst or Department Supervisor responsible for the instrument must complete the log if the repair technician does not.

10.8.3 PC and software changes must be documented in the “Instrument Repair and Maintenance” log. Software changes may require additional validation.

11.0 METHOD PERFORMANCE

11.1 Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), low-level blank spikes (LLBS), matrix spikes (MS), matrix spike duplicates (MSD) and sample duplicates (DUP). The MB, BS, LLBS are used to monitor overall method performance, while the MS and MSD or DUP are used to evaluate the method performance and reproducibility in a specific sample matrix.

11.2 The QC sample recoveries for water samples are compared to the required QC acceptance limits in table 5 and 6. The same limits must be used for soil samples until in-house limits can be developed by the laboratory.

12.0 QC REQUIREMENTS

Accuracy and matrix bias are monitored by the use of isotope dilution standards and by the analysis of a QC set that is prepared with each batch (maximum of 20 samples) of samples. The QC set consists of a method blank (MB), blank spike (BS), matrix spike (MS), matrix spike duplicate (MSD) or sample duplicate (DUP). All control limits are updated annually and are listed in the LIMS.

12.1 Initial Demonstration of Capability.
To establish the ability to generate acceptable precision and recovery, the laboratory must perform the following: four blank spikes (BS) and metho blank (MB) must be prepared and analyzed for each matrix type to be tested. Using the results, the average recovery and RSD (Relative Standard Deviation) are calculated. The average percent recovery and RSD must meet the requirements in the Table 5.

12.2 Non-Extracted Internal Standards (NIS)

12.2.1 The analytes listed in section 5.10 are used as the Non-Extracted Internals Standards for this method. The response of the NIS in all subsequent runs must be 50-200% of the average response from the initial calibration (see Table 5).

12.2.2 If the NIS responses are not within limits, the following are required.

12.2.2.1 Check to be sure that there are no errors in calculations, integrations, or internal standards solutions. If errors are found, recalculate the data accordingly.

12.2.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem, and reanalyze the sample. If no problem is found, prepare a second aliquot of extract, and reanalyze the sample.

12.2.2.3 If upon reanalysis, the responses are still not within limits reanalyze the sample at a dilution.

12.2.2.4 If upon analysis of the dilution the responses are within limits, then the sample or select analytes may need to be reported from the dilution or qualified.

12.3 Extracted Internal Standard (EIS)

12.3.1 The analytes listed in section 5.11 are used as the Extracted Internal Standards for this method.

A known amount of isotope dilution standard is added to each sample including the QC set prior to extraction. The recovery (corrected for dilution) for each isotope dilution standard must follow the limits in Table 6 for water and soil matrices.

The % recovery is calculated from the calculated concentrations.

% Recovery = (Sample Amount / Amount Spiked) X 100

Only those isotope dilution standards that directly link to the native analytes being reported need to pass. For example, 13C4-PFBA only needs to pass if PFBA is being reported.

12.3.2 If any isotope dilution standard response/recovery is not within the established control limits, the following are required.

12.3.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, isotope dilution standard solutions. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re- inject the extract to verify.

12.3.2.2 Check instrument performance. It may be necessary to re-vial and re- inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

12.3.2.3 Check for instrument suppression or enhancement by reanalyzing the sample at a dilution.

12.3.2.4 If no problem is found re-extract and reanalyze the sample. **NOTE:** If the recoveries are high and the sample is non-detect, then re-extraction may not be necessary. If there is insufficient sample for re-extraction, reanalyze the sample and footnote this on the report.

12.3.2.5 If upon reanalysis, the recovery is still not within control limits, the problem is considered matrix interference . Isotope dilution standards from both sets of analysis must be reported on the final report.

12.4 Method Blank

12.4.1 The method blank is either HPLC water or cleaned sand (depending upon sample matrix). The method blank is then taken through all procedures along with the other samples to determine any contamination from reagents, glassware, or high- level samples. The method blank must be free of any analytes of interest or interferences at ½ the required LOQ to be acceptable. If the method blank is not acceptable, corrective action must be taken to determine the source of the contamination. Samples associated with a contaminated method blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples, re-extracting and reanalyzing the samples or qualifying the results with a “B” or “V” qualifier.

12.4.2 If the MB is contaminated but the samples are non-detect, then the source of contamination must be investigated and documented. The samples may need to be re-extracted and reanalyzed for confirmation. If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers must be added to the results. This must be approved by the department supervisor.

12.4.3 If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination must be investigated and documented. The samples results may be reported with the appropriate “B” or “V” qualifier. This must be approved by the department supervisor.

12.4.4 If the MB is contaminated but the samples results are < 10 times the contamination level, the source of the contamination must be investigated and documented. The samples must be re-extracted and reanalyzed for confirmation. If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers must be added to the results. This must be approved by the department supervisor.

12.5 Blank Spike

12.5.1 The blank spike is either HPLC water or cleaned sand (depending upon sample matrix) to which the spike standard has been added. The blank spike is then taken through all procedures along with the other samples to monitor the efficiency of the extraction procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = (Blank Spike Amount / Amount Spiked) X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable (see Table 5). As additional analytes are added to this method, the recoveries will need to be carefully evaluated.

12.5.2 If the blank spike recoveries are not within the established control limits, the following are required.

12.5.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, or spike solutions. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

12.5.2.2 Check instrument performance. It may be necessary to re-vial and re- inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

12.5.2.3 If the recovery of an analyte in the BS is high and the associated sample is non-detect, the data may be reportable.

12.5.2.4 If no problem is found, the department supervisor shall review the data and determine what further corrective action is best for each particular sample. That may include reanalyzing the samples, re-extracting and reanalyzing the samples, or qualifying the results as estimated.

12.5.2.5 If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers must be added to the results. This must be approved by the department supervisor.

12.6 Low-Level Blank Spike

12.6.1 The low-level blank spike is either HPLC water or cleaned sand (depending upon sample matrix) to which the spike standard has been added at no more than 2 times the LLOQ. The low-level blank spike is then taken through all procedures along with the other samples to monitor the efficiency of the extraction procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = (Blank Spike Amount / Amount Spiked) X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable (see table 5). As additional analytes are added to this method, the recoveries will need to be carefully evaluated.

12.6.2 If the low-level blank spike recoveries are not within the established control limits, the following are required. Check to be sure that there are no errors in calculations, dilutions, integrations, or spike solutions. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

12.6.2.1 Check instrument performance. It may be necessary to re-vial and re- inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

12.6.2.2 If the recovery of an analyte in the BS is high and the associated sample is non-detect, the data may be reportable.

12.6.2.3 If no problem is found, the department supervisor shall review the data and determine what further corrective action is best for each particular sample. That may include reanalyzing the samples, re-extracting and reanalyzing the samples, or qualifying the results as estimated.

12.6.2.4 If there is insufficient sample to re-extract, or if the sample is re-extracted beyond hold time, the appropriate footnote and qualifiers must be added to the results. This must be approved by the department supervisor.

12.7 Matrix Spike and Matrix Spike Duplicate/Matrix Duplicate

12.7.1 Matrix spike and spike duplicates are second samples to which the spike standard has been added. The matrix spike and spike duplicate or matrix duplicate are then taken through all procedures along with the other samples to monitor the precision and accuracy of the procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = [(Spike Amount – Sample Amount) / Amount Spiked] X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable (see table 5).

12.7.2 If the matrix spike recoveries are not within the established control limits, the following are required.

12.7.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, or spike solutions. If errors are found, recalculate the data accordingly. If errors are suspected, re-vial and re-inject the extract to verify.

12.7.2.2 Check instrument performance. It may be necessary to re-vial and re- inject the extract in order to verify performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

12.7.2.3 If no problem is found, compare the recoveries to those of the blank spike. If the blank spike recoveries indicate that the problem is sample related, document this on the run narrative. Matrix spike recovery failures are not grounds for re-extraction but are indications of the sample matrix effects.

12.7.3 Precision

Matrix spike and spike duplicate or sample and matrix duplicate recoveries for each analyte OR sample result and duplicate result are used to calculate the relative percent difference (RPD) for each compound.

RPD = [| MS Result – MSD Result | / Average Result] X 100

The RPD for each Perfluorinated compound must be less than 30%. If the RPDs fall outside of the established control limits, the MS/MSD should be reanalyzed to ensure that there was no injection problem. If upon reanalysis the RPDs are still outside of the control limits, the department supervisor shall review the data and determine if any further action is necessary. RPD failures are generally not grounds for re-extraction.

The RPD for each Per fluorinated compound must be less than 30%. If the RPDs fall outside of the established control limits, the DUP should be reanalyzed to ensure that there was no injection problem. If upon reanalysis the RPDs are still outside of the control limits, the department supervisor shall review the data and determine if any further action is necessary. RPD failures are generally not grounds for re-extraction.

12.7.4 Accuracy assessment of the recovery of EIS and NIS compounds.

After the analysis of 30 samples of a given matrix type (water, solids, etc.), the lab must compute the recovery and the standard deviation of the percent recovery (SR) for the isotopically labeled compounds only. The assessment is expressed as a percent recovery interval from R - 2SR to R + 2SR for each matrix. The records must be maintained and assessed periodically(after every 10 new preparation batches).

13.0 CALCULATIONS

The concentration of each Perfluorinated compound in the original sample is calculated as follows:

$$\text{Water (ug/l)} = (\text{CONC}_{\text{inst}}) \text{ X } (V_F / V_I) \text{ X DF}$$

$$\text{Soil (ug/kg)} = [(\text{CONC}_{\text{inst}}) \text{ X } (V_F / W_I) \text{ X DF}] / \%\text{solids}$$

$\text{CONC}_{\text{inst}}$ = Instrument concentration calculated from the initial calibration using mean CF or curve fit (ppb)
DF = Dilution Factor
V_F = Volume of final extract (ml)
V_I = Volume of sample extracted (ml)
W_I = Weight of sample extracted (g)
% solids = Dry weight determination in decimal form

14.0 DOCUMENTATION

14.1 The Analytical Logbook is a record of the analysis sequence; the logbook must be completed daily. Each instrument will have a separate logbook.

14.1.1 If samples require reanalysis, a brief explanation of the reason must be documented in this log.

14.1.2 Overwriting of data files is never allowed.

14.2 The Standard Preparation Logbook must be completed for all standard preparations. All information requested must be completed; the page must be signed and dated by the respective person.

14.2.1 The SGS Lot Number must be cross-referenced on the standard vial.

14.3 The Instrument Maintenance Logbook must be completed when any type of maintenance is performed on the instrument. Each instrument has a separate log.

14.4 Any corrections to laboratory data must be done using a single line through the error. The initials of the person and date of correction must appear next to the correction.

14.5 Unused blocks of any form must be X'ed or Z'ed out by the analyst before submitting the data for review.

14.6 Supervisory (or peer) personnel must routinely review (at least once per month) all laboratory logbooks to ensure that information is being recorded properly. Additionally, the maintenance of the logbooks and the accuracy of the recorded information must also be verified during this review.

15.0 DATA REVIEW AND REPORTING

15.1 Initial and continuing calibration check. Verify that all calibration and continuing calibration criteria have been achieved. If the criteria had not been achieved, corrective action must be performed to bring the system in control before analyzing any samples.

15.1.1 If samples had been analyzed under non-compliant calibration criteria, all sample extracts must be re-analyzed once the system is brought into control.

15.2 Quality Control Data Review. Review all QC data. If QC criteria were not achieved, perform corrective action before proceeding with analysis.

15.2.1 In some situation, corrective action may demand that the entire sample batch be re-extracted and re-analyzed before processing data.

15.3 Chromatogram Review. The chromatogram of each sample is evaluated for target analytes.

15.3.1 Each sample may require the reporting of different target analytes. Review the login to assure that the correct target compounds are identified.

15.3.2 Manual integration of chromatographic peaks must be identified by the analysts. Upon review, the supervisor will initial and date the changes made to the report.

15.4 Transfer to LIMS. Following the initial screen review, transfer the processed data to the LIMS.

15.4.1 Compare the printed values to the original values to verify transfer accuracy.

15.4.2 If transfer errors occured, the errors must be corrected before the data is re-submitted.

15.4.3 The results in LIMS are reported in ug/L for water samples and in ug/Kg on a dry-weight basis for soil samples. All results in the samples and blanks are reported to the MDL as per the laboratory policy (refer to the SOP EQA035).

16.0 POLLUTION PREVENTION & WASTE MANAGEMENT

16.1 Wastewater and acetonitrile from the instrument are collected in waste storage bottles and are eventually transferred to the non-chlorinated waste drum.

16.2 Sample Extracts are archived and stored for 30 days after analysis. Old extracts and standards are disposed of in the waste vial drum.

17.0 REFERENCES

17.1 EPA Method 1633, Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS, January 2024.

Table 1 : Target Analytes

PFAS Analyte	Acronym	CAS #
Perfluorobutanoic acid	PFBA	375-22-4
Perfluoropentanoic acid	PFPeA	2706-90-3
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorononanoic acid	PFNA	375-95-1
Perfluorodecanoic acid	PFDA	335-76-2
Perfluoroundecanoic acid	PFUnA	2058-94-8
Perfluorododecanoic acid	PFDoA	307-55-1
Perfluorotridecanoic acid	PFTriA	72629-94-8
Perfluorotetradeconoic acid	PFTeA	376-06-7
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluoropentanesulfonic acid	PFPeS	2706-91-4
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorononanesulfonic acid	PFNS	68259-12-1
Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluorododecanesulfonic acid	PFDoDS	79780-39-5
4:2 Fluorotelomer sulfonate	4:2 FTS	757124-72-4
6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2
8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4
3:3 Fluorotelomer carboxylate	3:3 FTCA	356-02-5
5:3 Fluorotelomer carboxylate	5:3 FTCA	914637-49-3
7:3 Fluorotelomer carboxylate	7:3 FTCA	812-70-4
N-ethyl perfluorooctanesulfonamido acetic acid	EtFOSAA	2991-50-6
N-methyl perfluorooctanesulfonamido acetic acid	MeFOSAA	2355-31-9
Perfluorooctane sulfonamide	PFOSA	754-91-6
N-Ethyl perfluorooctane sulfonamide	EtFOSA	4151-50-2

N-Methyl perfluorooctane sulfonamide	MeFOSA	31506-32-8
N-Ethyl perfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2
N-Methyl perfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6
11-chloroicosafluoro-3-oxaundecade-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6
Perfluoro(2-ethoxyethane) sulfonic acid	PFEESA	113507-82-7
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5

TABLE 2: Precursor and Primary Transition Masses

Analyte	Type	RT	Primary Transition	Secondary Transition	Reference Compound
13C3-PFBA	NIS	3.34	216.0 -> 172.0		
13C4-PFBA	EIS	3.34	216.8 -> 171.9		13C3-PFBA
PFBA	Target	3.34	212.8 -> 168.9		13C4-PFBA
PFMPA	Target	3.99	229.0 -> 84.9		13C5-PFPeA
3:3FTCA	Target	4.32	241.0 -> 177.0	241.0 -> 117.0	13C5-PFPeA
13C5-PFPeA	EIS	4.93	268.3 -> 223.0		13C2-PFHxA
PFPeA	Target	4.93	263.0 -> 219.0		13C5-PFPeA
PFMBA	Target	5.38	279.0 -> 85.1		13C5-PFPeA
13C2-4:2FTS	EIS	5.85	329.1 -> 80.9		18O2-PFHxS
4:2FTS	Target	5.85	327.1 -> 307.0	327.1 -> 80.9	13C2-4:2FTS
NFDHA	Target	6.08	295.0 -> 201.0	295.0 -> 84.9	13C5-PFHxA
13C3-PFBS	EIS	6.15	302.1 -> 79.9		18O2-PFHxS
PFBS	Target	6.15	298.7 -> 79.9	298.7 -> 98.8	13C3-PFBS
13C2-PFHxA	NIS	6.20	315.1 -> 270.0		
13C5-PFHxA	EIS	6.20	318.0 -> 273.0		13C2-PFHxA
PFHxA	Target	6.20	313.0 -> 269.0	313.0 -> 118.9	13C5-PFHxA
13C3-HFPO- DA	EIS	6.59	286.9 -> 168.9		13C2-PFHxA
HFPO-DA	Target	6.59	284.9 -> 168.9	284.9 -> 184.9	13C3-HFPO-DA
PFEESA	Target	6.71	314.8 -> 134.9	314.8 -> 82.9	13C5-PFHxA
5:3FTCA	Target	6.82	341.0 -> 237.1	341.0 -> 217.0	13C5-PFHxA
13C4-PFHpA	EIS	7.14	367.1 -> 322.0		13C2-PFHxA

PFHpA	Target	7.14	363.1 -> 319.0	363.1-> 169.0	13C4-PFHpA
PFPeS	Target	7.22	349.1 -> 79.9	349.1 -> 98.9	13C3-PFHxS
ADONA	Target	7.40	376.8 -> 250.9	376.8 -> 84.8	13C3-HFPO-DA
13C2-6:2FTS	EIS	7.56	429.1 -> 80.9		18O2-PFHxS
6:2FTS	Target	7.56	427.1 -> 407.0	427.1 -> 80.9	13C2-6:2FTS
13C4-PFOA	NIS	7.81	417.1 -> 172.0	417.1 -> 372.0	
13C8-PFOA	EIS	7.81	421.0 -> 376.0		13C4-PFOA
PFOA	Target	7.81	413.0 -> 369.0	413.0 -> 169.0	13C8-PFOA
PFHxS	Target	7.96	398.9 -> 79.9	398.9 -> 98.9	13C3-PFHxS
18O2-PFHxS	NIS	7.97	403.0 -> 83.9		
13C3-PFHxS	EIS	7.97	402.1 -> 79.9		18O2-PFHxS
7:3FTCA	Target	8.27	441.0 -> 316.9	441.0 -> 336.9	13C5-PFHxA
13C5-PFNA	NIS	8.40	468.0 -> 427.0		
13C9-PFNA	EIS	8.40	472.1 -> 427.0		13C5-PFNA
PFNA	Target	8.40	463.0 -> 419.0	463.0 -> 219.0	13C9-PFNA
PFHpS	Target	8.58	449.0 -> 79.9	449.0 -> 98.8	13C8-PFOS
13C2-8:2FTS	EIS	8.69	529.1 -> 80.9		18O2-PFHxS
8:2FTS	Target	8.70	527.1 -> 507.0	527.1 -> 80.8	13C2-8:2FTS
13C2-PFDA	NIS	8.95	515.1 -> 470.1		
13C6-PFDA	EIS	8.95	519.1 -> 474.1		13C2-PFDA
PFDA	Target	8.95	512.9 -> 469.0	512.9 -> 219.0	13C6-PFDA
d3-MeFOSAA	EIS	8.97	573.2 -> 419.0		13C4-PFOS
MeFOSAA	Target	8.97	570.1 -> 419.0	570.1 -> 483.0	d3-MeFOSAA
13C4-PFOS	NIS	9.14	503.8 -> 79.9		
13C8-PFOS	EIS	9.13	507.1 -> 79.9		13C4-PFOS
PFOS	Target	9.14	498.9 -> 79.9	498.9 -> 98.8	13C8-PFOS
d5-EtFOSAA	EIS	9.19	589.2 -> 419.0		13C4-PFOS
EtFOSAA	Target	9.20	584.2 -> 419.1	584.2 -> 526.0	d5-EtFOSAA
13C7-	EIS	9.44	570.0 -> 525.1		13C2-PFDA
PFUnDA	Target	9.44	563.1 -> 519.0	563.1 -> 269.1	13C7-PFUnDA
9Cl-PF3ONS	Target	9.49	530.8 -> 351.0	532.8 -> 353.0	13C3-HFPO- DA
PFNS	Target	9.63	548.8 -> 79.9	548.8 -> 98.8	13C8-PFOS
13C2-	EIS	9.87	615.1 -> 570.0		13C2-PFDA
PFDoDA	Target	9.87	613.1 -> 569.0	613.1 -> 319.0	13C2-PFDoDA
PFDS	Target	10.05	599.0 -> 79.9	599.0 -> 98.8	13C8-PFOS
13C8-FOSA	EIS	10.23	506.1 -> 77.8		13C4-PFOS
FOSA	Target	10.23	498.1 -> 77.9	498.1 -> 478.0	13C8-FOSA
PFTrDA	Target	10.26	663.0 -> 619.0	663.0 -> 168.9	13C2-PFDoDA
11Cl-	Target	10.32	630.9 -> 451.0	632.9 -> 453.0	13C3-HFPO- DA
13C2-PFTeDA	EIS	10.60	715.1 -> 670.0		13C2-PFDA
PFTeDA	Target	10.60	713.1 -> 669.0	713.1 -> 168.9	13C2-PFTeDA

PFDoDS	Target	10.75	699.1 -> 79.9	699.1 -> 98.8	13C8-PFOS
d7-MeFOSE	EIS	11.21	623.1 -> 58.9		13C4-PFOS
MeFOSE	Target	11.22	616.1 -> 58.9		d7-MeFOSE
d3-MeFOSA	EIS	11.30	515.0 -> 219.0		13C4-PFOS
MeFOSA	Target	11.30	512.0 -> 219.0	512.0 -> 169.0	d3-MeFOSA
d9-EtFOSE	EIS	11.45	639.1 -> 58.9		13C4-PFOS
EtFOSE	Target	11.46	630.0 -> 58.9		d9-EtFOSE
d5-EtFOSA	EIS	11.53	531.1 -> 219.0		13C4-PFOS
EtFOSA	Target	11.53	526.0 -> 219.0	526.0 -> 169.0	d5-EtFOSA

TABLE 3: Standard Levels (Targets), ng/ml

Compound	CS1	CS2	CS3	CS4 (CV1)	CS5	CS6	CS7	CS8
Perfluoroalkyl carboxylic acids								
PFBA	0.8	1.6	5.0	10	20	50	100	250
PFPeA	0.4	0.8	2.5	5	10	25	50	125
PFHxA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFHpA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFOA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFNA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFDA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFUnA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFDoA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFTrDA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
PFTeDA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
Perfluoroalkyl sulfonic acids								
PFBS	0.177	0.354	1.109	2.218	4.435	11.087	22.17	55.438
PFPeS	0.188	0.376	1.176	2.353	4.705	11.762	23.52	58.813
PFHxS	0.183	0.366	1.143	2.285	4.570	11.425	22.85	57.125
PFHpS	0.191	0.382	1.191	2.383	4.765	11.912	23.82	59.563
PFOS	0.186	0.372	1.160	2.320	4.640	11.600	23.20	58.000
PFNS	0.192	0.384	1.203	2.405	4.810	12.025	24.05	60.125
PFDS	0.193	0.386	1.206	2.413	4.825	12.062	24.12	60.313
PFDoS	0.194	0.388	1.213	2.425	4.850	12.125	24.25	60.625
Fluorotelomer sulfonic acids								
4:2FTS	0.750	1.500	4.688	9.375	18.75	46.87	93.75	234.37
6:2FTS	0.760	1.520	4.750	9.500	19.00	47.50	95.00	237.50
8:2FTS	0.768	1.536	4.800	9.600	19.20	48.00	96.00	240.00
Perfluorooctane sulfonamides								
PFOSA	0.4	0.8	2.5	5	10	25	50	125
NMeFOSA	0.4	0.8	2.5	5	10	25	50	125
NEtFOSA	0.4	0.8	2.5	5	10	25	50	125
Perfluorooctane								
NMeFOSAA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
NEtFOSAA	0.2	0.4	1.25	2.5	5.0	12.5	25	62.5
Perfluorooctane sulfonamide								
NMeFOSE	1	2.0	6.25	12.5	25	62.5	125	312.5
NEtFOSE	1	2.0	6.25	12.5	25	62.5	125	312.5
Per- and polyfluoroether								

HFPO-DA	0.8	1.6	5.0	10	20	50	100	250
ADONA	0.756	1.512	4.725	9.45	18.9	47.25	94.5	236.25
PFMPA	0.4	0.8	2.5	5.0	10	25	50	125
PFMBA	0.4	0.8	2.5	5.0	10	25	50	125
NFDHA	0.4	0.8	2.5	5.0	10	25	50	125
Ether sulfonic acids								
9Cl-PF3ONS	0.748	1.496	4.675	9.35	18.7	46.75	93.5	233.75
11Cl-PF3OUdS	0.756	1.512	4.725	9.45	18.9	47.25	94.5	236.25
PFEESA	0.356	0.712	2.225	4.45	8.90	22.25	44.5	111.25
Fluorotelomer carboxylic acids								
3:3FTCA	0.9984	1.997	6.24	12.48	25.0	62.4	124.8	312.0
5:3FTCA	4.992	9.984	31.20	62.4	124.8	312.0	624.0	1560
7:3FTCA	4.992	9.984	31.20	62.4	124.8	312.0	624.0	1560
Extracted Internal Standard (EIS)								
13C4-PFBA	10	10	10	10	10	10	10	10
13C5-PFPeA	5	5	5	5	5	5	5	5
13C5-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C9-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C6-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C7-PFUnA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C3-PFBS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C3-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C2-4:2 FTS	5	5	5	5	5	5	5	5
13C2-6:2 FTS	5	5	5	5	5	5	5	5
13C2-8:2 FTS	5	5	5	5	5	5	5	5
13C8-PFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D5-NEtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSAA	5	5	5	5	5	5	5	5
D5-NEtFOSAA	5	5	5	5	5	5	5	5
D7-NMeFOSE	25	25	25	25	25	25	25	25
D9-NEtFOSE	25	25	25	25	25	25	25	25
13C3-HFPO-DA	10	10	10	10	10	10	10	10
Non-extracted Internal Standard								
13C3-PFBA	5	5	5	5	5	5	5	5
13C2-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C5-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
18O2-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

TABLE 4 : Method Names vs Lab Names

METHOD		**LABORATORY**		
ANALYTE NAME	**ACRONYM**	**LIMS REPORT NAME**	**RAW DATA NAME**	**RAW DATA EIS as ISTD**
Perfluorobutanoic acid	PFBA	Perfluorobutanoic acid	PFBA	
Perfluoropentanoic acid	PFPeA	Perfluoropentanoic acid	PFPeA	
Perfluorohexanoic acid	PFHxA	Perfluorohexanoic acid	PFHxA	
Perfluoroheptanoic acid	PFHpA	Perfluoroheptanoic acid	PFHpA	
Perfluorooctanoic acid	PFOA	Perfluorooctanoic acid	PFOA	
Perfluorononanoic acid	PFNA	Perfluorononanoic acid	PFNA	
Perfluorodecanoic acid	PFDA	Perfluorodecanoic acid	PFDA	
Perfluoroundecanoic acid	PFUnA	Perfluoroundecanoic acid	PFUnDA	
Perfluorododecanoic acid	PFDoA	Perfluorododecanoic acid	PFDoDA	
Perfluorotridecanoic acid	PFTrDA	Perfluorotridecanoic acid	PFTrDA	
Perfluorotetradecanoic acid	PFTeDA	Perfluorotetradecanoic acid	PFTeDA	
Perfluorobutanesulfonic acid	PFBS	Perfluorobutanesulfonic acid	PFBS	
Perfluoropentanesulfonic acid	PFPeS	Perfluoropentanesulfonic acid	PFPeS	
Perfluorohexanesulfonic acid	PFHxS	Perfluorohexanesulfonic acid	PFHxS	
Perfluoroheptanesulfonic acid	PFHpS	Perfluoroheptanesulfonic acid	PFHpS	
Perfluorooctanesulfonic acid	PFOS	Perfluorooctanesulfonic acid	PFOS	
Perfluorononanesulfonic acid	PFNS	Perfluorononanesulfonic acid	PFNS	
Perfluorodecanesulfonic acid	PFDS	Perfluorodecanesulfonic acid	PFDS	
Perfluorododecanesulfonic acid	PFDoS	Perfluorododecanesulfonic acid	PFDoDS	
1H ,1H ,2H ,2H -Perfluorohexane sulfonic acid	4:2FTS	4:2 Fluorotelomer sulfonate	4:2FTS	
1H ,1H ,2H ,2H -Perfluorooctane sulfonic acid	6:2FTS	6:2 Fluorotelomer sulfonate	6:2FTS	
1H ,1H ,2H ,2H -Perfluorodecane sulfonic acid	8:2FTS	8:2 Fluorotelomer sulfonate	8:2FTS	
Perfluorooctanesulfonamide	PFOSA	PFOSA	FOSA	
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	EtFOSAA	EtFOSAA	
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	MeFOSAA	MeFOSAA	
N-ethyl perfluorooctanesulfonamide	NEtFOSA	EtFOSA	EtFOSA	
N-methyl perfluorooctanesulfonamide	NMeFOSA	MeFOSA	MeFOSA	
N-ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	EtFOSE	MeFOSE	
N-methyl perfluorooctanesulfonamidoethanol	NMeFOSE	MeFOSE	EtFOSE	
Hexafluoropropylene oxide dimer acid	HFPO-DA	HFPO-DA (GenX)	HFPO-DA	
4,8-dioxa-3H-perfluorononanoic acid	ADONA	ADONA	ADONA	
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	9Cl-PF3ONS (F-53B Major)	9Cl-PF3ONS	
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	11Cl-PF3OUdS (F-53B Minor)	11Cl-PF3OUdS	
Perfluoro-3-methoxypropanoic acid	PFMPA	PFMPA	PFMPA	
Perfluoro-4-methoxybutanoic acid	PFMBA	PFMBA	PFMBA	
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	NFDHA	NFDHA	

Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	PFEESA	PFEESA	
3-Perfluoropropyl propanoic acid	3:3FTCA	3:3 Fluorotelomer carboxylate	3:3FTCA	
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	5:3 Fluorotelomer carboxylate	5:3FTCA	
3-Perfluoroheptyl propanoic acid	7:3FTCA	7:3 Fluorotelomer carboxylate	7:3FTCA	
Perfluoro-n-[13C4]butanoic acid	13C4-PFBA	13C4-PFBA	13C4-PFBA	M4-PFBA
Perfluoro-n-[13C5]pentanoic acid	13C5-PFPeA	13C5-PFPeA	13C5-PFPeA	M5-PFPeA
Perfluoro-n-[1,2,3,4,6-13C5]hexanoic acid	13C5-PFHxA	13C5-PFHxA	13C5-PFHxA	M5-PFHxA
Perfluoro-n-[1,2,3,4-13C4]heptanoic acid	13C4-PFHpA	13C4-PFHpA	13C4-PFHpA	M4-PFHpA
Perfluoro-n-[13C8]octanoic acid	13C8-PFOA	13C8-PFOA	13C8-PFOA	M8-PFOA
Perfluoro-n-[13C9]nonanoic acid	13C9-PFNA	13C9-PFNA	13C9-PFNA	M9-PFNA
Perfluoro-n-[1,2,3,4,5,6-13C6]decanoic acid	13C6-PFDA	13C6-PFDA	13C6-PFDA	M6-PFDA
Perfluoro-n-[1,2,3,4,5,6,7-13C7]undecanoic acid	13C7-PFUnA	13C7-PFUnDA	13C7-PFUnDA	M7-PFUnDA
Perfluoro-n-[1,2-13C2]dodecanoic acid	13C2-PFDoA	13C2-PFDoDA	13C2-PFDoDA	M2-PFDoDA
Perfluoro-n-[1,2-13C2]tetradecanoic acid	13C2-PFTeDA	13C2-PFTeDA	13C2-PFTeDA	M2-PFTeDA
Perfluoro-1-[2,3,4-13C3]butanesulfonic acid	13C3-PFBS	13C3-PFBS	13C3-PFBS	M3-PFBS
Perfluoro-1-[1,2,3-13C3]hexanesulfonic acid	13C3-PFHxS	13C3-PFHxS	13C3-PFHxS	M3-PFHxS
Perfluoro-1-[13C8]octanesulfonic acid	13C8-PFOS	13C8-PFOS	13C8-PFOS	M8-PFOS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2]hexanesulfonic acid	13C2-4:2FTS	13C2-4:2FTS	13C2-4:2FTS	M2-4:2FTS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2]octanesulfonic acid	13C2-6:2FTS	13C2-6:2FTS	13C2-6:2FTS	M2-6:2FTS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2]decanesulfonic acid	13C2-8:2FTS	13C2-8:2FTS	13C2-8:2FTS	M2-8:2FTS
Perfluoro-1-[13C8]octanesulfonamide	13C8-PFOSA	13C8-FOSA	13C8-FOSA	M8-FOSA
N-ethyl-d5-perfluoro-1-octanesulfonamide	D5-NEtFOSA	d5-EtFOSA	d5-EtFOSA	M5-EtFOSA
N-methyl-d3-perfluoro-1-octanesulfonamide	D3-NMeFOSA	d3-MeFOSA	d3-MeFOSA	M3-MeFOSA
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	D5-NEtFOSAA	d5-EtFOSAA	d5-EtFOSAA	M5-EtFOSAA
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	D3-NMeFOSAA	d3-MeFOSAA	d3-MeFOSAA	M3-MeFOSAA
N-methyl-d7-perfluorooctanesulfonamidoethanol	D7-NMeFOSE	d7-MeFOSE	d7-MeFOSE	M7-MeFOSE
N-ethyl-d9-perfluorooctanesulfonamidoethanol	D9-NEtFOSE	d9-EtFOSE	d9-EtFOSE	M9-EtFOSE
Tetrafluoro-2-heptafluoropropoxy-13C3-propanoic acid	13C3-HFPO-DA	13C3-HFPO-DA	13C3-HFPO-DA	M3-HFPO-DA
Perfluoro-n-[2,3,4-13C3]butanoic acid	13C3-PFBA	13C3-PFBA	13C3-PFBA	
Perfluoro-n-[1,2,3,4-13C4]octanoic acid	13C4-PFOA	13C4-PFOA	13C4-PFOA	
Perfluoro-n-[1,2-13C2]decanoic acid	13C2-PFDA	13C2-PFDA	13C2-PFDA	
Perfluoro-n-[1,2,3,4-13C4]octanesulfonic acid	13C4-PFOS	13C4-PFOS	13C4-PFOS	
Perfluoro-1-hexane[18O2]sulfonic acid	18O2-PFHxS	18O2-PFHXS	18O2-PFHxS	
Perfluoro-n-[1,2-13C2]hexanoic acid	13C2-PFHxA	13C2-PFHXA	13C2-PFHxA	
Perfluoro-n-[1,2,3,4,5-13C5]nonanoic acid	13C5-PFNA	13C5-PFNA	13C5-PFNA	

Table 5. Acceptance QC limits for wastewater and soil samples

Compounds	iDOC Recovery (%)	iDOC RSD (%)	BS/BS-LL Recovery (%)
PFBA	70-135	21	70-140
PFPeA	70-135	23	65-135
PFHxA	70-135	24	70-145
PFHpA	70-135	28	70-150
PFOA	65-155	27	70-150
PFNA	70-140	28	70-150
PFDA	65-140	26	70-140
PFUnA	70-135	29	70-145
PFDoA	70-130	21	70-140
PFTrDA	60- 145	29	65-140
PFTeDA	70-145	27	60-140
PFBS	70-140	23	60-145
PFPeS	70-135	25	65-140
PFHxS	70-135	27	65-145
PFHpS	70-140	30	70-150
PFOS	70-140	29	55-150
PFNS	70-135	29	65-145
PFDS	70-135	30	60-145
PFDoS	45-135	35	50 – 145
4:2FTS	70 – 135	27	70-145
6:2FTS	70-135	32	65-155
8:2FTS	70-140	33	60-150
PFOSA	70-135	22	70-145
NMeFOSA	70-135	30	60-150
NEtFOSA	70-130	26	65 – 145
NMeFOSAA	65-140	32	50-140
NEtFOSAA	70-135	28	70-145
NMeFOSE	70-135	29	70-145
NEtFOSE	70-130	21	70-135
HFPO-DA	70 – 135	23	70-140
ADONA	70-135	23	65-145
PFMPA	60-140	23	55-140
PFMBA	65 – 145	27	60-150
NFDHA	65-140	37	50-150
9Cl-PF3ONS	70-145	30	70-155

	iDOC		
Compounds	**Recovery (%)**	**RSD (%)**	**BS/BS-LL Recovery (%)**
11Cl-PF3OUdS	50-150	35	55-160
PFEESA	70-135	25	70-140
3:3FTCA	70-130	23	65-130
5:3FTCA	70 – 130	24	70-135
7:3FTCA	55 – 130	34	50 – 145

Table 6. QC Acceptance Limits for EIS and NIS Recoveries in wastewater and soil samples

EIS Compound	**Recovery Range (%)**
13C$_4$-PFBA	5 – 130 *
13C$_5$-PFPeA	40-130
13C5-PFHxA	40-130
13C$_4$-PFHpA	40-130
13C$_8$-PFOA	40-130
13C$_9$-PFNA	40-130
13C$_6$-PFDA	40-130
13C$_7$-PFUnA	30 – 130
13C$_2$-PFDoA	10 – 130
13C$_2$-PFTeDA	10 – 130
13C$_3$-PFBS	40-135
13C$_3$-PFHxS	40-130
13C$_8$-PFOS	40-130
13C$_2$-4:2FTS	40 – 220
13C$_2$-6:2FTS	40 – 200
13C$_2$-8:2FTS	40-300
13C$_8$-PFOSA	40 – 130
D$_3$-NMeFOSA	10 – 130
D$_5$-NEtFOSA	10 – 130
D$_3$-NMeFOSAA	35-170
D$_5$-NEtFOSAA	25-135
D$_7$-NMeFOSE	10 – 130
D$_9$-NEtFOSE	10 – 130
13C$_3$-HFPO-DA	40-130
13C3-PFBA	50-200
13C2-PFHxA	
13C4-PFOA	
13C5-PFNA	
13C2-PFDA	
18O2-PFHxS	
13C4-PFOS	

* Recovery of 13C4-PFBA can be problematic in some field samples. Although the lower limit for recovery for this EIS is set below 10%, laboratories should routinely track recovery of this EIS and take reasonable steps to ensure that recovery is at least 10% in the majority of samples.

Current Version Revision Information

Changes / Edits made (this should include added or deleted information within a sentence or paragraph only):

Section / Subsection	Detailed description of what was revised
Reference,15.1	Reference updated to the most current method reference.
2.1	Updated the method reference.
Table 6	Recovery limits for $13C_2$-4:2FTS and D_3-NMeFOSAA is revised according to the EPA method 1633

Sections or Subsections deleted:

Section / Subsection	Reason section or subsection was removed

Sections or Subsections added:

Section / Subsection	Reason section or subsection was added

History of Revisions

Version #	Date of Revision	Revised By
00	01/05/2023	Anita Jagtap
01	05/22/2023	Olga Azarian
02	06/20/2023	Olga Azarian
03	07/21/2023	Olga Azarian
04	8/8/2023	Olga Azarian
05	01/04/2023	Olga Azarian
06	2/05/2024	Olga Azarian
07	03/21/2024	Raj Singh

END OF DOCUMENT

ATTACHMENT B

Chain of Custody Forms

Hampton-Clarke, Inc. (WBE/DBE/SBE)
175 US Highway 46 and 2 Madison Road, Fairfield, New Jersey 07004
Ph: 800-426-9992 | 973-244-9770 Fax: 973-244-9787 | 973-439-1458

Service Center: 137-D Gaither Drive, Mount Laurel, New Jersey 08054
Ph (Service Center): 856-780-6057 Fax: 856-780-6056

Hampton-Clarke
WBE/DBE/SBE 800-426-9992

CHAIN OF CUSTODY RECORD

A Women-Owned, Disadvantaged, Small Business Enterprise

Project# (Lab Use Only)

Page _______ of _______

NELAC/NJ #07071 | PA #68-00463 | NY #11408 | CT #PH-0671 | KY #90124 | DE HSCA Approved

Customer Information

1a) Customer: ______________________
Address: ______________________
____
1b) Email/Cell/Fax/Ph: ______________________
1c) Send Invoice to: ______________________
1d) Send Report to: ______________________

Project Information

2a) Project: ______________________
____
2b) Project Mgr: ______________________
2c) Project Location (City/State): ______________________
2d) Quote/PO # (If Applicable): ______________________

3) Reporting Requirements (Please Circle)

Turnaround	Report Type	Electronic Data Deliv.
When Available:	Summary	NJ Hazsite
1 Business Day (100%) *	Results + QC (Waste)	Excel Reg. NJ / NY / PA
2 Business Days (75%) *	Reduced:	EnviroData
3 Business Days (50%) *	[ ] NJ [ ] NY	EQuIS:
4 Business Days (35%) *	[ ] PA [ ] Other___	[ ] 4-File [ ] EZ
5 Business Days (25%)	NJ Full / NY ASP CatB	[ ] NYDEC
8 Business Days (Stand.)	NY ASP CatA	[ ] Region 2 or 5
Other: ______________		Other: ______________

*** Expedited TAT Not Always Available. Please Check with Lab.**

FOR LAB USE ONLY
↓
Batch #

===> Check If Contingent ===>

Matrix Codes
DW - Drinking Water **S** - Soil **A** - Air
GW - Ground Water **SL** - Sludge
WW - Waste Water **OL** - Oil
OT - Other (please specify under item 9, Comments)

7) Analysis *(specify methods & parameter lists)*

<=== Check If Contingent <===

8) # of Bottles

Lab Sample #	4) Customer Sample ID	5) Matrix	6) Sample Date	Time	Sample Type Composite (C)	Grab (G)												None	MeOH	En Core	NaOH	HCl	H2SO4	HNO3	Other:	9) Comments

10) Relinquished by:	Accepted by:	Date	Time

Comments, Notes, Special Requirements, HAZARDS

Indicate if low-level methods required to meet current groundwater standards (SPLP for soil):
☐ **BN or BNA (8270E SIM)**
☐ **VOC (8260D SIM or 8011)**
☐ **SPLP (BN, BNA, Metals)**
☐ **1,4 Dioxane**

For NJ LSRP projects, indicate which standards need to be met:
☐ **NJDEP GWQS**
☐ **NJDEP SRS**
☐ **NJDEP SPLP**
☐ **Other (specify):**

Check if applicable:
☐ **Project-Specific Reporting Limits**
☐ **High Contaminant Concentrations**
☐ **NJ LSRP Project** (also check boxes above/right)

Cooler Temperature

11) Sampler (print name): **Date:**

Additional Notes

Please note NUMBERED items. If not completed your analytical work may be delayed.
A fee of $5/sample will be assessed for storage should sample not be activated for any analysis.

AIR ANALYSIS

CHAIN OF CUSTODY

PAGE_______ OF _______

320 Forbes Blvd, Mansfield, MA 02048
TEL: 508-822-9300 FAX: 508-822-3288

Date Rec'd in Lab:

ALPHA Job #:

Client Information

Client:

Address:

Phone:

Fax:

Email:

☐ These samples have been previously analyzed by Alpha

Project Information

Project Name:

Project Location:

Project #:

Project Manager:

ALPHA Quote #:

Turn-Around Time

☐ Standard ☐ RUSH *(only confirmed if pre-approved!)*

Date Due: **Time:**

Report Information - Data Deliverables

- ☐ FAX
- ☐ ADEx
  - Criteria Checker: __________
  - *(Default based on Regulatory Criteria Indicated)*
  - Other Formats: __________
- ☐ EMAIL (standard pdf report)
- ☐ Additional Deliverables:

Report to: (if different than Project Manager)

Billing Information

☐ Same as Client info PO #:

Regulatory Requirements/Report Limits

State/Fed	*Program*	*Res / Comm*

Other Project Specific Requirements/Comments:

Project-Specific Target Compound List: ☐

ANALYSIS

All Columns Below Must Be Filled Out

ALPHA Lab ID (Lab Use Only)	Sample ID	COLLECTION					Sample Matrix*	Sampler's Initials	Can Size	I D Can	I D - Flow Controller	TO-15	TO-15 SIM	APH	☐ Subtract Non-petroleum HCs	Fixed Gases	Sulfides & Mercaptans by TO-15		Sample Comments (i.e. PID)
		End Date	Start Time	End Time	Initial Vacuum	Final Vacuum													

**SAMPLE MATRIX CODES*

AA = Ambient Air (Indoor/Outdoor)
SV = Soil Vapor/Landfill Gas/SVE
Other = Please Specify

Container Type								

Relinquished By:	Date/Time	Received By:	Date/Time:

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Terms and Conditions.
See reverse side.

Form No: 101-02 Rev: (25-Sep-15)

APPENDIX C

Community Air Monitoring Plan

COMMUNITY AIR MONITORING PLAN

The Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area at the Site. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities do not spread contamination off-site through the air.

Community Air Monitoring Plan

Real-time air monitoring for VOCs and observations of particulate levels at the perimeter of the work areas will be completed during all ground-intrusive activities. Note that the CAMP will not be implemented during surveying, groundwater monitoring well development or groundwater sampling.

VOC Monitoring, Response Levels, and Actions

VOCs will be monitored at the downwind and upwind perimeters of each designated work area on a continuous basis. Upwind concentrations will be monitored to establish background conditions, particularly if wind direction changes. The monitoring work will be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment will be calibrated daily. The equipment will be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities will be temporarily halted and monitoring will continue. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.
2. If total organic vapor levels at the downwind perimeter of the work area persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring will continue. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the work area or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.
3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.
4. All 15-minute readings will be recorded and will be available for State (NYSDEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes will also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations will be monitored continuously at the upwind and downwind locations of the borings at temporary particulate monitoring stations. The particulate monitoring will be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment will be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration will be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques will be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 $\mu g/m^3$ above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 $\mu g/m^3$ above the upwind level, work will be stopped and a re-evaluation of activities will be initiated. Work will be able to be resumed provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 $\mu g/m^3$ of the upwind level and in preventing visible dust migration.

3. All readings will be recorded and be available for State (NYSDEC and NYSDOH) personnel to review.

APPENDIX D

Health and Safety Plan

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Mariners Marsh Park
3418 Richmond Terrace
Staten Island, New York

Prepared for:
City of New York
Department of Parks & Recreation

Prepared by:
TRC Engineers, Inc.
1407 Broadway, Suite 3301
New York, New York 10018
TRC Project No. No. 554398

SEPTEMBER 2024

Table of Contents

Figures

Appendices

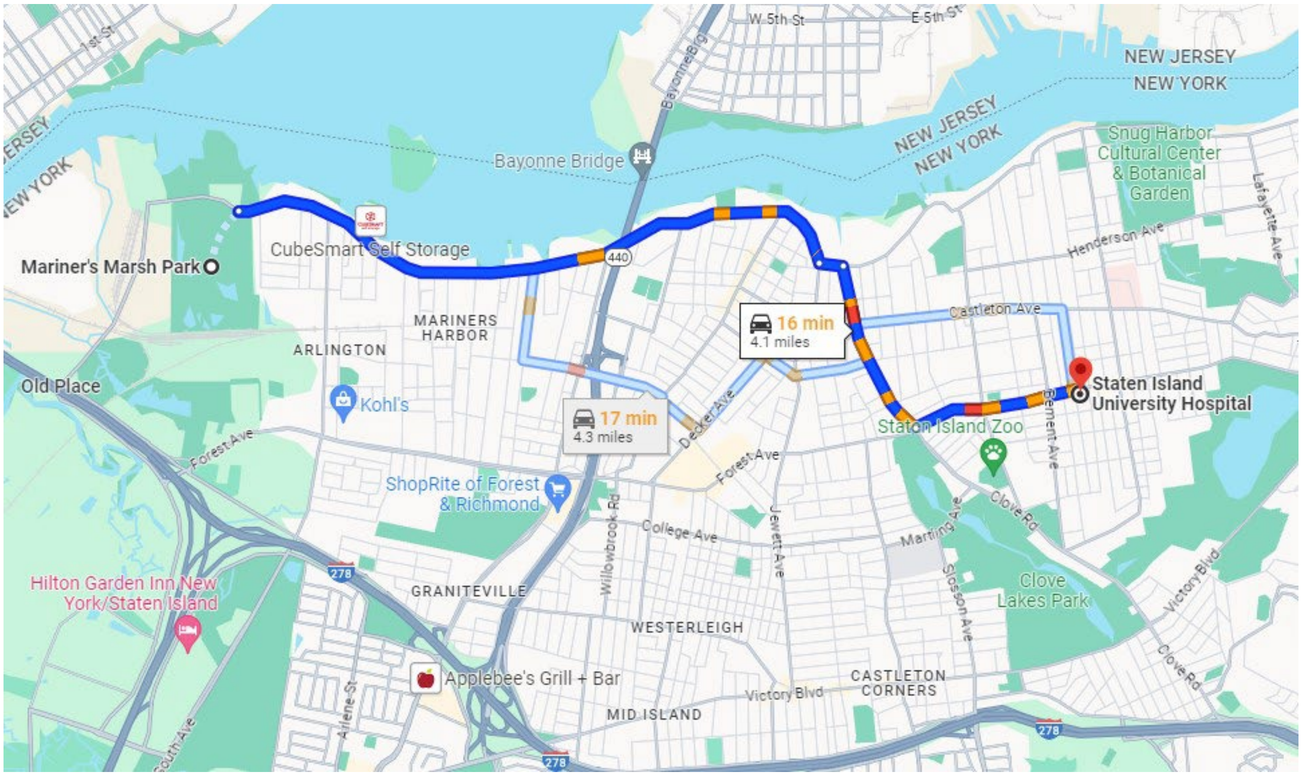
1. Medical Facility Identification and Directions

Nearest Hospital: Staten Island University Hospital – 584 Forest Avenue, Staten Island, NY 10310
Phone: 718-273-0553

Directions to Hospital:

1. Head southeast on Richmond Terrace Road toward Holland Avenue – 2.6 miles
2. Turn left to stay on Richmond Terrace – 495 feet
3. Turn Right onto Clove Road – 0.7 miles
4. Turn left onto Forest Avenue – 1.1 miles
5. Destination will be on the right.

Map to Hospital



2. Client/Personnel Contact Information

Site Name/Location, Project Number, Client and Contractor Contact Information		
Site Name: Mariners Marsh Park	**TRC Project Number:** 554398	
Site Address: Staten Island, New York		
Client Contact/Title	**Office Phone Number**	**Cellular Phone Number**
Caroline Morris / Project Planner	(212) 360-8167	(347) 519-0528
Kay Zias / NYC Parks Dept. Project Manager		NA
Contractor Contact/Title	**Office Phone Number**	**Cellular Phone Number**
Christine Lamprecht, Land, Air, Water Environmental Services, Inc.	(631) 874-2112	NA
Peter Nimmer, Greenstar Environmental Solutions, LLC	(917) 655-5123	NA
TBD, Land Surveying Services	TBD	NA

TRC Personnel and Project Role		
Name / Project Role	**Office Phone Number**	**Cellular Phone Number**
Lindsay O’Hara / TRC Office Practice Leader	(917) 809-9372	(914) 420-9649
Wes Lindemuth / TRC Program Manager	(917) 794-3107	(347) 738-1452
Emily Kessler / TRC Project Manager and TRC Office Safety Coordinator	(347) 618-6526	(908) 451-0203
Elise He / TRC Deputy Project Manager and TRC Environmental Scientist	(332) 240-6723	(917) 576-5867
Cristina Niclas / TRC Project Scientist and TRC on-Site Health and Safety Officer (OHSO)	NA	(516) 524-2388
Elizabeth Denly / TRC Quality Assurance Officer	(978) 656-3577	(978) 328-2551
Mike Glenn / TRC Health & Safety Director	(949) 727-7347	(949) 697-7418
Notes: * The OHSO is 40-hour OSHA certified, is current on refresher training, and has OSHA 8-hour supervisor training. The OHSO can be Field Lead or a member of the Field Staff as suits the work at hand and/or the availability of qualified personnel.		

3. Site Information

The Phase I area of Mariners Marsh Park (the “Site”) encompasses approximately 25 acres of the northeast portion of Mariners Marsh Park and is located near the North Shore of Staten Island, New York. The legal description for the Site is Block 1318, Lot 9. The Site is bordered to the north by Richmond Terrace; to the east by residential properties followed by Holland Avenue; to the south by Arlington Railyard followed by undeveloped land; and to the west by the New York Container Terminal facility (formerly Proctor &

Gamble). The Site is currently closed to the public with a secure fence but is intended for use as a public park in the future.

This Health and Safety Plan covers the on-site environmental site characterization activities. The activities involved with these efforts are summarized below.

The nearest hospital to the Site is Staten Island University Hospital located at 584 Forest Avenue, Staten Island, NY 10310. A hospital route map with directions is included in Section 1.1.

4. Work Scope Summary

Geophysical Survey

A geophysical survey will be performed at the Site to clear the boring locations for the presence of underground utilities. Greenstar Environmental Solutions, LLC, under subcontract and supervision by TRC, will survey a 20-foot by 20-foot maximum area around each of the proposed boring locations. Approximate extents of ground-penetrating radar (GPR) at each boring location will be recorded via handheld global positioning system (GPS) instrument and/or documented based on field measurements. For each Site, the geophysical subcontractor will prepare a geophysical report that will provide a detailed summary of the geophysical activities as well as a site map noting the findings of the geophysical survey. Additionally, TRC's drilling subcontractor will notify 811 "Call before you Dig" to perform utility mark out prior to start of subsurface disturbance. TRC anticipates DPR providing all available drawings and information regarding existing utilities.

Advancement of Soil Borings and Collection of Soil Samples

TRC's drilling subcontractor will advance soil borings at the Site. TRC's drilling subcontractor will utilize direct drive equipment (i.e., Geoprobe) or similar to advance 4- or 5-foot long 2-inch diameter macro-core samplers with acetate core liners to collect soil samples at the boring locations. Hand augers will be utilized to collect samples where access to the Geoprobe is restricted due to dense vegetation and/or terrain.

Soil samples will be collected continuously from ground surface to the boring termination depth, screened with a photoionization detector (PID) and inspected by TRC for signs of potential contamination (e.g., staining, odors, etc.) until the boring termination depth. Geologic descriptions of the soil, signs of potential contamination, and field PID screening results will be recorded in field logs. The approximate location of each boring will be recorded using a handheld GPS instrument and/or documented based on field measurements.

TRC's drilling subcontractor will advance forty-six (46) borings at the site. It is estimated that a total of 92 soil samples will be submitted for chemical laboratory analysis.

In accordance with NYSDEC DER-10, investigation derived wastes (IDW) will be minimized by returning excess soil from soil borings to its original location except where prohibited (i.e., soil is grossly contaminated, free product is present, boring has penetrated an aquitard, etc.) as outlined in DER-10 Section 3.3(e)(1). Contaminated soil, as applicable, will be containerized and staged at a DPR-designated area prior to proper off-site transportation and disposal. Soil borings will be backfilled to ground surface (if necessary) using hydrated bentonite powder or chips. If free of visible contamination, disposable PPE and sampling equipment (scoops, gloves, rope, etc.) will be placed in heavy-duty plastic bags and disposed of properly.

Groundwater Sampling

Groundwater samples will be collected from ten (10) temporary groundwater monitoring wells and six (6) permanent monitoring wells at the Site.

Groundwater samples will be collected from temporary well points by installing a 1-inch diameter schedule 40 PVC with at least 5 feet of 10-slot well screen into previously installed boreholes up to 5 feet below the observed groundwater interface. The annular space surrounding each well casing will be filled with clean sand (Morie No. 1). The groundwater sample will then be collected using a peristaltic pump with dedicated polyethylene tubing.

Permanent monitoring wells will be constructed using 2-inch diameter polyvinyl chloride (PVC) monitoring well riser and screen and installed to approximately 5 feet below the observed water table. Each well will be screened from approximately 5 feet above the observed water table to 5 feet below the observed water table. Clean silica sand, Morie No. 1, or similar, will be placed in the annular space around each groundwater monitoring well to a minimum of one foot above the top of the well screen, two feet being optimal. A two-foot bentonite seal will be placed above the sand pack. Permanent monitoring wells will be completed with a stick-up outer protective casing. Well construction diagrams will be prepared for each well.

Before sampling, groundwater at each sampling location will be purged, in order for turbidity to reach a steady minimum and the other water chemistry parameters (e.g., pH, temperature, conductivity) to stabilize. Turbidity and water chemistry parameters will be recorded during and after purging, and before sampling and the volume of water purged will be recorded. Data will be recorded in a field logbook.

All non-dedicated equipment related to groundwater sampling including downhole drilling equipment, the probe rods, sampling tools, and pumps will be properly decontaminated prior to collection of each groundwater sample. New tubing will be used for each sample. Proper decontamination procedures will include a cleaning detergent water wash (e.g., Alconox or equivalent) and a potable water rinse. If significant contamination is encountered at a location, a biodegradable citrus-based cleaner (e.g., Simple Green) may also be used to clean non-dedicated sampling equipment.

IDW will be minimized in the extent practical in accordance with DER-10. Excess and purged groundwater, as applicable, will be containerized and staged at a DPR-designated area prior to proper off-site transportation and disposal.

Soil Vapor Sampling

Fourteen (14) soil vapor samples will be collected at the Site. Soil vapor sample locations will be focused in the recreation area, as previous investigations identified chlorinated solvent contamination in groundwater in this area. The soil vapor samples will be collected over a 2-hour period, from approximately 5-feet bgs or one foot above the water table, whichever is shallower.

Sediment Sampling

Four (4) sediment samples will be collected at the Site. Sediment samples will be collected from approximately 0 to 0.5 feet bgs utilizing a hand auger.

5. Hazard Assessment

This Health and Safety Plan (HASP) assumes that an ongoing hazard assessment process with Project Management, On-Site Health and Safety Officer (OHSO), and TRC Office Safety Coordinator (OSC) will take place regularly (via meetings/teleconferences), to ensure the project work is conducted at a high level of technical excellence both safely and efficiently. Certain tasks are not covered by this HASP, including vacuum excavation, confined space entry, respiratory protection upgrades of Level C or greater, radioactive materials, or other hazards as determined by the Project Manager and OSC. Where the hazard assessment indicates the presence of these tasks and potential impact on the work involved, supplemental planning will be conducted and documented in a revised or higher level HASP document.

Chemical Hazards: Based on previous investigations completed at the Sites, the presence of the following contaminants is expected in soil and/or groundwater:

- The primary contaminants of concern in soil, soil vapor, and groundwater include VOCs, SVOCs, PCBs, PAHs, pesticides, chlorinated solvents, and metals (including arsenic, copper, lead, mercury, and zinc).

Safety Data Sheets (SDS) for compounds of concern are provided in **Appendix A**.

TRC anticipates the presence of small quantities of hydrochloric acid (HCl) and nitric acid (HNO_3) and methyl alcohol (methanol; CH_3OH), as sample preservatives, within the sample bottles that will be used. In addition, TRC anticipates using deionized water, and Alconox during decontamination procedures. Safety Data Sheets (SDS) for preservatives and decontamination products that will be used on-Site are provided in **Appendix A**. Sample bottles containing hazardous preservatives will be handled with care. Sample bottles will be checked for leaks and lids tightened. Nitrile chemical resistant gloves and safety glasses will be worn at all times when handling sample bottles.

Isobutylene will be used during a short time period at the beginning of each work day to calibrate the PID. One-hundred parts per million (ppm) isobutylene will be primarily contained in a tedlar bag. Any gas that is released to the air will quickly disperse and will not pose a threat to on-Site workers. No monitoring is required for isobutylene.

Physical Hazards: Outlined below.

Edges/Material Handling – Kevlar gloves are required to be worn at all times while performing tasks that have the potential for hand injuries. A glove selection guideline is presented in Appendix B.

Weather – In the event of adverse weather conditions, the OHSO will determine if work can continue without potentially risking the safety of all field workers. Some of the items to be considered prior to determining if work should continue are:

- Potential for heat stress and heat-related injuries;
- Potential for cold stress and cold-related injuries;
- Treacherous weather-related working conditions (hail, rain, snow, ice, high winds);
- Limited visibility (fog);
- Potential for electrical storms; or
- Other major incidents.

Please refer to Appendix C for the signs, symptoms and precautions for cold and heat stress. If thunder or lightning is noted by on-Site personnel, work will cease until the storm passes (thunder and/or lightning ceases and is not observed over at least a 15-minute period). Personnel will seek shelter in buildings or vehicles. Site activities will be limited to daylight hours, or when suitable artificial light is provided, and acceptable weather conditions prevail. The OHSO, in consultation with the PM, will determine the need to cease field operations or observe daily weather reports and evacuate, if necessary, in case of severe inclement weather conditions.

Hand Tools – Use only the appropriate tool for the task at hand. Use the tool(s) as designed, described, and intended by the manufacturer. Hand tools will meet the manufacturer's safety standards. Hand tools will not be altered in any way. Makeshift tools will not be used. At a minimum, hand and eye protection will be used when working with hand tools (see glove selection guide provided herein). Wrenches, including adjustable, pipe, end and socket wrenches, will not be used when jaws are sprung to the point that slippage occurs. Impact tools such as drift pins, wedges and chisels, will be kept free of mushroom heads. Wooden handles will be free of splinters or cracks and secured tightly to the tool. At all times use appropriate hand protection when utilizing hand tools.

Slips/Trips and Falls - Be aware of uneven ground, and buried debris (metal, plastic, etc.), to avoid potential slip/trip/fall hazards, and use caution near open excavations. Maintain good housekeeping practices to minimize physical hazards. Use proper lifting techniques to avoid injury.

Manual lifting of heavy objects – Use caution when lifting heavy objects such as drilling equipment, sampling supplies, etc., is anticipated. Failure to follow proper lifting techniques can result in back injuries and strains. Back injuries are a serious concern, as they are the most common workplace injury, often resulting in lost or restricted work time, and long treatment and recovery periods. To prevent back strain and injury, bend from the knees when lifting heavy objects. If possible, use a teammate's help in spotting you and/or lifting the object with you.

Heavy Equipment/Drill Rigs - Use caution around drill rigs and construction equipment. Ensure the equipment operator is aware of the location of on-Site personnel at all times to avoid potential injuries (e.g., maintain eye contact with the equipment operator). A spotter should be used to direct the movement of heavy equipment. Exercise caution and wear protective equipment as noted herein around the equipment to guard against crushing and pinching hazards. On-Site personnel will maintain a distance (approximately 10 feet) from mechanical hazards associated with heavy equipment.

Noise – Hearing protection must be worn when noise levels exceed 85 dBA in the work area. If you need to raise your voice to be heard at the work site, then hearing protection should be worn. Hearing protection will be worn near drill rigs.

Pressurized Fluids/Gases – All compressed gases are hazardous due to the high pressures inside the cylinders. Even at a relatively low pressure, gas can flow rapidly from an open or leaking cylinder. Damaged cylinders can become projectiles resulting in severe injury and property damage. An unsecured or uncapped cylinder can become a cause of a major accident. Cylinders shall be secured when not in use, in transport, and as much as possible when in use.

Underground, Overhead, and Exposed Utilities –Utilities may currently exist at the Sites. TRC has requested the NYC Parks provide all available drawings and site plans that show any on-site utilities. Prior to conducting work activities, the Site will be visually observed for potential overhead hazards (e.g., tree branches and wires), and drilling locations will be selected that are located at safe distances from the hazard. (The Dig Safe utility clearance ticket number is: 811). Use caution when heavy equipment may come in contact with utilities. Maintain a minimum distance of 10 feet from high voltage (up to 50 kV) overhead utilities at all times. Proceed cautiously and with due diligence to minimize the possibility of contacting underground utilities. When inspecting any electrical boxes, units, or electrified components, use caution and disconnect power prior to beginning any invasive work.

Driving/Traffic Hazards - Driving to and from the Site each day is considered a physical hazard. Directions and travel time to the Site should be determined in advance and adequate time should be allocated to drive safely. The use of cellular phones is prohibited, and distracted driving should be avoided. Seatbelts should be worn at all times while the vehicle is moving. Use caution around traffic flow. Ensure proper traffic control (e.g., signs, traffic cones, jersey barriers, etc., or where jurisdictionally required, police details) are in place prior to and throughout the work day where work takes place in or near traffic. Work personnel must wear ANSI-rated class 3 reflective traffic vests at all times.

Pedestrians/Park-goers – All unauthorized personnel without proper HAZWOPER training will not be permitted within the active work zone while drilling and sampling activities are underway. On-site TRC personnel will mark/cordon off the exclusion zone and actively scan the perimeter for anyone who may endanger themselves or interfere with operations.

Biological Hazards: Outlined below.

Ticks - Ticks generally favor areas of high grass and dense vegetation so to the extent possible, these areas should be avoided. It is advisable when entering these areas to tuck pants into socks and to wear a light colored long sleeve shirt to help spot ticks before they bite. DEET-based insect repellents may be worn to repel ticks but hands should be washed thoroughly after use and DEET should not be sprayed directly onto the skin surface. Self-checks should be made frequently and at least at the end of the field day for ticks when working in or near vegetated areas.

If discovered, the tick should be removed with a pair of tweezers and saved in a sealed plastic bag. Sometimes, tick bites occur but the tick may not stay attached, followed by a rash developing in the area within a few days of the bite**. If bitten by a tick or a bulls-eye like rash develops, it is advisable to consult WorkCare**.

Blood-Borne Pathogens - Injuries received in the field may require assistance from a field team member to perform first aid. Contact with blood and certain body fluids can contain pathogens that may be transmitted by contact with an open wound by the caregiver. The following precautions should be used when giving first aid:

- Use nitrile gloves to avoid contact with blood/fluids. Spent bandages and gloves used to perform first aid should be placed in a plastic bag and properly disposed.
- Blood/fluid should be cleaned from surfaces that may be contacted by other individuals.
- Use an appropriate barrier if required to perform rescue breathing.

Spiders - Spiders typically seek cover in dark protected areas. Common areas where spiders may be encountered are heavy vegetation and trees. Spider bites may cause swelling, pain and respiratory problems. If bitten, wash the area and use ice on the bite area to reduce swelling. If respiratory stress, significant pain or swelling is noted, or discoloration around the bite area occurs, seek immediate medical attention.

Stinging Insects - Spiders, wasps and yellow jackets often nest in dense vegetation and in the ground. A sting from these insects can cause pain, swelling, and respiratory problems that may be life-threatening to certain individuals. If stung, remove stinger if present using tweezers or similar, and wash the area and use ice on the sting area to reduce swelling. If respiratory stress, significant pain or swelling is noted, or discoloration around the sting area occurs, seek immediate medical attention.

Dogs and Wild Animals - Dogs often are not leashed and may be unfriendly. Bites from dogs and wild animals can cause infections or transmit disease. In general, it is best to not approach dogs even if they appear to be friendly, and wild animals should never be approached. If bitten, the area should be washed with soap and water. If the bite resulted in puncturing or tearing of the skin, the wound should be covered with a sterile dressing and medical attention should be sought immediately. A description of the dog should be noted and if possible, the dog's owner.

Plants – There are many types of plants which can cause irritation or allergic type reactions. Examples of some encountered on TRC sites include the following:

Poison Ivy – the trademarks of this plant are its solid green, pointed leaves that hang from the stem in groups of three. It grows as both a vine and a shrub. The look of poison ivy can change with the seasons. It produces yellow-green flowers in the spring and its green leaves can change to yellow and red in autumn.

Wild Parsnip/Giant Hogweed – Both plants are part of the carrot family and can grow up to 15 feet tall. They look similar to giant Queen Anne's lace with bristly stalks. Contact with the sap from the plant can cause phytophotodermatits or irritation (sometimes severe) when skin is exposed to sunlight.

Radiological Hazards: None anticipated. If any new condition is encountered during this activity, the HASP will be adjusted accordingly.

General Safety Rules: Outlined below

The general safety rules listed below apply to TRC personnel and subcontractors at the Site:

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of materials is prohibited, except in the support zone after proper decontamination;
- All on-Site personnel must wear protective clothing appropriate for designated level of protection and decontaminate before entering clean areas;
- Avoid walking through puddles, pools, or mud;
- Maintain a position upwind from work activities whenever possible;
- Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking, or any other activities

- All equipment will be delivered to the Site free of any contamination, and decontaminated or discarded, as designated by the OHSO, before leaving the Site.

6. Air Monitoring

Air Monitoring Equipment and Use Recommendations: The following table outlines air monitoring equipment needs and rationale. Note that an upgrade to a higher level of respiratory protection (C or higher) will warrant revision or addendum to this HASP and consultation with a TRC Certified Industrial Hygienist (CIH) before work recommences.

Monitoring Equipment Use Recommendations			
Instrument	**Use Code**	**Action Levels**	**Notes/Rationale**
PID	R	5 ppmv	Recommended for VOC screening to monitor airborne VOC concentrations in breathing zone levels. If PID readings are sustained above 5 ppmv in the breathing zone for at least 5 minutes, move to an upwind location for 15 minutes. After 15 minutes, measure again. If PID readings are still above 5 ppmv in the breathing zone, contact the OSC or TRC Safety Director to evaluate suitable response actions. Any upgrade in respiratory protection will be coordinated with the corporate health and safety director and/or the OSC. Withdraw from area if PID readings exceed 50 ppmv.
TSI Dustrak™ (or equivalent)	C	> 150 µg/m^3; 15 minute average*	Used where contaminants could adhere to fugitive dust, and where fugitive dust migration could potentially serve as a significant exposure pathway.
O^2/LEL	N/A		Recommended for landfill work/confined space work.
H$_2$S Meter	N/A		Recommended for landfill work, lagoon work and confined space entry.
MINIRAM (or equivalent)	O		Supplement operation of Dustrak™ stations for work near sensitive receptors.
Radiation meters	N/A		Not known or anticipated to be a Contaminant of Concern.
Other _______			Coordinate all additional instrumentation with the OSC.

Notes:
Instrument code: PID – Photoionization detector LEL – Lower Explosive Limit O$_2$ – Oxygen H$_2$S – Hydrogen Sulfide
Use code: R – Required, C – Condition specific, O – Optional, N/A – Not applicable
ppmv - parts per million by volume
* Above background upwind levels

Monitoring Procedures: The OHSO will measure organic vapor concentrations continuously in the breathing zone using the PID during intrusive activities. When required, air monitoring will be performed using a combination of real-time dust monitoring upwind and downwind of the work area, and at a point near the closest receptor.

Exposure Limits: The following tables summarizes anticipated concentrations and accepted exposure limits of chemicals potentially present at the Site.

Known or Suspected Chemicals/Contaminants	
Chemical/Contaminant of Concern	**OSHA Permissible Exposure Limit (PEL)**
Heavy metals – lead, antimony, barium, cadmium, arsenic, chromium, copper, mercury,	0.01 mg/m^3 (OSHA PEL for arsenic) 0.5 mg/m^3 (OSHA PEL for antimony) 0.5 mg/m^3 (OSHA PEL for barium) 5 µg/m^3 (OSHA PEL for cadmium) 1.0 mg/m^3 (OSHA PEL for chromium) 1.0 mg/m^3 (OSHA PEL for copper)

Known or Suspected Chemicals/Contaminants	
Chemical/Contaminant of Concern	**OSHA Permissible Exposure Limit (PEL)**
	50 µg/m^3 (OSHA PEL for lead) 0.1 mg/m^3 (OSHA PEL for mercury) 5 mg/m^3 (fume) (OSHA PEL for zinc); 15 mg/m^3 (total dust) (OSHA PEL for zinc)
Chlorinated VOCs – cis-1,2-dichloroethene, 1,2-dichloroethane, trans-1,2-dichloroethene,trichloroethylene, vinyl chloride,	Not established (OSHA PEL for cis-1,2-dichloroethene) 100 ppm (OSHA PEL for 1,2-dichloroethane) Not established (OSHA PEL for trans-1,2-dichloroethene) 25 ppm (OSHA PEL for trichloroethylene) 2.6 mg/m^3 (OSHA PEL for vinyl chloride)
PAHs – 2-methylnapthaelne, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene	Not established (OSHA PEL for 2-methylnapthaelne) 0.2 mg/m^3 (OSHA PEL for benzo(a)pyrene) Not established (OSHA PEL for benzo(b)fluoranthene) Not established (OSHA PEL for chrysene) Not established (OSHA PEL for dibenz(a,h)anthracene) Not established (OSHA PEL for dibenzofuran) Not established (OSHA PEL for fluoranthene) Not established (OSHA PEL for indeno(1,2,3-cd)pyrene) 0.2 mg/m^3 (OSHA PEL for phenanthrene) 0.2 mg/m^3 (OSHA PEL for pyrene)

Preservatives and Decontamination Products		
Chemical of Concern	**On-Site Usage and Potential Exposures**	**Exposure Limit**
Hydrochloric Acid (HCl)	Less than 20 ml quantities used for sample preservation. Air phase exposure is expected to be minimal and incidental to sample containerization.	5 ppm (OSHA PEL)
Methyl Alcohol (methanol; CH_3OH)	Less than 20 ml quantities used for sample preservation. Air phase exposure is expected to be minimal and incidental to sample containerization.	200 ppm (OSHA PEL)
Nitric Acid (HNO_3) 1:1 concentration	Less than 20 ml quantities used for sample preservation. Air phase exposure is expected to be minimal and incidental to sample containerization.	5 mg/m^3 (OSHA PEL)
Isobutylene	100 ppm gas for use during calibration of PID instruments	No specific exposure limits for isobutylene (simple asphyxiant). Maintain oxygen levels above 19.5%.

Preservatives and Decontamination Products		
Chemical of Concern	**On-Site Usage and Potential Exposures**	**Exposure Limit**
Alconox	For equipment decontamination, make a 1% solution (2.5 tbsp. per gallon) in cold or warm water.	No specific exposure limits for Alconox.

Table Notes: *Exposure and hazard data obtained from the NIOSH Pocket Guide to Chemical Hazards*

ppm – parts per million
OSHA – Occupational Safety and Health Administration
PEL – Permissible Exposure Limit
mg/m^3 - milligrams per cubic meter

7. Work Zones and Site Control Measures

Site zones are intended to control the potential exposure to and the spread of contamination throughout the Site and to assure that only authorized individuals are permitted into potentially hazardous areas. The daily work zones and daily activities will be discussed in the daily job briefing. A three-zone approach will be utilized as the control measure and will include an Exclusion Zone (EZ), Contamination Reduction Zone (CRZ), and a Support Zone (SZ). Specific zones will be established on the property when operations begin. Generally, the EZ will be located in the immediate vicinity of the sampling activities, the CRZ will be located near the entrance/exit on Franklin Street and the SZ will be the public sidewalk area located to the east and outside of the Site perimeter wall. Further details regarding these zones is included below.

Support Zone (SZ) - The SZ is an uncontaminated area that will be the support area for most operations. The SZ provides for field team communications and staging for emergency response. Appropriate sanitary facilities and safety equipment are typically located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged/decontaminated and labeled samples.

Contamination Reduction Zone (CRZ) - The CRZ is established between the EZ and the SZ. The CRZ contains the contamination reduction area and provides for an area for decontamination of personnel and portable hand-held equipment, tools and heavy equipment. A personnel decontamination area will be set up at each CRZ. The CRZ will be used for EZ entry and egress in addition to access for heavy equipment and emergency support services.

Exclusion Zone (EZ) - All activities in an area that may involve exposure to contaminants and hazardous materials should be considered the EZ. This zone will be clearly delineated by cones, tapes or other means. The On-Site Health and Safety Officer (OHSO) may establish more than one EZ where different levels of protection may be employed or different hazards exist. The size of the EZ will be determined by the OHSO allowing adequate space for the activity to be completed, field members and emergency equipment.

7.1 Site Security

The OHSO is responsible for monitoring the status of all TRC and subcontractor employees on-Site. The OHSO will greet any persons attempting to enter the CRZ or EZ to inform them of hazards and direct them elsewhere if they are not required on-site. All workers will sign in daily and provide appropriate photo identification if requested. Equipment and materials will be stored on-Site or at an alternate location provided by DPR and will be locked, immobilized, and/or otherwise secured to prevent theft or unauthorized use or access.

8. Personal Protective Equipment (PPE)

TRC personnel will use Level D PPE as noted/modified below:

Level D Personal Protective Equipment	
Item	**Rationale/Notes**
Hardhat	Appropriately rated hard hats will be worn by personnel for protection against overhead hazards, including electrical.
Hearing protection	Hearing protection will be worn by all personnel exposed to more than 85 dB of sound during the workday.
Safety boots	Safety boots will be worn by all personnel during project work described in this HASP and at all times on site.
Eye protection (safety glasses)	Eye protection will be worn when personnel are exposed to flying debris, chemical vapors or particulates. Chemical splash goggles will be worn for protection against chemical gases, vapors or particulates. Safety glasses will be worn for protection against flying objects.
Safety vest	Utilize in areas in or near vehicular traffic of any kind on or off property.
Gloves	Gloves to be changed between samples to avoid cross-contamination. Nitrile chemically resistant gloves will be worn when handling sample bottles.
Kevlar work gloves	As indicated herein, use Cut and Abrasion Resistance Level 4 or Level 5 gloves when necessary for hand protection during field tasks. See Appendix B for a Glove Selection Guide. ***Leather work gloves are expressly prohibited.***

A basic first aid kit will be readily available on-Site in the event of an emergency.

A fire extinguisher should be present with the drill rig. All personnel working on or around the drill rig should know the location of and how to operate the fire extinguisher.

9. Decontamination Procedures

9.1 Minimization of Contact with Contaminants

During the completion of all Site activities, personnel should attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep "clean" during Site activities. All personnel should minimize kneeling, splash generation, and other physical contact with contamination. This may ultimately minimize the degree of decontamination required and the generation of waste materials from Site operations.

Field procedures will be developed to control dust generation, contact with Site soils, and to ensure that unprotected personnel working nearby are not affected.

9.2 Personnel Decontamination Sequence

Following the removal of PPE, pre-moistened towels or wipes, and/or waterless cleansers will be used by field personnel for decontamination of hands and faces.

Consideration will be given to prevailing wind directions so that the decontamination line, the SZ, and CRZ exit are upwind from the EZ. Personnel who are performing decontamination will remove all soiled PPE used in the EZ and place it within in drums/trash cans located within the CRZ.

9.3 Personnel Decontamination Procedures

The following describes procedures to be employed for personnel decontamination.

PERSONNEL DECONTAMINATION PROCEDURES FOR LEVEL D PROTECTION	
1.	Decontaminate equipment used on-Site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) with moist towel.
2.	Use boot brush to remove soil from treads of shoes.
3.	Remove PPE and wipe down with moist towel.
4.	Remove gloves and deposit in waste container.
5.	If inner clothing has become contaminated, remove it and place it into a poly bag.
6.	Wash hands and face.

9.4 Equipment Decontamination Procedures

Decontamination of equipment may be accomplished using dry decon with brushes and shovels. All equipment decontamination will take place in the exclusion zone. Vehicles or equipment, which are brought into an EZ will be treated as contaminated and will be decontaminated prior to removal from the EZ. All liquids used in the decontamination procedure will be collected, stored, and disposed in accordance with federal, state, and local regulations.

Other decontamination equipment may include:

- Wash tubs (1 wash and 1 rinse);
- Several scrub brushes;
- Disposable towels; or
- Decontamination solution (e.g., non-phosphate detergent, Simple Green).

9.5 Emergency Decontamination

If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination and wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or equipment.

If the injured person can be moved, he/she will be moved to the EZ boundary and decontaminated by Site personnel as described above before emergency responders handle the victim. If the person cannot be moved because of the extent of the injury (a back or neck injury), provisions will be made to ensure that emergency response personnel are able to respond to victim without being exposed to potentially hazardous atmospheric conditions. If the potential for inhalation hazards exist, such as with open excavation, this area will be covered with poly to eliminate any potential inhalation hazards. All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

9.6 Hand Held Equipment Decontamination

Hand held equipment includes all monitoring instruments, samples, hand tools, and field logbooks. To aid in decontamination, monitoring instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants. The instruments will be wiped clean using wipes or paper towels if contamination is visually evident.

Decontamination procedures for sampling equipment, hand tools, etc. will include a moist towel wipe, as appropriate for the Site conditions.

10. Job Safety Analyses

A Job Safety Analysis (JSA) is a safety management tool in which the risks or hazards of a specific job in the workplace are identified, and then measures to eliminate or control those hazards are determined and implemented. More specifically, a JSA is a process of systematically evaluating certain jobs, tasks, processes or procedures and eliminating or reducing the risks or hazards to as low as reasonably practical (ALARP) in order to protect workers from injury or illness. The JSA process is documented and the JSA document is used in the workplace or at the job site to guide workers in safe job performance. The JSA document is also a living document that is adjusted as conditions warrant.

The JSA process begins with identification of the potential hazards or risks associated with a particular job. Once the hazards are understood, the consequences of those hazards are then identified, followed by control measures to eliminate or mitigate the hazards.

Please refer to Appendix D for the Job Safety Analyses for Direct Push Drilling.

11. Required Personnel Training

TRC field personnel will have the training outlined below before on-Site work activities:

Project Training Requirements

(* required for all sites; but minimum recommended)

Check "A" if training required for everyone, and check "T" if training required for specific task or per notations.

A	T	SUBJECT	REFERENCE	
			29 CFR 1910	29 CFR 1926 or Other
☒	☐	HAZWOPER 40 hour	1910.120	1926.65
☐	☐	3-Day HAZWOPER Supervised On-site	1910.120	1926.65
☒	☐	8-Hour HAZWOPER Refresher	1910.120	1926.65
☐	☒	8-Hour Supervisor HAZWOPER*	1910.120	1926.65
☐	☒	First Aid, CPR[1]	1910.151	1926.23,.50
☒	☐	Hazard Communication (HAZCOM)	1910.1200	1926.59
☐	☐	DOT / IATA Shipping Training	1910.1201	49 CFR 172.704
☒	☐	TRC Hand Protection Policy	1910.138	TRC Policy[2]
☒	☐	Defensive Driving	N/A	White Paper[3] TRC Manual[4]

Client-specific training: ☐ Not Applicable ☐ Specify
Client-specific training: ☐ Not Applicable ☐ Specify
Client-specific training: ☐ Not Applicable ☐ Specify

Note:
* The OHSO shall have OSHA 8-hour supervisor training, in addition to 40-hour HAZWOPER.
1 Per the TRC Health and Safety Policy and Procedure Manual, each TRC project will have at least one certified CPR/first aid trained person on- Site at all times. All Project Managers, and anyone acting as the on-site Health and Safety Officer, must be current in First Aid/CPR.
2 TRC RMD Hand Protection Policy, August 2012
3 Guidelines for Employers to Reduce Motor Vehicle Crashes (joint white paper by NETS, NHTSA and OSHA)
4 TRC Driver and Vehicle Management Policy and Procedure Manual, Rev 1 (April 2012)

Project training requirements beyond those provided in the above table will require a HASP revision/upgrade or concurrence of the TRC Safety Director or Practice Safety Manager.

12. Medical Monitoring

Medical monitoring will apply routinely to all employees who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year (40 CFR 1910.120[f][2][i]). Said TRC field personnel will have the medical surveillance outlined in the table below prior to commencing on-site work activities.

Medical Surveillance Required			
*Baseline is minimum recommended.			
	29 CFR 1910	**29 CFR 1926 or Other**	**Notes**
☒ HAZWOPER Physical - Baseline	1910.120	1926.65	
☒ HAZWOPER Physical – Annual	1910.120	1926.65	
☐ HAZWOPER Physical - Biennial	1910.120	1926.65	
Client-specific drug testing[1]	☒ Not Applicable ☐ Specify		
Client-specific medical monitoring[1]	☒ Not Applicable ☐ Specify		
Site-specific medical monitoring:	☒ Not Applicable ☐ Specify		

Note:
[1] Client required drug testing or medical monitoring should be coordinated through the Project Manager.

TRC has a Drug and Alcohol-Free Workplace Policy. TRC may require employees or subcontractors to be tested upon reasonable suspicion, following accidents or incidents during work activities, or during travel to or from a project Site. Client policies may be stricter in regard to procedures following an accident. Project Managers must be aware of these and inform employees and subcontractors of any additional requirements.

13. General Safety Requirements

The general safety rules listed below apply to all personnel present at the Site.

- Maintain safety equipment in good condition and proper working order and make sure that all air sampling equipment (i.e., PID and dust monitoring equipment) is calibrated prior to use. Calibration information will be recorded in field notes.
- A tailgate health and safety meeting will be held with all field team members each day prior to the start of work.
- Adhere to all requirements of this HASP.
- Wear protective clothing appropriate for the designated level of protection and decontaminate before entering clean areas, when applicable.
- Use safety equipment in accordance with OSHA guidance and labeling instructions.
- Immediately report unsafe acts or conditions to the Project Manager and OHSC.
- Eating, drinking, and smoking are prohibited on site, except in designated areas.
- Maintaining a position upwind from intrusive activities is encouraged.
- The emergency shutoff switch should be demonstrated to be working prior to initiating drilling.
- An adequately stocked first-aid kit will be maintained at the work site.

14. Tailgate Safety Meetings

A tailgate safety meeting will be conducted daily prior to commencement of the work day (see checklist provided in Appendix E) or if site conditions change.

Topics covered by the tailgate safety meeting will include, but not be limited to:

- Scope of work and who will conduct each task
- Potential hazards for the scope of work
- Weather forecast
- PPE
- Emergency procedures and the route to the medical facility
- Site conditions and features
- Communication guidelines related to stakeholder engagement and visitors

Safety meetings will be held to address modifications to this HASP and any addenda prepared to supplement the HASP. Subcontractors and personnel present at the tailgate safety meeting shall be required to sign an acknowledgement form after each meeting.

15. Emergency/Contingency Plan

Before commencing any on-Site operations, the TRC OHSO will advise all personnel of potential emergencies. Personnel will be advised on their roles in the event of an emergency, and the steps to take for a timely and controlled response.

Communication networks/chain of command - All on-Site personnel will communicate any accident, injury or near miss to the TRC OHSO who will provide instruction on how to proceed further.

First Aid / Safety Equipment - First aid equipment should be readily available in the event of an emergency. First aid equipment should include a well-stocked first aid kit, fire extinguisher and emergency eye wash.

Evacuation Plans and Refuge Area - All personnel should safely remove themselves from danger in the event of an emergency and safely access the refuge area. The refuge area should be in an upwind location a safe distance from the work zone. The refuge area will be determined during the daily safety briefing.

Notifications of Fire, Police and Emergency Facilities - In the event of an emergency that cannot be controlled by on-Site personnel, the appropriate emergency contact shall be notified. All personnel shall remove themselves from the area of danger and wait for the arrival of help in the predetermined refuge area. The following is a list of local emergency contacts:

Non-Emergency Medical Assistance **-** If an injury does occur and it is not life threatening, then the employee or employee's supervisor/project manager should contact WorkCare as soon as possible, but within the first hour after an injury. WorkCare information is proved in Appendix F. This information will help assist the injured employee by connecting them with instant access to a medically qualified professional in order to provide guidance on appropriate first aid measures and medications.

Non-Emergency Telephone Number		
Service	**Telephone Numbers**	**Notes**
TRC Work Care	888-449-7787	See Appendix F

Emergency Telephone Numbers		
Service	**Emergency Telephone Numbers**	**Direct Telephone Numbers**
Police: New York Police Department	**Emergency:** 911	**NYPD –121st Precinct** (718) 697-8700
Fire: Fire Department of New York		(718) 999-2000
Poison Control		800-222-1222 Local Number: (212) 689-9014
CHEMTREC		800-424-9300 (Customer No. CCN 671126)
National Response Center		(800) 424-8802
NYS Spill Hotline*		1-800-457-7362

***If on-site petroleum spills are identified, a QEP will determine the nature and extent of the spill and report it to NYSDEC's spill hotline at 800-457-7362 within two hours of the incident.

16. Observations

Note that the Project Manager and/or OSC may notify field staff that their site activities may be the subject of Safety Observation, an integral part of the continuous improvement safety culture promoted at TRC. If subject to an observation, please note the following:

- The Observation will tend to focus on the highest risk activity (as a general example, drilling in a public right-of-way).
- Follow-up observations may be required, depending on prior data collected.
- The observer's preparation before visiting the site will be a review of the HASP, JSAs, client-specific requirements, etc., and a review of the work scope with the Project Manager to ensure the context of the work is well understood in advance.
- Review items may include PPE, body use and positioning, work environment, operating procedures, and tools and equipment.
- The observation should last between 30 and 60 minutes.

Observations will be documented using the TRC General Project Safety Audit in the iAuditor application. Both positive and negative observations are candidates for documentation and later discussion. The overarching goals are to identify and correct questionable practices, and to identify and promote good, safe and efficient practices. It is a data gathering process that will allow TRC safety specialists to identify root causes for safety issues in both categories to better inform policy decisions.

17. Incident Reporting

In case of an accident, TRC personnel must report the incident immediately to their project manager/supervisor and/or OHSC, and client's representative, and follow the TRC Incident Response and Reporting Process (see Appendix G and H). Required forms must be completed within 24 hours following the incident. If the forms are unavailable, the incident shall be reported to the TRC Safety Director (Mike Glenn). Accident/injury/exposure information must be recorded per TRC policy (see Appendix G) and will be the basis of any accident/incident investigations.

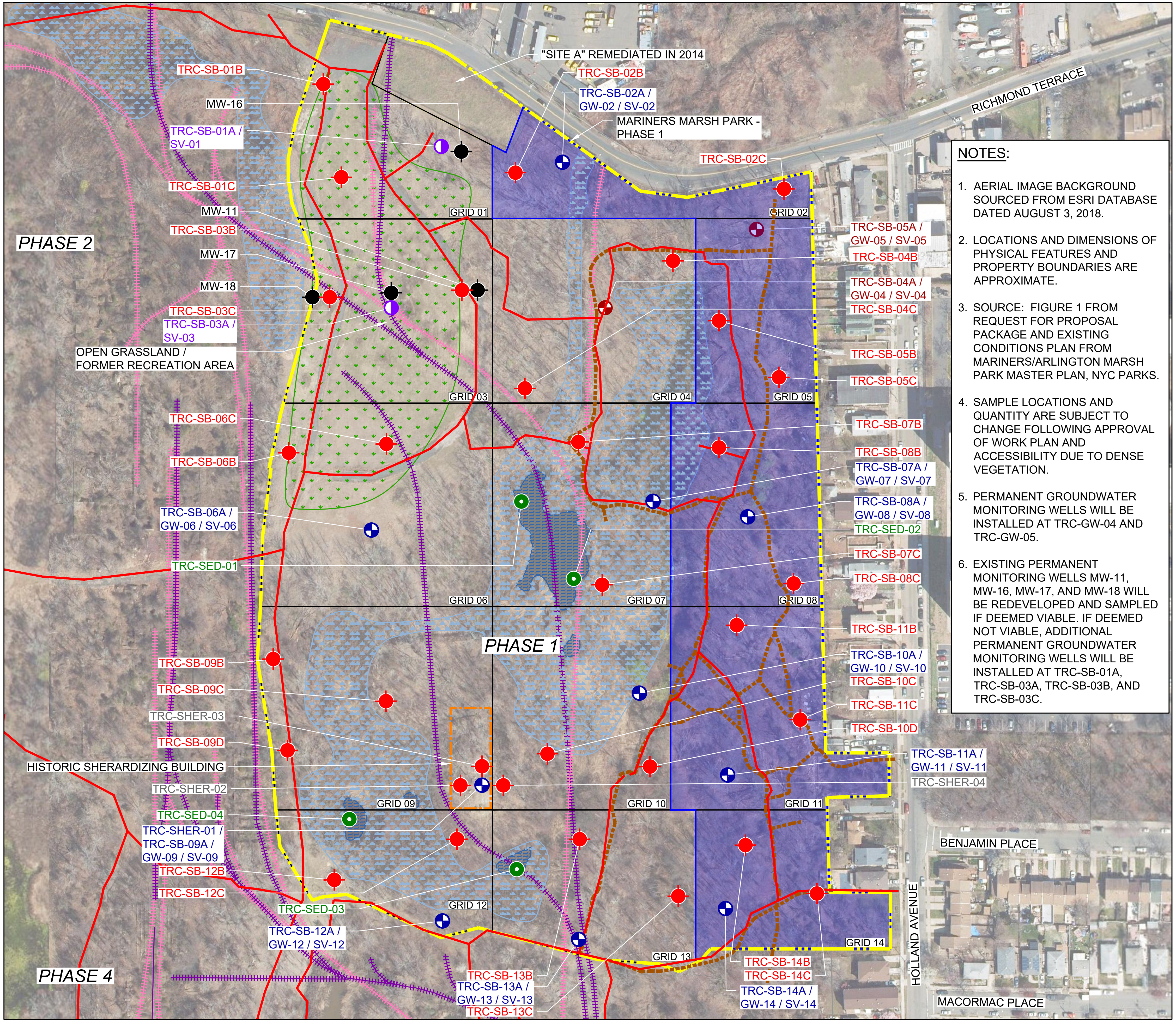
18. Acknowledgement

All TRC personnel operating under this HASP must read the HASP and sign the acknowledgment page in Appendix I.

19. Subcontractors and Health and Safety Planning

TRC personnel must provide the complete HASP to all subcontractors for their reference in advance of the work. Subcontractors must prepare their own site-specific HASP and provide evidence of HASP preparation before the start of site work to ensure that the subcontractor has an understanding of the safety hazards associated with the work that they are performing. Subcontractor HASPs are not required to be included unless contractually/client required, or if so desired by the Project Manager or OSC.

Figures

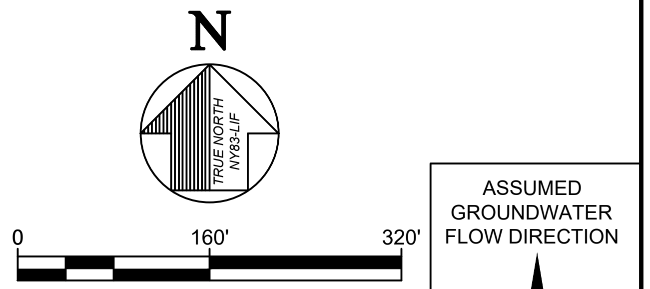


NOTES:

1. AERIAL IMAGE BACKGROUND SOURCED FROM ESRI DATABASE DATED AUGUST 3, 2018.
2. LOCATIONS AND DIMENSIONS OF PHYSICAL FEATURES AND PROPERTY BOUNDARIES ARE APPROXIMATE.
3. SOURCE: FIGURE 1 FROM REQUEST FOR PROPOSAL PACKAGE AND EXISTING CONDITIONS PLAN FROM MARINERS/ARLINGTON MARSH PARK MASTER PLAN, NYC PARKS.
4. SAMPLE LOCATIONS AND QUANTITY ARE SUBJECT TO CHANGE FOLLOWING APPROVAL OF WORK PLAN AND ACCESSIBILITY DUE TO DENSE VEGETATION.
5. PERMANENT GROUNDWATER MONITORING WELLS WILL BE INSTALLED AT TRC-GW-04 AND TRC-GW-05.
6. EXISTING PERMANENT MONITORING WELLS MW-11, MW-16, MW-17, AND MW-18 WILL BE REDEVELOPED AND SAMPLED IF DEEMED VIABLE. IF DEEMED NOT VIABLE, ADDITIONAL PERMANENT GROUNDWATER MONITORING WELLS WILL BE INSTALLED AT TRC-SB-01A, TRC-SB-03A, TRC-SB-03B, AND TRC-SB-03C.

LEGEND (SYMBOLS NOT TO SCALE):

▬ · ▬ ·	MARINERS MARSH PHASE 1 BOUNDARY
▭	MOBILIZATION 1
―	HISTORIC TRAILS, PATHWAYS, AND DESIRE LINES
- - -	2024 TRAILS, PATHWAYS, AND DESIRE LINES
▨	OPEN GRASSLAND / FORMER RECREATION AREA
▤	POND
▨	WETLAND
┼┼┼┼	FORMER RAILROAD SPUR - SANBORN 1910
┼┼┼┼	FORMER RAILROAD SPUR - SANBORN 1917
⊕ , ⊕	PROPOSED SOIL BORING SAMPLE LOCATION
◐	PROPOSED SOIL BORING AND SOIL VAPOR SAMPLE LOCATION
⊕	PROPOSED SOIL BORING, TEMPORARY GROUNDWATER MONITORING WELL, AND SOIL VAPOR SAMPLE LOCATION
⊕	PROPOSED SOIL BORING, PERMANENT GROUNDWATER MONITORING WELL, AND SOIL VAPOR SAMPLE LOCATION
⊙	PROPOSED SEDIMENT SAMPLE LOCATION
⊕	EXISTING PERMANENT GROUNDWATER MONITORING WELL LOCATION (2010 ATC)
GRID ##	SAMPLE GRID AND IDENTIFICATION



SCALE: 1" = 160'
SHEET SIZE: 11" BY 17"

PROJECT:

NEW YORK CITY PARKS AND RECREATION - CAPITAL PROJECTS DIVISION
MARINERS MARSH PARK PHASE 1 - 3418 RICHMOND TERRACE
BOROUGH OF STATEN ISLAND, RICHMOND COUNTY, NY

TITLE:

PROPOSED SAMPLING PLAN

DRAWN BY:	H. DELGADO	PROJ NO.:	554398.0000.0000
CHECKED BY:	E. HE	**FIGURE 4**	
APPROVED BY:	E. KESSLER		
DATE:	SEPTEMBER 2024		

TRC
1407 Broadway, Suite 3301
New York, NY 10018
Phone: 212.221.7822
www.TRCcompanies.com

FILE NO.: Fig 4 - Prop. Samp. Plan (MM).dwg

11x17 --- ATTACHED XREF'S: StatenIsland --- ATTACHED IMAGES: Esri Database Image 08.03.2018 (Mariners Marsh); Esri Database Image 08.03.2018 (Mariners Marsh)NorthCZ2; Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ; Esri Database Image 08.03.2018 (Mariners Marsh)NorthZ2; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ; Esri Database Image 08.03.2018 (Mariners Marsh)SouthZ2; Mariners Marsh- basemaps_Page_1; Mariners Marsh- basemaps_Page_2;
DRAWING NAME: \\nyc-fp1\Projects\NYC Parks Contract 20216200991\554398.0000 - Mariners Marsh Park\3_Deliverables\Work Plan\Figures\TRC WD\ Fig 4 - Prop. Samp. Plan (MM).dwg --- PLOT DATE: September 24, 2024 - 4:53PM --- LAYOUT: 11X17L

Appendix A
Safety Data Sheets for Preservatives and Decontamination Products

MATERIAL SAFETY DATA SHEET

ALCONOX®

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS, Australian WorkSafe, Japanese Industrial Standard JIS Z 7250:2000, and European Union REACH Regulations

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	**ALCONOX®**	
CHEMICAL FAMILY NAME:	Detergent.	
PRODUCT USE:	Critical-cleaning detergent for laboratory, healthcare and industrial applications	
U.N. NUMBER:	Not Applicable	
U.N. DANGEROUS GOODS CLASS:	Non-Regulated Material	
SUPPLIER/MANUFACTURER'S NAME:	Alconox, Inc.	
ADDRESS:	30 Glenn St., Suite 309, White Plains, NY 10603. USA	
EMERGENCY PHONE:	**TOLL-FREE in USA/Canada**	800-255-3924
	International calls	813-248-0585
BUSINESS PHONE:	914-948-4040	
DATE OF PREPARATION:	May 2011	
DATE OF LAST REVISION:	February 2008	

SECTION 2 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: This product is a white granular powder with little or no odor. Exposure can be irritating to eyes, respiratory system and skin. It is a non-flammable solid. The Environmental effects of this product have not been investigated.

US DOT SYMBOLS	CANADA (WHMIS) SYMBOLS	EUROPEAN and (GHS) Hazard Symbols
Non-Regulated		 Signal Word: **Warning!**

EU LABELING AND CLASSIFICATION:

Classification of the substance or mixture according to Regulation (EC) No1272/2008 Annex 1
EC# 205-633-8 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 268-356-1 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 231-838-7 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 231-767-1 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 207-638-8 Index# 011-005-00-2
EC# 205-788-1 This substance is not classified in the Annex I of Directive 67/548/EEC

GHS Hazard Classification(s):

Eye Irritant Category 2A

Hazard Statement(s):

H319: Causes serious eye irritation

Precautionary Statement(s):

P260: Do not breath dust/fume/gas/mist/vapors/spray
P264: Wash hands thoroughly after handling
P271: Use only in well ventilated area.
P280: Wear protective gloves/protective clothing/eye protection/face protection/

Hazard Symbol(s):

[Xi] Irritant

Risk Phrases:
R20: Harmful by inhalation
R36/37/38: Irritating to eyes, respiratory system and skin

Safety Phrases:
S8: Keep container dry
S22: Do not breath dust
S24/25: Avoid contact with skin and eyes

HEALTH HAZARDS OR RISKS FROM EXPOSURE:

ACUTE: Exposure to this product may cause irritation of the eyes, respiratory system and skin. Ingestion may cause gastrointestinal irritation including pain, vomiting or diarrhea.

CHRONIC: This product contains an ingredient which may be corrosive.

TARGET ORGANS: ACUTE: Eye, respiratory System, Skin CHRONIC: None Known

SECTION 3 - COMPOSITION and INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS:	CAS #	EINECS #	ICSC #	WT %	HAZARD CLASSIFICATION; RISK PHRASES
Sodium Bicarbonate	144-55-8	205-633-8	1044	33 - 43%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	268-356-1	Not Listed	10 – 20%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium Tripolyphosphate	7758-29-4	231-838-7	1469	5 - 15%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Tetrasodium Pyrophosphate	7722-88-5	231-767-1	1140	5 - 15%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium Carbonate	497-19-8	207-638-8	1135	1 - 10%	HAZARD CLASSIFICATION: [Xi] Irritant RISK PHRASES: R36
Sodium Alcohol Sulfate	151-21-3	205-788-1	0502	1 – 5%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Balance of other ingredients are non-hazardous or less than 1% in concentration (or 0.1% for carcinogens, reproductive toxins, or respiratory sensitizers).					

NOTE: ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-2004 format. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR, EU Directives and the Japanese Industrial Standard *JIS Z 7250: 2000*.

SECTION 4 - FIRST-AID MEASURES

Contaminated individuals of chemical exposure must be taken for medical attention if any adverse effect occurs. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to health professional with contaminated individual.

EYE CONTACT: If product enters the eyes, open eyes while under gentle running water for at least 15 minutes. Seek medical attention if irritation persists.

SKIN CONTACT: Wash skin thoroughly after handling. Seek medical attention if irritation develops and persists. Remove contaminated clothing. Launder before re-use.

INHALATION: If breathing becomes difficult, remove victim to fresh air. If necessary, use artificial respiration to support vital functions. Seek medical attention if breathing dificulty continues.

INGESTION: If product is swallowed, call physician or poison control center for most current information. If professional advice is not available, do not induce vomiting. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow. Seek medical advice. Take a copy of the label and/or MSDS with the victim to the health professional.

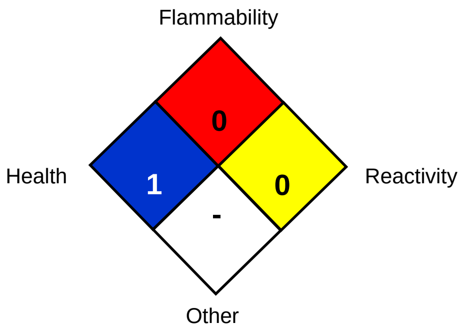
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin, or eye problems may be aggravated by prolonged contact.

RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and reduce over-exposure.

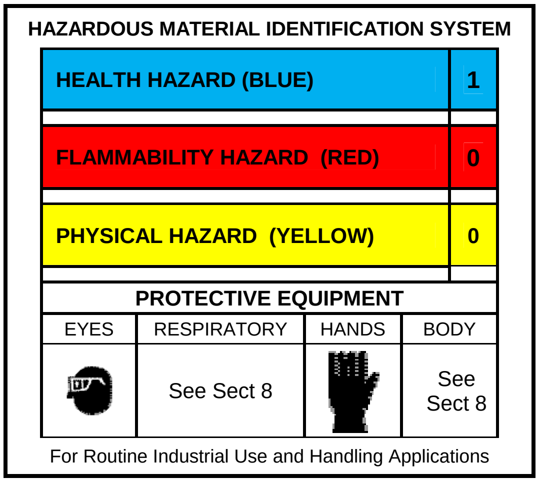
SECTION 5 - FIRE-FIGHTING MEASURES

FLASH POINT:	Not Flammable
AUTOIGNITION TEMPERATURE:	Not Applicable
FLAMMABLE LIMITS (in air by volume, %):	Lower (LEL): NA Upper (UEL): NA
FIRE EXTINGUISHING MATERIALS:	As appropriate for surrounding fire. Carbon dioxide, foam, dry chemical, halon, or water spray.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	This product is non-flammable and has no known explosion hazards.
Explosion Sensitivity to Mechanical Impact:	Not Sensitive.
Explosion Sensitivity to Static Discharge:	Not Sensitive
SPECIAL FIRE-FIGHTING PROCEDURES:	Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Isolate materials not yet involved in the fire and protect personnel. Move containers from fire area if this can be done without risk; otherwise, cool with carefully applied water spray. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas.

NFPA RATING SYSTEM



HMIS RATING SYSTEM



HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

HEALTH HAZARD (BLUE)	1
FLAMMABILITY HAZARD (RED)	0
PHYSICAL HAZARD (YELLOW)	0

PROTECTIVE EQUIPMENT

EYES	RESPIRATORY	HANDS	BODY
	See Sect 8		See Sect 8

For Routine Industrial Use and Handling Applications

Hazard Scale: **0** = Minimal **1** = Slight **2** = Moderate **3** = Serious **4** = Severe * = Chronic hazard

SECTION 6 - ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Personnel should be trained for spill response operations.

SPILLS: Contain spill if safe to do so. Prevent entry into drains, sewers, and other waterways. Sweep, shovel or vacuum spilled material and place in an appropriate container for re-use or disposal. Avoid dust generation if possible. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations).

SECTION 7 - HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Do not eat, drink, smoke, or apply cosmetics while handling this product. Avoid breathing dusts generated by this product. Use in a well-ventilated location. Remove contaminated clothing immediately.

STORAGE AND HANDLING PRACTICES: Containers of this product must be properly labeled. Store containers in a cool, dry location. Keep container tightly closed when not in use. Store away from strong acids or oxidizers.

SECTION 8 - EXPOSURE CONTROLS - PERSONAL PROTECTION

EXPOSURE LIMITS/GUIDELINES:

Chemical Name	CAS#	ACGIH TWA	OSHA TWA	SWA
Sodium Bicarbonate	144-55-8	10 mg/m^3 Total Dust	15 mg/m^3 Total Dust	10 mg/m^3 Total Dust
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	10 mg/m^3 Total Dust	15 mg/m^3 Total Dust	10 mg/m^3 Total Dust
Sodium Tripolyphosphate	7758-29-4	10 mg/m^3 Total Dust	15 mg/m^3 Total Dust	10 mg/m^3 Total Dust
Tetrasodium Pyrophosphate	7722-88-5	5 mg/m^3	5 mg/m^3	5 mg/m^3
Sodium Carbonate	497-19-8	10 mg/m^3 Total Dust	15 mg/m^3 Total Dust	10 mg/m^3 Total Dust
Sodium Alcohol Sulfate	151-21-3	10 mg/m^3 Total Dust	15 mg/m^3 Total Dust	10 mg/m^3 Total Dust

Currently, International exposure limits are not established for the components of this product. Please check with competent authority in each country for the most recent limits in place.

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation to ensure exposure levels are maintained below the limits provided below. Use local exhaust ventilation to control airborne dust. Ensure eyewash/safety shower stations are available near areas where this product is used.

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EU member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection), and those of Japan. Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Based on test data, exposure limits should not be exceeded under normal use conditions when using Alconox Detergent. Maintain airborne contaminant concentrations below guidelines listed above, if applicable. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, or EU member states.

EYE PROTECTION: Safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: Use chemical resistant gloves to prevent skin contact.. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate to prevent contact (e.g. lab coat, overalls). If necessary, refer to appropriate Standards of Canada, or appropriate Standards of the EU, Australian Standards, or relevant Japanese Standards.

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES

PHYSICAL STATE:	Solid
APPEARANCE & ODOR:	White granular powder with little or no odor.
ODOR THRESHOLD (PPM):	Not Available
VAPOR PRESSURE (mmHg):	Not Applicable
VAPOR DENSITY (AIR=1):	Not Applicable.
BY WEIGHT:	Not Available
EVAPORATION RATE (nBuAc = 1):	Not Applicable.
BOILING POINT (C°):	Not Applicable.
FREEZING POINT (C°):	Not Applicable.
pH:	9.5 (1% aqueous solution)
SPECIFIC GRAVITY 20°C: (WATER =1)	0.85 – 1.1
SOLUBILITY IN WATER (%)	>10% w/w
COEFFICIENT OF WATER/OIL DIST.:	Not Available
VOC:	None
CHEMICAL FAMILY:	Detergent

SECTION 10 - STABILITY and REACTIVITY

STABILITY: Product is stable
DECOMPOSITION PRODUCTS: When heated to decomposition this product produces Oxides of carbon (COx)
MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong acids and strong oxidizing agents.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: Contact with incompatible materials and dust generation.

SECTION 11 - TOXICOLOGICAL INFORMATION

TOXICITY DATA: Toxicity data is available for mixture:

CAS# 497-19-8 LD50 Oral (Rat)	4090 mg/kg
CAS# 497-19-8 LD50 Oral (Mouse)	6600 mg/kg
CAS# 497-19-8 LC50 Inhalation (Rat)	2300 mg/m³ 2H
CAS# 497-19-8 LC50 Inhalation (Mouse)	1200 mg/m³ 2H
CAS# 7758-29-4 LD50 Oral (Rat)	3120 mg/kg
CAS# 7758-29-4 LD50 Oral (Mouse)	3100 mg/kg
CAS# 7722-88-5 LD50 Oral (Rat)	4000 mg/kg

SUSPECTED CANCER AGENT: None of the ingredients are found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC and therefore is not considered to be, nor suspected to be a cancer-causing agent by these agencies.
IRRITANCY OF PRODUCT: Contact with this product can be irritating to exposed skin, eyes and respiratory system.
SENSITIZATION OF PRODUCT: This product is not considered a sensitizer.
REPRODUCTIVE TOXICITY INFORMATION: No information concerning the effects of this product and its components on the human reproductive system.

SECTION 12 - ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

ENVIRONMENTAL STABILITY: No Data available at this time.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: No evidence is currently available on this product’s effects on plants or animals.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on this product’s effects on aquatic life.

SECTION 13 - DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations, those of Canada, Australia, EU Member States and Japan.

SECTION 14 - TRANSPORTATION INFORMATION

US DOT; IATA; IMO; ADR:

THIS PRODUCT IS NOT HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.
PROPER SHIPPING NAME: Non-Regulated Material
HAZARD CLASS NUMBER and DESCRIPTION: Not Applicable
UN IDENTIFICATION NUMBER: Not Applicable
PACKING GROUP: Not Applicable.
DOT LABEL(S) REQUIRED: Not Applicable
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2004): Not Applicable
MARINE POLLUTANT: None of the ingredients are classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B)

U.S. DEPARTMENT OF TRANSPORTATION (DOT) SHIPPING REGULATIONS:
This product is not classified as dangerous goods, per U.S. DOT regulations, under 49 CFR 172.101.

TRANSPORT CANADA, TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:
This product is not classified as Dangerous Goods, per regulations of Transport Canada.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA):
This product is not classified as Dangerous Goods, by rules of IATA:

INTERNATIONAL MARITIME ORGANIZATION (IMO) DESIGNATION:
This product is not classified as Dangerous Goods by the International Maritime Organization.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR):

SECTION 15 - REGULATORY INFORMATION

UNITED STATES REGULATIONS

SARA REPORTING REQUIREMENTS: This product is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows: None

TSCA: All components in this product are listed on the US Toxic Substances Control Act (TSCA) inventory of chemicals.

SARA 311/312:

Acute Health:	Yes	Chronic Health:	No	Fire:	No	Reactivity:	No

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for this product. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): None

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): None of the ingredients are on the California Proposition 65 lists.

CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: All of the components of this product are on the DSL Inventory

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: No component of this product is on the CEPA First Priorities Substance Lists.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: This product is categorized as a Controlled Product, Hazard Class D2B as per the Controlled Product Regulations

EUROPEAN ECONOMIC COMMUNITY INFORMATION:

EU LABELING AND CLASSIFICATION:

Classification of the mixture according to Regulation (EC) No1272/2008. See section 2 for details.

AUSTRALIAN INFORMATION FOR PRODUCT:

AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) STATUS: All components of this product are listed on the AICS.

STANDARD FOR THE UNIFORM SCHEDULING OF DRUGS AND POISONS: Not applicable.

JAPANESE INFORMATION FOR PRODUCT:

JAPANESE MINISTER OF INTERNATIONAL TRADE AND INDUSTRY (MITI) STATUS: The components of this product are not listed as Class I Specified Chemical Substances, Class II Specified Chemical Substances, or Designated Chemical Substances by the Japanese MITI.

INTERNATIONAL CHEMICAL INVENTORIES:

Listing of the components on individual country Chemical Inventories is as follows:

Asia-Pac:	Listed
Australian Inventory of Chemical Substances (AICS):	Listed
Korean Existing Chemicals List (ECL):	Listed
Japanese Existing National Inventory of Chemical Substances (ENCS):	Listed
Philippines Inventory if Chemicals and Chemical Substances (PICCS):	Listed
Swiss Giftliste List of Toxic Substances:	Listed
U.S. TSCA:	Listed

SECTION 16 - OTHER INFORMATION

PREPARED BY: Paul Eigbrett Global Safety Management, 10006 Cross Creek Blvd. Suite 440, Tampa, FL 33647

ANNEX:

IDENTIFIED USES OF ALCONOX® AND DIRECTIONS FOR USE

Used to clean: Healthcare instruments, laboratory ware, vacuum equipment, tissue culture ware, personal protective equipment, sampling apparatus, catheters, tubing, pipes, radioactive contaminated articles, optical parts, electronic components, pharmaceutical apparatus, cosmetics manufacturing equipment, metal castings, forgings and stampings, industrial parts, tanks and reactors. Authorized by USDA for use in federally inspected meat and poultry plants. Passes inhibitory residue test for water analysis. FDA certified.

Used to remove: Soil, grit, grime, buffing compound, slime, grease, oils, blood, tissue, salts, deposits, particulates, solvents, chemicals, radioisotopes, radioactive contaminations, silicon oils, mold release agents.

Surfaces cleaned: Corrosion inhibited formulation recommended for glass, metal, stainless steel, porcelain, ceramic, plastic, rubber and fiberglass. Can be used on soft metals such as copper, aluminum, zinc and magnesium if rinsed promptly. Corrosion testing may be advisable.

Cleaning method: Soak, brush, sponge, cloth, ultrasonic, flow through clean-inplace. Will foam—not for spray or machine use.

Directions: Make a fresh 1% solution (2 1/2 Tbsp. per gal., 1 1/4 oz. per gal. or 10 grams per liter) in cold, warm, or hot water. If available use warm water. Use cold water for blood stains. For difficult soils, raise water temperature and use more detergent. Clean by soak, circulate, wipe, or ultrasonic method. Not for spray machines, will foam. For nonabrasive scouring, make paste. Use 2% solution to soak frozen stopcocks. To remove silver tarnish, soak in 1% solution in aluminum container. RINSE THOROUGHLY—preferably with running water. For critical cleaning, do final or all rinsing in distilled, deionized, or purified water. For food contact surfaces, rinse with potable water. Used on a wide range of glass, ceramic, plastic, and metal surfaces. Corrosion testing may be advisable.

SAFETY DATA SHEET

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Hydrochloric Acid, 31 – 36.7%

Product Name: Hydrochloric Acid, 31 – 36.7%

Identified Uses: acid etching, steel pickling, oil and gas, ore and mineral, food processing, pharmaceutical, organic chemical synthesis

Company Information:
ASHTA Chemicals Inc.
P.O. Box 858
Ashtabula Ohio 44005
Phone: (440) 997-5221
Fax: (440) 998-0286
24-hour Emergency Phone: CHEMTREC: (800) 424-9300

SECTION 2: HAZARDS IDENTIFICATION

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

GHS label elements, including precautionary statements:

Signal Word: **Danger**

Pictogram(s):

Hazard Statements	
H290	May be corrosive to metals.
H314	Causes severe skin burns and eye damage.
H318	Causes serious eye damage.
H335	May cause respiratory irritation.
Precautionary Statements	
P234	Keep only in original container.
P261	Avoid breathing dust/ fume/ mist/ vapors/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water. Shower.

P304 + P340 + P310	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/ physician.
P305 + P351 + P338 + P310	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/ physician.
P363	Wash contaminated clothing before reuse.
P390	Absorb spillage to prevent material damage.
P403 + P233	Store in a well-ventilated place. Keep container with a resistant inner liner.
P405	Store locked up.
P406	Store in corrosive resistant stainless steel container with a resistant inner liner.
P501	Dispose of contents/ container to an approved waste disposal plant.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms:

CHEMICAL NAME:	Hydrochloric acid
TRADE NAME:	Hydrochloric acid, 31 – 36.7%
SYNONYMS:	Muriatic acid, Chlorohydric acid, Hydrogen Chloride
C.A.S:	7647-01-0
EC:	231-595-7
WHMIS:	D2A, E
CHEMICAL FORMULA:	HCl (in aqueous solution)
CHEMICAL FAMILY:	Inorganic Acid

SECTION 4 FIRST AID MEASURES

Description of first aid measures:
Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. If breathing is difficult, give humidified air. Give oxygen, but only by a certified physician. Consult a physician.

In case of skin contact
Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician. Remove contact lenses if present and easy to do. Continue rinsing eyes during transport to medical facility.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth thoroughly with water. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Consult a physician.

SECTION 5 FIRE FIGHTING MEASURES

Flash Point (Method):	Non-combustible.
Extinguishing Media:	Use extinguishing agents compatible with acid and appropriate for the burning material. Use water spray to keep fire-exposed containers cool.
Auto Ignition Temp:	Non-combustible.
Special Fire Fighting Procedures:	Wear self-contained breathing apparatus and full protective clothing. In case of fire and/or explosion do not breathe fumes. Use standard firefighting procedures and consider the hazards of other involved materials.
Unusual Fire/Explosion Hazards:	Releases flammable hydrogen gas when reacting with metals.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Environmental Precautions:
Use closed systems when possible. Provide local exhaust ventilation where vapor or mist may be generated. Avoid discharge into drains, water courses or onto the ground.

Containment and Cleaning:
Follow preplanned emergency procedures. Only properly equipped, trained, functional personnel should attempt to contain a leak. All other personnel should be evacuated from the danger area. Using full protective equipment, apply appropriate emergency device or other securement technology to stop the leak if possible.

Small Spill:	Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: neutralize the residue with a dilute solution of sodium carbonate.
Large Spill:	Corrosive liquid. Stop leak if without risk. Do not touch spilled material. Use water spray curtain to knock down vapor drift. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that vapor is not present at a concentration level above TLV.

SECTION 7: HANDLING AND STORAGE

Precautions to be taken for handling and storage:
Wear appropriate personal protective equipment. Do not get in eyes, on skin, on clothing. Do not breathe mist or vapor. Observe good industrial hygiene practices. Do not empty into drains. Use caution when combining with water; DO NOT add water to acid, ALWAYS add acid to water while stirring to prevent release of heat, steam and fumes. Store in a well-ventilated place. Store away from incompatible materials. Store closed containers in a clean, cool, open or well ventilated area. Keep out of sun.

SECTION 8: EXPOSURE CONTROL/PERSONAL PROTECTION

Principal Component: Hydrochloric Acid
Occupational Exposure Limits:
Regulatory Limits:

Component	OSHA Final PEL TWA	OSHA Final PEL STEL	OSHA Final PEL Ceiling
Hydrochloric Acid Mixture	---	---	5 ppm 7.59 mg/m^3

ACGIH TLV = 5 ppm (7.59 mg/m^3) TWA

NIOSH IDLH = 50 ppm (as HCl, 2010)

Exposure Controls:

Eye Protection:	Tightly fitting safety goggles. Face shield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
Respiratory Protection:	Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).
Other Protection:	Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Ventilation Recommended:	Exhaust ventilation is required to meet PEL limits.
Glove Type Recommended:	Wear neoprene, nitrile, butyl rubber or PVC gloves to prevent exposure.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties:

Appearance	Colorless to light yellow liquid
Odor	Pungent (irritating/strong)
Odor Threshold	0.3ppm (can cause olfactory fatigue)
pH	<1 (in aqueous solution)
Melting point/freezing point	-30°C (-22°F)
Initial boiling point	>100°C (>212°F)
Flash point	Not applicable
Auto-ignition Temp	Not applicable
Evaporation rate	No data available

Decomposition temperature	No data available
Flammability (solid, gas)	Not combustible
Upper/lower flammability or explosive limits	Not combustible
Water solubility	100%
Molecular Weight	36.46
Relative Density (Specific Gravity)	1.16 (32% HCl solution) 1.19 (36.5% HCl solution)
Bulk Density	8.75 lbs/gal (32% HCl solution) 9.83 lbs/gal (36.5% HCl solution)
Vapor Density (air = 1)	1.267 at 20 °C
Vapor Pressure	84 mm Hg @ 20°C
Partition Coefficient: n-octanol/water	No data available

SECTION 10: STABILITY AND REACTIVITY

Stability:	Hydrochloric acid is stable under normal conditions and pressures.
Conditions to avoid:	Incompatible materials, metals, excess heat, bases.
Incompatibility:	Bases, amines, metals, permanganates, (e.g. potassium permanganate), fluorine, metal acetylides, hexalithium disilicide.
Hazardous decomposition products:	Hydrogen chloride, chlorine, hydrogen gas.
Polymerization:	Hazardous polymerization WILL NOT occur.

SECTION 11: TOXICOGICAL INFORMATION

Information on likely routes of exposure:

Inhalation:	Vapors and mist will irritate throat and respiratory system and cause coughing.
Skin contact:	Causes skin burns.
Eye contact:	Causes eye burns.
Ingestion:	Harmful if swallowed. Causes digestive tract burns. Ingestion may produce burns to the lips, oral cavity, upper airway, esophagus and possibly the digestive tract.

Symptoms related to the physical, chemical and toxicological characteristics:
Contact with this material will cause burns to the skin, eyes and mucous membranes. Permanent eye damage including blindness could result.

Information on toxicological effects:

Acute toxicity:	Harmful if swallowed.
Skin corrosion/irritation:	Causes severe skin burns and eye damage.
Serious eye damage/eye Irritation:	Causes serious eye damage.
Respiratory sensitization:	Not available.

Skin sensitization:	No data available.
Germ cell mutagenicity:	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity:	This product is not considered to be a carcinogen by IARC, ACGIH, NTP or OSHA.
Reproductive toxicity:	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure:	May cause respiratory irritation.
Specific target organ toxicity - repeated exposure:	No data available.
Aspiration hazard:	Not available.
Chronic effects:	Prolonged inhalation may be harmful.

Components Species Test Results:
Hydrochloric acid (CAS# 7647-01-0)

Rat - Inhalation LC_{50}:	3124 ppm, (1 hour)
Rabbit - Dermal LD_{50}:	5010 mg/kg

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity:	Because of the low pH of this product, it would be expected produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems.
Aquatic Toxicity:	This material is toxic to fish and aquatic organisms. Most aquatic species do not tolerate pH lower than 5.5 for any extended period.
Fish Toxicity:	Fish LC_{50} Mosquito fish: 282 mg/l, 96 hours Fish LC_{50} Bluegill: 3.6 mg/l, 48 hours
Persistence and degradability:	Not biodegradable. Hydrochloric acid will likely be neutralized to chloride by alkalinity present in natural environment..
Bioaccumulative Potential:	No data available.
Mobility in soil:	Hydrochloric acid will be neutralized by naturally occurring alkalinity. The acid will permeate soil, dissolving some soil material and will then neutralize.
Other adverse effects:	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation

SECTION 13: DISPOSAL CONSIDERATIONS

Collect and reclaim or dispose in sealed containers at a properly licensed waste disposal site. This material , if not neutralized, must be disposed of as hazardous waste. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national or international regulations.

SECTION 14: TRANSPORT INFORMATION

Shipping:

Usual Shipping Containers:	Tank cars, bulk tankers.
Usual Shelf Life:	Indefinite (life of containers).
Storage/Transport Temperatures:	Ambient.

Suitable Storage:

Materials/Coatings:	Teflon, Tygon, Rubber, PVC and polypropylene materials.

D.O.T. Information:

Labeling:	Corrosive
D.O.T. Identification Number	UN 1789
D.O.T. Shipping Name:	Hydrochloric Acid
Hazard Class:	8
Packing Group:	II
Hazard Guide:	157
Placard:	UN 1789

SECTION 15 REGULATORY INFORMATION

SARA 302 Components

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

The following components are subject to reporting levels established by SARA Title III, Section 313:

Hydrochloric Acid	CAS#: 7647-01-0

SARA 311/312 Hazards

Acute health hazard, reactive hazard.

Massachusetts Right To Know Components

Hydrochloric Acid	CAS#: 7647-01-0

Pennsylvania Right To Know Components

Hydrochloric Acid	CAS#: 7647-01-0

New Jersey Right To Know Components

Hydrochloric Acid	CAS#: 7647-01-0

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects or any other reproductive harm.

OSHA PSM TPQ:

CAS# 7647-01-0 is regulated under OSHA PSM ***only*** if anhydrous or >37% HCl.

Toxic Substances Control Act (TSCA):

Hydrochloric Acid	CAS#: 7647-01-0

Comprehensive Environmental Response Compensation Liability Act: (CERCLA)

Hydrochloric Acid	CAS#: 7647-01-0

SECTION 16 OTHER INFORMATION

NFPA Rating:
Health hazard: 3
Fire Hazard: 0
Reactivity Hazard: 1

This information is drawn from recognized sources believed to be reliable. ASHTA Chemicals, Inc. Makes no guarantees or assumes any liability in connection with this information. The user should be aware of changing technology, research, regulations, and analytical procedures that may require changes herein. The above data is supplied upon the condition that persons will evaluate this information and then determine its suitability for their use. Only U.S.A regulations apply to the above.

Version 1.0	For the new GHS SDS Standard	Revision Date: 12/31/2014
Version 1.1	Graphics updated	Revision Date: 3/9/2015
Version 1.2	Title updated	Revision Date: 6/2/2015
Version 1.3	Section 9 changes	Revision Date: 7/30/2015

Isobutylene

Safety Data Sheet P-4614

This SDS conforms to U.S. Code of Federal Regulations 29 CFR 1910.1200, Hazard Communication.

Issue date: 01/01/1979 Revision date: 01/22/2021 Supersedes: 01/17/2019 Version: 1.0

SECTION: 1. Product and company identification

1.1. Product identifier

Product form	:	Substance
Substance name	:	Isobutylene
Chemical name	:	2-methylpropene
CAS-No.	:	115-11-7
Formula	:	C4H8 / CH2=C(CH3)2
Other means of identification	:	Isobutene, 2-methylpropene

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture	:	Industrial use; Use as directed.

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
10 Riverview Drive
Danbury, CT 06810-6268 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number : Onsite Emergency: 1-800-645-4633

CHEMTREC, 24hr/day 7days/week
— Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887
(collect calls accepted, Contract 17729)

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS US classification

Simple asphyxiant	SIAS
Flam. Gas 1	H220
Press. Gas (Liq.)	H280

2.2. Label elements

GHS US labeling

Hazard pictograms (GHS US) :

GHS02

GHS04

Signal word (GHS US) : Danger

Hazard statements (GHS US) :
H220 - EXTREMELY FLAMMABLE GAS
H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
OSHA-H01 - MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION.
CGA-HG04 - MAY FORM EXPLOSIVE MIXTURES WITH AIR
CGA-HG01 - MAY CAUSE FROSTBITE.

Precautionary statements (GHS US) :
P202 - Do not handle until all safety precautions have been read and understood.
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Heat, Open flames, Sparks, Hot surfaces
P271+P403 - Use and store only outdoors or in a well-ventilated place.
P280 - Wear protective gloves/protective clothing/eye protection/face protection.
P377 - LEAKING GAS FIRE: Do not extinguish, unless leak can be stopped safely.

P381 - Eliminate all ignition sources if safe to do so.
CGA-PG05 - Use a back flow preventive device in the piping.
CGA-PG12 - Do not open valve until connected to equipment prepared for use.
CGA-PG06 - Close valve after each use and when empty.
CGA-PG10 - Use only with equipment rated for cylinder pressure.
CGA-PG11 - Never put cylinders into unventilated areas of passenger vehicles.
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F).
P304 - IF INHALED:
P340 - Remove person to fresh air and keep comfortable for breathing.
P313 - Get medical advice/attention.
P302 - IF ON SKIN:
P336 - Thaw frosted parts with lukewarm water. Do not rub affected area.
P315 - Get immediate medical advice/attention.

2.3. Other hazards

Other hazards which do not result in classification : None.

2.4. Unknown acute toxicity (GHS US)

No data available

SECTION 3: Composition/Information on ingredients

3.1. Substances

Name	Product identifier	%
Isobutylene (Main constituent)	(CAS-No.) 115-11-7	100

3.2. Mixtures

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Remove to fresh air and keep at rest in a position comfortable for breathing. If not breathing, give artificial respiration. If breathing is difficult, trained personnel should give oxygen. Call a physician.

First-aid measures after skin contact : The liquid may cause frostbite. For exposure to liquid, immediately warm frostbite area with warm water not to exceed 105°F (41°C). Water temperature should be tolerable to normal skin. Maintain skin warming for at least 15 minutes or until normal coloring and sensation have returned to the affected area. In case of massive exposure, remove clothing while showering with warm water. Seek medical evaluation and treatment as soon as possible.

First-aid measures after eye contact : Immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. Contact an ophthalmologist immediately.

First-aid measures after ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

No additional information available

4.3. Indication of any immediate medical attention and special treatment needed

None.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Carbon dioxide, Dry chemical, Water spray or fog.

5.2. Special hazards arising from the substance or mixture

Fire hazard	: EXTREMELY FLAMMABLE GAS. If venting or leaking gas catches fire, do not extinguish flames. Flammable vapors may spread from leak, creating an explosive reignition hazard. Vapors can be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharge, or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering an area, especially a confined area, check the atmosphere with an appropriate device.
Explosion hazard	: EXTREMELY FLAMMABLE GAS. Forms explosive mixtures with air and oxidizing agents.
Reactivity	: No reactivity hazard other than the effects described in sub-sections below.

5.3. Advice for firefighters

Firefighting instructions	: **Danger: FLAMMABLE LIQUID AND VAPOR.** Evacuate all personnel from danger area. Use self-contained breathing apparatus. Immediately cool surrounding containers with water spray from maximum distance, taking care not to extinguish flames. Avoid spreading burning liquid with water. Remove ignition sources if safe to do so. If flames are accidentally extinguished, explosive reignition may occur. Reduce vapors with fine water spray or fog. Stop flow of liquid if safe to do so, while continuing cooling water spray. Remove all containers from area of fire if safe to do so. Allow fire to burn out. On-site fire brigades must comply with OSHA 29 CFR 1910.156 and applicable standards under 29 CFR 1919 Subpart L - Fire Protection.
Special protective equipment for fire fighters	: Standard protective clothing and equipment (Self Contained Breathing Apparatus) for fire fighters.
Other information	: Containers are equipped with a pressure relief device. (Exceptions may exist where authorized by DOT.).

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures	: **Danger: Flammable, liquefied gas.** FORMS EXPLOSIVE MIXTURES WITH AIR. Immediately evacuate all personnel from danger area. Use self-contained breathing apparatus where needed. Remove all sources of ignition if safe to do so. Reduce vapors with fog or fine water spray, taking care not to spread liquid with water. Shut off flow if safe to do so. Ventilate area or move container to a well-ventilated area. Flammable vapors may spread from leak and could explode if reignited by sparks or flames. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with an appropriate device.

6.1.1. For non-emergency personnel

No additional information available

6.1.2. For emergency responders

No additional information available

6.2. Environmental precautions

Try to stop release. Prevent waste from contaminating the surrounding environment. Prevent soil and water pollution. Dispose of contents/container in accordance with local/regional/national/international regulations. Contact supplier for any special requirements.

6.3. Methods and material for containment and cleaning up

No additional information available

6.4. Reference to other sections

See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use only non-sparking tools. Use only explosion-proof equipment.

Wear leather safety gloves and safety shoes when handling cylinders. Protect cylinders from physical damage; do not drag, roll, slide or drop. While moving cylinder, always keep in place removable valve cover. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Never insert an object (e.g, wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Slowly open the valve. If the valve is hard to open, discontinue use and contact your supplier. Close the container valve after each use; keep closed even when empty. Never apply flame or localized heat directly to any part of the container. High temperatures may damage the container and could cause the pressure relief device to fail prematurely, venting the container contents. For other precautions in using this product, see section 16.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Store only where temperature will not exceed 125°F (52°C). Post “No Smoking/No Open Flames” signs in storage and use areas. There must be no sources of ignition. Separate packages and protect against potential fire and/or explosion damage following appropriate codes and requirements (e.g, NFPA 30, NFPA 55, NFPA 70, and/or NFPA 221 in the U.S.) or according to requirements determined by the Authority Having Jurisdiction (AHJ). Always secure containers upright to keep them from falling or being knocked over. Install valve protection cap, if provided, firmly in place by hand when the container is not in use. Store full and empty containers separately. Use a first-in, first-out inventory system to prevent storing full containers for long periods. For other precautions in using this product, see section 16.

OTHER PRECAUTIONS FOR HANDLING, STORAGE, AND USE: When handling product under pressure, use piping and equipment adequately designed to withstand the pressures to be encountered. Never work on a pressurized system. Use a back flow preventive device in the piping. Gases can cause rapid suffocation because of oxygen deficiency; store and use with adequate ventilation. If a leak occurs, close the container valve and blow down the system in a safe and environmentally correct manner in compliance with all international, federal/national, state/provincial, and local laws; then repair the leak. Never place a container where it may become part of an electrical circuit.

7.3. Specific end use(s)

None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Isobutylene (115-11-7)		
ACGIH	ACGIH OEL TWA [ppm]	250 ppm

8.2. Exposure controls

Appropriate engineering controls : Use an explosion-proof local exhaust system. Local exhaust and general ventilation must be adequate to meet exposure standards. MECHANICAL (GENERAL): **Inadequate - Use only in a closed system.** Use explosion proof equipment and lighting.

Eye protection : Wear safety glasses when handling cylinders; vapor-proof goggles and a face shield during cylinder changeout or whenever contact with product is possible. Select eye protection in accordance with OSHA 29 CFR 1910.133.

Skin and body protection : Wear metatarsal shoes and work gloves for cylinder handling, and protective clothing where needed. Wear appropriate chemical gloves during cylinder changeout or wherever contact with product is possible. Select per OSHA 29 CFR 1910.132, 1910.136, and 1910.138.

Respiratory protection	: When workplace conditions warrant respirator use, follow a respiratory protection program that meets OSHA 29 CFR 1910.134, ANSI Z88.2, or MSHA 30 CFR 72.710 (where applicable). Use an air-supplied or air-purifying cartridge if the action level is exceeded. Ensure that the respirator has the appropriate protection factor for the exposure level. If cartridge type respirators are used, the cartridge must be appropriate for the chemical exposure. For emergencies or instances with unknown exposure levels, use a self-contained breathing apparatus (SCBA).
Thermal hazard protection	: Wear cold insulating gloves when transfilling or breaking transfer connections.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Gas
Molecular mass	: 56 g/mol
Color	: Colorless.
Odor	: Poor warning properties at low concentrations. Sweetish.
Odor threshold	: Odor threshold is subjective and inadequate to warn for overexposure.
pH	: Not applicable.
Relative evaporation rate (butyl acetate=1)	: No data available
Relative evaporation rate (ether=1)	: Not applicable.
Melting point	: -140.3 °C
Freezing point	: No data available
Boiling point	: -6.9 °C
Flash point	: -80 °C (closed cup)
Critical temperature	: 144.7 °C
Auto-ignition temperature	: 465 °C
Decomposition temperature	: No data available
Flammability (solid, gas)	: 1.8 – 8.8 vol %
Vapor pressure	: 260 kPa
Critical pressure	: 4000 kPa
Relative vapor density at 20 °C	: No data available
Relative density	: 0.63
Density	: 0.599 g/cm³ (at 20 °C)
Relative gas density	: 2
Solubility	: Water: 388 mg/l
Partition coefficient n-octanol/water (Log Pow)	: 2.35
Partition coefficient n-octanol/water (Log Kow)	: Not applicable.
Viscosity, kinematic	: Not applicable.
Viscosity, dynamic	: Not applicable.
Explosive properties	: Not applicable.
Oxidizing properties	: None.
Explosion limits	: No data available

9.2. Other information

Gas group	: Press. Gas (Liq.)
Additional information	: Gas/vapor heavier than air. May accumulate in confined spaces, particularly at or below ground level.

SECTION 10: Stability and reactivity

10.1. Reactivity

No reactivity hazard other than the effects described in sub-sections below.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

May occur.

10.4. Conditions to avoid

High temperature. Catalyst.

10.5. Incompatible materials

Halogens. Oxidizing agents. Acids.

10.6. Hazardous decomposition products

Thermal decomposition may produce : Carbon monoxide. Carbon dioxide.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

Isobutylene (\f)115-11-7	
LC50 Inhalation - Rat	620 mg/l/4h
LC50 Inhalation - Rat [ppm]	541657 ppm/1h
ATE US (gases)	270828.5 ppmV/4h
ATE US (vapors)	620 mg/l/4h
ATE US (dust, mist)	620 mg/l/4h

Skin corrosion/irritation : Not classified
pH: Not applicable.

Serious eye damage/irritation : Not classified
pH: Not applicable.

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Isobutylene (115-11-7)	
National Toxicology Program (NTP) Status	1 - Evidence of Carcinogenicity

Reproductive toxicity : Not classified

STOT-single exposure : Not classified

STOT-repeated exposure : Not classified

Aspiration hazard : Not classified

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : No known ecological damage caused by this product.

12.2. Persistence and degradability

Isobutylene (115-11-7)	
Persistence and degradability	The substance is biodegradable. Unlikely to persist.

12.3. Bioaccumulative potential

Isobutylene (115-11-7)	
Partition coefficient n-octanol/water (Log Pow)	2.35
Partition coefficient n-octanol/water (Log Kow)	Not applicable.

Isobutylene (115-11-7)	
Bioaccumulative potential	Not expected to bioaccumulate due to the low log Kow (log Kow < 4). Refer to section 9.

12.4. Mobility in soil

Isobutylene (115-11-7)	
Mobility in soil	No data available.
Ecology - soil	Because of its high volatility, the product is unlikely to cause ground or water pollution.

12.5. Other adverse effects

Effect on ozone layer : None.

Effect on the global warming : No known effects from this product.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Product/Packaging disposal recommendations : Do not attempt to dispose of residual or unused quantities. Return container to supplier.

SECTION 14: Transport information

In accordance with DOT

Transport document description (DOT) : UN1055 Isobutylene, 2.1
UN-No.(DOT) : UN1055
Proper Shipping Name (DOT) : Isobutylene
Class (DOT) : 2.1 - Class 2.1 - Flammable gas 49 CFR 173.115
Hazard labels (DOT) : 2.1 - Flammable gas

DOT Special Provisions (49 CFR 172.102) : 19 - For domestic transportation only, the identification number UN1075 may be used in place of the identification number specified in column (4) of the 172.101 table. The identification number used must be consistent on package markings, shipping papers and emergency response information.
T50 - When portable tank instruction T50 is referenced in Column (7) of the 172.101 Table, the applicable liquefied compressed gases are authorized to be transported in portable tanks in accordance with the requirements of 173.313 of this subchapter.

Additional information

Emergency Response Guide (ERG) Number : 115 (UN1055)

Other information : No supplementary information available.

Special transport precautions : Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers: - Ensure there is adequate ventilation. - Ensure that containers are firmly secured. - Ensure cylinder valve is closed and not leaking. - Ensure valve outlet cap nut or plug (where provided) is correctly fitted. - Ensure valve protection device (where provided) is correctly fitted.

Transport by sea

UN-No. (IMDG) : 1055
Proper Shipping Name (IMDG) : ISOBUTYLENE
Class (IMDG) : 2 - Gases
Division (IMDG) : 2.1 - Flammable gases
MFAG-No : 115

Air transport

UN-No. (IATA) : 1055
Proper Shipping Name (IATA) : Isobutylene
Class (IATA) : 2
Civil Aeronautics Law : Gases under pressure/Gases flammable under pressure

SECTION 15: Regulatory information

15.1. US Federal regulations

Isobutylene (115-11-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

All components of this product are listed on the Toxic Substances Control Act (TSCA) inventory.

15.2. International regulations

CANADA

Isobutylene (115-11-7)
Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

Isobutylene (115-11-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

15.2.2. National regulations

Isobutylene (115-11-7)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Japanese ISHL (Industrial Safety and Health Law) Listed on KECL/KECI (Korean Existing Chemicals Inventory) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances) Listed on INSQ (Mexican National Inventory of Chemical Substances) Listed on the TCSI (Taiwan Chemical Substance Inventory)

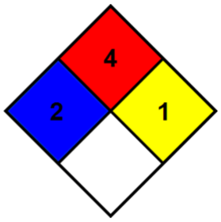
15.3. US State regulations

Isobutylene(115-11-7)	
U.S. - California - Proposition 65 - Carcinogens List	No
U.S. - California - Proposition 65 - Developmental Toxicity	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Female	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No
State or local regulations	U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Other information	: When you mix two or more chemicals, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Before using any plastics, confirm their compatibility with this product. Linde asks users of this product to study this SDS and become aware of the product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this SDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information. The opinions expressed herein are those of qualified experts within Linde Inc. We believe that the information contained herein is current as of the date of this Safety Data Sheet. Since the use of this information and the conditions of use are not within the control of Linde Inc, it is the user's obligation to determine the conditions of safe use of the product. Linde SDSs are furnished on sale or delivery by Linde or the independent distributors and suppliers who package and sell our products. To obtain current SDSs for these products, contact your sales representative, local distributor, or supplier, or download from www.lindeus.com. If you have questions regarding Linde SDSs, would like the document number and date of the latest SDS, or would like the names of the Linde suppliers in your area, phone or write the Linde Call Center (Phone: 1-800-772-9247; Address: Linde Call Center, Linde Inc, P.O. Box 44, Tonawanda, NY 14151-0044). Linde, Praxair, the Linde wordmark and the Flowing Airstream design are trademarks or registered trademarks of Linde plc or its affiliates. The information contained herein is offered for use by technically qualified personnel at their discretion and risk without warranty of any kind. Copyright © 2020, Linde plc.
Revision date	: 01/22/2021

NFPA health hazard	: 2 - Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.
NFPA fire hazard	: 4 - Materials that rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air and burn readily.
NFPA instability	: 1 - Materials that in themselves are normally stable but can become unstable at elevated temperatures and pressures.



SDS US GHS DUAL BRANDED LINDE->PRAXAIR

SAFETY DATA SHEET

Airgas

Methanol (Methyl Alcohol)

Section 1. Identification

GHS product identifier : Methanol (Methyl Alcohol)

Chemical name : methanol

Other means of identification : Methyl alcohol

Product use : Synthetic/Analytical chemistry.

Synonym : Methyl alcohol

SDS # : 001065

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE LIQUIDS - Category 2
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (respiratory tract) - Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Highly flammable liquid and vapor.
May displace oxygen and cause rapid suffocation.
Corrosive to the respiratory tract.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Wear protective gloves. Wear eye or face protection. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use explosion-proof electrical, ventilating, lighting and all material-handling equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Keep container tightly closed. Use only outdoors or in a well-ventilated area. Avoid breathing vapor.

Response : IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or physician if you feel unwell. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower.

Storage : Store locked up. Store in a well-ventilated place. Keep cool.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Section 2. Hazards identification

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : methanol

Other means of identification : Methyl alcohol

CAS number/other identifiers

CAS number : 67-56-1

Product code : 001065

Ingredient name	%	CAS number
methanol	100	67-56-1

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If necessary, call a poison center or physician. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention if adverse health effects persist or are severe. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : May cause respiratory irritation.

Skin contact : No known significant effects or critical hazards.

Section 4. First aid measures

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : No known significant effects or critical hazards.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media : Do not use water jet.

Specific hazards arising from the chemical : Highly flammable liquid and vapor. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

Large spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Do not ingest. Avoid contact with eyes, skin and clothing. Avoid breathing vapor or mist. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Take precautionary measures against electrostatic discharges. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Section 7. Handling and storage

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
methanol	**ACGIH TLV (United States, 3/2012). Absorbed through skin.** STEL: 328 mg/m³ 15 minutes. STEL: 250 ppm 15 minutes. TWA: 262 mg/m³ 8 hours. TWA: 200 ppm 8 hours. **NIOSH REL (United States, 1/2013). Absorbed through skin.** STEL: 325 mg/m³ 15 minutes. STEL: 250 ppm 15 minutes. TWA: 260 mg/m³ 10 hours. TWA: 200 ppm 10 hours. **OSHA PEL (United States, 6/2010).** TWA: 260 mg/m³ 8 hours. TWA: 200 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989). Absorbed through skin.** STEL: 325 mg/m³ 15 minutes. STEL: 250 ppm 15 minutes. TWA: 260 mg/m³ 8 hours. TWA: 200 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Section 8. Exposure controls/personal protection

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Liquid. [CLEAR, COLORLESS, FLAMMABLE, POISONOUS LIQUID WITH CHARACTERISTIC PUNGENT ODOR]

Color : Colorless. Clear.

Molecular weight : 32.05 g/mole

Molecular formula : C-H4-O

Boiling/condensation point : 64.7°C (148.5°F)

Melting/freezing point : -97.8°C (-144°F)

Critical temperature : Not available.

Odor : Characteristic.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: 9.7°C (49.5°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : 2.1 (butyl acetate = 1)

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Lower: 6%
Upper: 44%

Vapor pressure : 16.9 kPa (126.963291808 mm Hg) [room temperature]

Vapor density : 1.1 (Air = 1)

Specific Volume (ft ^{3}/lb) :

Gas Density (lb/ft ^{3}) : Not available.

Section 9. Physical and chemical properties

Relative density	0.79
Solubility	Not available.
Solubility in water	1000 g/l
Partition coefficient: n-octanol/water	-0.77
Auto-ignition temperature	455°C (851°F)
Decomposition temperature	Not available.
SADT	Not available.
Viscosity	Dynamic (room temperature): 0.544 to 0.59 mPa·s (0.544 to 0.59 cP)

Section 10. Stability and reactivity

Reactivity	No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	The product is stable.
Possibility of hazardous reactions	Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow vapor to accumulate in low or confined areas.
Incompatibility with various substances	Extremely reactive or incompatible with the following materials: oxidizing materials.
Hazardous decomposition products	Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous polymerization	Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
methanol	LC50 Inhalation Gas. LC50 Inhalation Gas.	Rat Rat	145000 ppm 64000 ppm	1 hours 4 hours

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
methanol	Eyes - Moderate irritant	Rabbit	-	24 hours 100 milligrams	-
	Eyes - Moderate irritant	Rabbit	-	40 milligrams	-
	Skin - Moderate irritant	Rabbit	-	24 hours 20 milligrams	-

Sensitization

Not available.

Mutagenicity

Section 11. Toxicological information

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Name	Category	Route of exposure	Target organs
methanol	Category 3	Not applicable.	Respiratory tract irritation

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure	:	Not available.

Potential acute health effects

Eye contact	:	No known significant effects or critical hazards.
Inhalation	:	May cause respiratory irritation.
Skin contact	:	No known significant effects or critical hazards.
Ingestion	:	No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact	:	No specific data.
Inhalation	:	Adverse symptoms may include the following: respiratory tract irritation coughing
Skin contact	:	No specific data.
Ingestion	:	No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects	:	Not available.
Potential delayed effects	:	Not available.

Long term exposure

Potential immediate effects	:	Not available.
Potential delayed effects	:	Not available.

Potential chronic health effects

Not available.

Section 11. Toxicological information

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	LogP_{ow}	BCF	Potential
methanol	-0.77	<10	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

United States - RCRA Toxic hazardous waste "U" List

Section 13. Disposal considerations

Ingredient	CAS #	Status	Reference number
Methanol (I); Methyl alcohol (I)	67-56-1	Listed	U154

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1230	UN1230	UN1230	UN1230	UN1230
UN proper shipping name	METHANOL	METHANOL	METHANOL	METHANOL	METHANOL
Transport hazard class(es)	3 	3 	3 	3 (6.1)  	3 (6.1)  
Packing group	II	II	-	II	II
Environment	No.	No.	No.	No.	No.
Additional information	**Reportable quantity** 5000 lbs / 2270 kg [759.08 gal / 2873.4 L] Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements. **Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 1 L **Cargo aircraft** Quantity limitation: 60 L **Special provisions** IB2, T7, TP2	**Explosive Limit and Limited Quantity Index** 1 **Passenger Carrying Road or Rail Index** 1 **Special provisions** 43	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 1 L **Cargo Aircraft Only** Quantity limitation: 60 L **Limited Quantities - Passenger Aircraft** Quantity limitation: 1 L

“Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product.”

Special precautions for user : **Transport within user’s premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard
Immediate (acute) health hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
methanol	100	Yes.	No.	No.	Yes.	No.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	methanol	67-56-1	100
Supplier notification	methanol	67-56-1	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.

New York : This material is listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.

Section 15. Regulatory information

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
methanol	No.	Yes.	No.	No.

Canada inventory : This material is listed or exempted.

International regulations

International lists :
Australia inventory (AICS): This material is listed or exempted.
China inventory (IECSC): This material is listed or exempted.
Japan inventory: This material is listed or exempted.
Korea inventory: This material is listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): This material is listed or exempted.
Philippines inventory (PICCS): This material is listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

Canada

WHMIS (Canada) :
Class B-2: Flammable liquid
Class D-1B: Material causing immediate and serious toxic effects (Toxic).
Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements :
Class B-2: Flammable liquid
Class D-1B: Material causing immediate and serious toxic effects (Toxic).
Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

Hazardous Material Information System (U.S.A.)

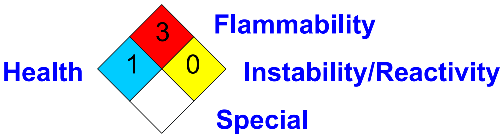
Health		1
Flammability		3
Physical hazards		0

Section 16. Other information

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

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



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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing : 5/20/2015.

Date of issue/Date of revision : 5/20/2015.

Date of previous issue : 10/16/2014.

Version : 0.04

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health

Section 16. Other information

TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

◤ **Indicates information that has changed from previously issued version.**

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

Creation Date 12-Mar-2009 **Revision Date** 15-Dec-2015 **Revision Number** 4

1. Identification

Product Name **Nitric acid (65 - 70%)**

Cat No. : **A198C-212, A200-212, A200-212LC, A200-500, A200-500LC, A200-612GAL, A200C-212, A200S-212, A200S-212LC, A200S-500, A200SI-212, A467-1, A467-2, A467-250, A467-500, A483-212; S719721**

Synonyms Azotic acid; Engraver's acid; Aqua fortis

Recommended Use Laboratory chemicals.

Uses advised against No Information available

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Oxidizing liquids	Category 2
Corrosive to metals	Category 1
Skin Corrosion/irritation	Category 1 A
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney.	

Label Elements

Signal Word
Danger

Hazard Statements
May cause fire or explosion; strong oxidizer
May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements

Prevention

Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep/Store away from clothing/ other combustible materials
Take any precaution to avoid mixing with combustibles
Keep only in original container

Response

Immediately call a POISON CENTER or doctor/physician

Inhalation

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

Skin

IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse

Eyes

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing

Ingestion

IF SWALLOWED: Rinse mouth. DO NOT induce vomiting

Fire

In case of fire: Use CO2, dry chemical, or foam for extinction

Spills

Absorb spillage to prevent material damage

Storage

Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place

Disposal

Dispose of contents/container to an approved waste disposal plant

Hazards not otherwise classified (HNOC)

None identified

Unknown Acute Toxicity

.? percent of the mixture consists of ingredient(s) of unknown acute toxicity

3. Composition / information on ingredients

Component	CAS-No	Weight %
Nitric acid	7697-37-2	65 - 70
Water	7732-18-5	30 - 35

4. First-aid measures

General Advice	Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before re-use. Call a physician immediately.
Inhalation	If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Remove from exposure, lie down. Call a physician immediately.
Ingestion	Do not induce vomiting. Never give anything by mouth to an unconscious person. Clean mouth with water. Call a physician immediately.
Most important symptoms/effects	Causes burns by all exposure routes. . Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	CO_2, dry chemical, dry sand, alcohol-resistant foam.
Unsuitable Extinguishing Media	No information available
Flash Point	Not applicable
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Oxidizing Properties	Oxidizer
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes. Oxidizer: Contact with combustible/organic material may cause fire. May ignite combustibles (wood paper, oil, clothing, etc.).

Hazardous Combustion Products

Nitrogen oxides (NOx) Thermal decomposition can lead to release of irritating gases and vapors

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
4	0	0	OX

6. Accidental release measures

Personal Precautions	Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Use personal protective equipment.
Environmental Precautions	Should not be released into the environment. Do not flush into surface water or sanitary sewer system. See Section 12 for additional ecological information.
Methods for Containment and Clean	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

Up	Sweep up and shovel into suitable containers for disposal.

7. Handling and storage

Handling	Use only under a chemical fume hood. Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Do not ingest. Do not breathe vapors or spray mist. Keep away from clothing and other combustible materials.
Storage	Keep containers tightly closed in a cool, well-ventilated place. Do not store near combustible materials.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Nitric acid	TWA: 2 ppm STEL: 4 ppm	(Vacated) TWA: 2 ppm (Vacated) TWA: 5 mg/m^3 (Vacated) STEL: 4 ppm (Vacated) STEL: 10 mg/m^3 TWA: 2 ppm TWA: 5 mg/m^3	IDLH: 25 ppm TWA: 2 ppm TWA: 5 mg/m^3 STEL: 4 ppm STEL: 10 mg/m^3

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Nitric acid	TWA: 2 ppm TWA: 5.2 mg/m^3 STEL: 4 ppm STEL: 10 mg/m^3	TWA: 2 ppm TWA: 5 mg/m^3 STEL: 4 ppm STEL: 10 mg/m^3	TWA: 2 ppm STEL: 4 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures	Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye/face Protection	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. Tightly fitting safety goggles. Face-shield.
Skin and body protection	Long sleeved clothing.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Keep away from food, drink and animal feeding stuffs. When using, do not eat, drink or smoke. Contaminated work clothing should not be allowed out of the workplace. Provide regular cleaning of equipment, work area and clothing. Avoid contact with skin, eyes and clothing. For environmental protection remove and wash all contaminated protective equipment before re-use. Wear suitable gloves and eye/face protection.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Clear Colorless, Light yellow
Odor	Strong Acrid
Odor Threshold	No information available

pH	< 1.0 (0.1M)
Melting Point/Range	-41 °C / -41.8 °F
Boiling Point/Range	Not applicable °C / °F
Flash Point	Not applicable
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	0.94 kPa (20°C)
Vapor Density	No information available
Specific Gravity	1.40
Solubility	miscible
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	HNO_3
Molecular Weight	63.02

10. Stability and reactivity

Reactive Hazard	Yes
Stability	Oxidizer: Contact with combustible/organic material may cause fire.
Conditions to Avoid	Incompatible products. Combustible material. Excess heat. Exposure to air or moisture over prolonged periods.
Incompatible Materials	Combustible material, Strong bases, Reducing agents, Metals, Powdered metals, Organic materials, Aldehydes, Alcohols, Cyanides, Ammonia, Strong reducing agents
Hazardous Decomposition Products	Nitrogen oxides (NOx), Thermal decomposition can lead to release of irritating gases and vapors
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Dermal LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Vapor LC50	Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Nitric acid	Not listed	Not listed	LC50 = 2500 ppm. (Rat) 1h
Water	-	Not listed	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	Causes severe burns by all exposure routes
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Nitric acid	7697-37-2	Not listed	Not listed	Not listed	Not listed	Not listed
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Respiratory system
STOT - repeated exposure	Kidney
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. Large amounts will affect pH and harm aquatic organisms. Contains a substance which is:. Harmful to aquatic organisms. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Nitric acid	Not listed	LC50: = 72 mg/L, 96h (Gambusia affinis)	Not listed	Not listed

Persistence and Degradability	Miscible with water Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	Will likely be mobile in the environment due to its water solubility.

Component	log Pow
Nitric acid	-2.3

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	I

TDG

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	I

IATA

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	I

IMDG/IMO

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	I

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Nitric acid	X	X	-	231-714-2	-		X	X	X	X	X
Water	X	X	-	231-791-2	-		X	-	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Nitric acid	7697-37-2	65 - 70	1.0

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	Yes

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Nitric acid	X	1000 lb	-	-

Clean Air Act Not applicable

OSHA Occupational Safety and Health Administration

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Nitric acid	-	TQ: 500 lb

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Nitric acid	1000 lb	1000 lb

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Nitric acid	X	X	X	X	X
Water	-	-	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security

This product contains the following DHS chemicals:

Component	DHS Chemical Facility Anti-Terrorism Standard
Nitric acid	2000 lb STQ

Other International Regulations

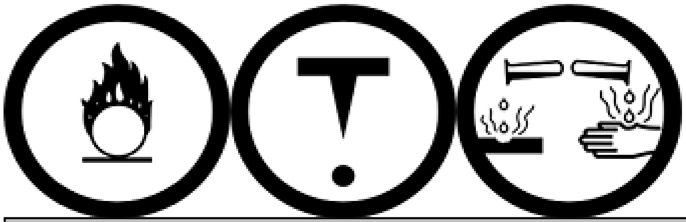
Mexico - Grade No information available

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

WHMIS Hazard Class

C Oxidizing materials
E Corrosive material
D2B Toxic materials



16. Other information

Prepared By

Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date	12-Mar-2009
Revision Date	15-Dec-2015
Print Date	15-Dec-2015
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

Disclaimer

End of SDS

Polycyclic Aromatic Hydrocarbons (PAHs) - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polycyclic aromatic hydrocarbons (PAHs). For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing air contaminated by wild fires or coal tar, or by eating foods that have been grilled. PAHs have been found in at least 600 of the 1,430 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polycyclic aromatic hydrocarbons?

(Pronounced pŏl′ĭ-sī′klĭk ăr′ə-măt′ĭk hī′drə-kar′bənz)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

What happens to PAHs when they enter the environment?

- PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- PAHs can occur in air attached to dust particles.
- Some PAH particles can readily evaporate into the air from soil or surface waters.
- PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days to weeks.
- PAHs enter water through discharges from industrial and wastewater treatment plants.
- Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- Microorganisms can break down PAHs in soil or water after a period of weeks to months.
- In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live.

How might I be exposed to PAHs?

- Breathing air containing PAHs in the workplace of coking, coal-tar, and asphalt production plants; smokehouses; and municipal trash incineration facilities.
- Breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts, asphalt roads, or agricultural burn smoke.
- Coming in contact with air, water, or soil near hazardous waste sites.
- Eating grilled or charred meats; contaminated cereals, flour, bread, vegetables, fruits, meats; and processed or pickled foods.
- Drinking contaminated water or cow's milk.
- Nursing infants of mothers living near hazardous waste sites may be exposed to PAHs through their mother's milk.

How can PAHs affect my health?

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people.

Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

How likely are PAHs to cause cancer?

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.

Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Is there a medical test to show whether I've been exposed to PAHs?

In the body, PAHs are changed into chemicals that can attach to substances within the body. There are special tests that can detect PAHs attached to these substances in body tissues or blood. However, these tests cannot tell whether any health effects will occur or find out the extent or source of your exposure to the PAHs. The tests aren't usually available in your doctor's office because special equipment is needed to conduct them.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 milligrams of PAHs per cubic meter of air (0.2 mg/m^3). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist that contains PAHs is 5 mg/m^3 averaged over an 8-hour exposure period.

The National Institute for Occupational Safety and Health (NIOSH) recommends that the average workplace air levels for coal tar products not exceed 0.1 mg/m^3 for a 10-hour workday, within a 40-hour workweek. There are other limits for workplace exposure for things that contain PAHs, such as coal, coal tar, and mineral oil.

Glossary

Carcinogen: A substance that can cause cancer.

Ingest: Take food or drink into your body.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

National Biomonitoring Program

Organophosphorus Insecticides: Dialkyl Phosphate Metabolites Factsheet

Organophosphorus insecticides are chemicals used to kill many types of insects. These chemicals account for a large share of all insecticides used in the United States, including those used on food crops. Most home uses of organophosphorus insecticides have been phased out in the United States. Certain organophosphorus insecticides (e.g., malathion, naled) are also used for mosquito control in the United States.

How People Are Exposed to Organophosphorus Insecticides

People are exposed to organophosphorus insecticides by eating foods treated with these chemicals. Exposure can also occur from hand-to-mouth contact with surfaces contaminated with the insecticides. Less common exposures include breathing in the insecticides or absorbing them through the skin. Farm workers, gardeners, florists, pesticide applicators, and manufacturers of these insecticides may have greater exposure than the general population.

Once they enter the body, about 75% of the organophosphorus insecticides in use in the U.S. are converted to breakdown products called dialkyl phosphate metabolites. These metabolites are not considered toxic, but indicate an exposure to organophosphate insecticides.

How Organophosphorus Insecticides Affect People's Health

A sudden exposure to large amounts of organophosphorus insecticides may lead to health problems such as nausea, vomiting, irregular or slow heartbeat, difficulty breathing or tightness in the chest, salivation, weakness, paralysis, and seizures.

When people are exposed over a long period of time to smaller amounts of these pesticides, they may feel tired or weak, irritable, depressed, or forgetful.

Levels of Organophosphorus Insecticides: Dialkyl Phosphate Metabolites in the U.S. Population

In the *Fourth National Report on Human Exposure to Environmental Chemicals (Fourth Report)*, scientists with the CDC scientists measured six different dialkyl phosphate metabolites in at least 1,903 participants aged 6–59 years old who took part in the National Health and Nutrition Examination Survey (NHANES) during 2003–2004. Prior survey periods of 1999–2000 and 2001–2002 are also included in the *Fourth Report*. By measuring dialkyl phosphate metabolites in urine, scientists can estimate the amounts of organophosphorus pesticides that have entered peoples' bodies.

- In the *Fourth Report*, levels are similar to those of previous survey periods, lower than the levels found in some studies in other countries, and much lower than levels seen in workers who used organophorphorus insecticides.

Finding measurable amounts of dialkyl phosphate metabolites in urine does not imply that the levels of dialkyl phosphate metabolites cause an adverse health effect. Biomonitoring studies of dialkyl phosphate metabolites provide physicians and public health officials with reference values so that they can determine whether or not people have been exposed to higher levels of organophosphorus pesticides than are found in the general population. Biomonitoring data can also help scientists plan and conduct research on exposure and health effects.

Additional Resources

Centers for Disease Control and Prevention

- Health Studies: Pesticides

Environmental Protection Agency

- Types of Pesticides
- Pesticide Re-registration Status for Organophosphates

National Institute for Occupational Safety and Health

- Pesticide Illness and Injury Surveillance

National Pesticide Information Center

- Recognition and Management of Pesticide Poisonings, 5th Edition, Chapter 4
- Recognition and Management of Pesticide Poisonings (Home Page)

Page last reviewed: April 7, 2017

SIGMA-ALDRICH sigma-aldrich.com

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006
Version 5.0 Revision Date 29.10.2012
Print Date 19.04.2017
GENERIC EU MSDS - NO COUNTRY SPECIFIC DATA - NO OEL DATA

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1 Product identifiers

Product name : Arsenic

Product Number : 267961
Brand : Aldrich
Index-No. : 033-001-00-X
CAS-No. : 7440-38-2

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Israel Ltd.
3 PARK RABIN, PLAUT
7670603 REHOVOT
ISRAEL

Telephone : +972 8948-4222
Fax : +972 8948-4200

1.4 Emergency telephone number

Emergency Phone # : +972 (8) 948-4222

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008 [EU-GHS/CLP]
Acute aquatic toxicity (Category 1)
Chronic aquatic toxicity (Category 1)
Acute toxicity, Inhalation (Category 3)
Acute toxicity, Oral (Category 3)

Classification according to EU Directives 67/548/EEC or 1999/45/EC
Toxic by inhalation and if swallowed. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

2.2 Label elements

Labelling according Regulation (EC) No 1272/2008 [CLP]
Pictogram

Signal word Danger

Hazard statement(s)

H301	Toxic if swallowed.
H331	Toxic if inhaled.
H410	Very toxic to aquatic life with long lasting effects.

Precautionary statement(s)

P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P273	Avoid release to the environment.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER or doctor/

	physician.
P311	Call a POISON CENTER or doctor/ physician.
P501	Dispose of contents/ container to an approved waste disposal plant.

Supplemental Hazard Statements	none

According to European Directive 67/548/EEC as amended.

Hazard symbol(s)

R-phrase(s)	
R23/25	Toxic by inhalation and if swallowed.
R50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

S-phrase(s)	
S20/21	When using do not eat, drink or smoke.
S28	After contact with skin, wash immediately with plenty of soap and water.
S45	In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S60	This material and its container must be disposed of as hazardous waste.
S61	Avoid release to the environment. Refer to special instructions/ Safety data sheets.

2.3 Other hazards - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula : As
Molecular Weight : 74,92 g/mol

Component		Concentration
Arsenic		
CAS-No.	7440-38-2	-
EC-No.	231-148-6	
Index-No.	033-001-00-X	

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

Absorption into the body leads to the formation of methemoglobin which in sufficient concentration causes cyanosis. Onset may be delayed 2 to 4 hours or longer.

4.3 Indication of any immediate medical attention and special treatment needed

no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Arsenic oxides

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
no data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear respiratory protection. Avoid dust formation. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up
Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed.

7.2 Conditions for safe storage, including any incompatibilities
Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end uses
no data available

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Immersion protection
Material: Nitrile rubber
Minimum layer thickness: 0,11 mm
Break through time: > 480 min
Material tested:Dermatril® (Aldrich Z677272, Size M)

Splash protection
Material: Nitrile rubber
Minimum layer thickness: 0,11 mm
Break through time: > 30 min
Material tested:Dermatril® (Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 873000, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N99 (US) or type P2 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

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9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: powder Colour: grey
b)	Odour	no data available
c)	Odour Threshold	no data available
d)	pH	no data available
e)	Melting point/freezing point	Melting point/range: 817 °C - lit.
f)	Initial boiling point and boiling range	613 °C - lit.
g)	Flash point	not applicable
h)	Evaporation rate	no data available
i)	Flammability (solid, gas)	no data available
j)	Upper/lower flammability or explosive limits	no data available
k)	Vapour pressure	no data available
l)	Vapour density	no data available
m)	Relative density	5,727 g/mL at 25 °C
n)	Water solubility	no data available
o)	Partition coefficient: n-octanol/water	no data available

p)	Autoignition temperature	no data available
q)	Decomposition temperature	no data available
r)	Viscosity	no data available
s)	Explosive properties	no data available
t)	Oxidizing properties	no data available

9.2 Other safety information
no data available

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10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
no data available

10.3 Possibility of hazardous reactions
no data available

10.4 Conditions to avoid
Heat. Exposure to air may affect product quality.

10.5 Incompatible materials
Oxidizing agents, Halogens, Palladium undergoes a violent reaction with arsenic, Zinc, Platinum oxide, Nitrogen trichloride, Bromine azide

10.6 Hazardous decomposition products
Other decomposition products - no data available

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11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 763 mg/kg
Remarks: Behavioral:Ataxia. Diarrhoea

LD50 Oral - mouse - 145 mg/kg
Remarks: Behavioral:Ataxia. Diarrhoea

Inhalation: no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

This is or contains a component that has been reported to be carcinogenic based on its IARC, OSHA, ACGIH, NTP, or EPA classification.

IARC: 1 - Group 1: Carcinogenic to humans (Arsenic)

Reproductive toxicity
no data available

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation	Toxic if inhaled. May cause respiratory tract irritation.
Ingestion	Harmful if swallowed.
Skin	May be harmful if absorbed through skin. May cause skin irritation.
Eyes	May cause eye irritation.

Signs and Symptoms of Exposure
Absorption into the body leads to the formation of methemoglobin which in sufficient concentration causes cyanosis. Onset may be delayed 2 to 4 hours or longer.

Additional Information
RTECS: CG0525000

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12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Pimephales promelas (fathead minnow) - 9,9 mg/l - 96,0 h
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 3,8 mg/l - 48 h

12.2 Persistence and degradability
no data available

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
no data available

12.6 Other adverse effects
Very toxic to aquatic life with long lasting effects.

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13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

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14. TRANSPORT INFORMATION

14.1 UN number

ADR/RID: 1558	IMDG: 1558	IATA: 1558

14.2 UN proper shipping name
ADR/RID: ARSENIC
IMDG: ARSENIC
IATA: Arsenic

14.3 Transport hazard class(es)

ADR/RID: 6.1
IMDG: 6.1
IATA: 6.1

14.4 Packaging group

ADR/RID: II
IMDG: II
IATA: II

14.5 Environmental hazards

ADR/RID: yes
IMDG Marine pollutant: yes
IATA: no

14.6 Special precautions for user

no data available

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15. REGULATORY INFORMATION

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

no data available

15.2 Chemical Safety Assessment

no data available

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16. OTHER INFORMATION

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Barium Chloride Dihydrate

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name : **Barium Chloride Dihydrate**

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: **S25187A**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Toxic
Acute toxicity (oral, dermal, inhalation), category 3

Irritant
Acute toxicity (oral, dermal, inhalation), category 4

AcTox Oral 3
AcTox Inhaln. 4

Signal word :Danger

Hazard statements:
Toxic if swallowed
Harmful if inhaled
Precautionary statements:
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
Do not eat, drink or smoke when using this product
Use only outdoors or in a well-ventilated area
Avoid breathing dust/fume/gas/mist/vapours/spray
Wash skin thoroughly after handling
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
Rinse mouth
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Specific treatment (see supplemental first aid instructions on this label)
Call a POISON CENTER or doctor/physician if you feel unwell
Store locked up

Dispose of contents and container as instructed in Section 13

Other Non-GHS Classification:

WHMIS

D1B

NFPA/HMIS

NFPA SCALE (0-4)

Health	**3**
Flammability	**1**
Physical Hazard	**0**
Personal Protection	**X**

HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:		
CAS 10326-27-9	Barium Chloride Dihydrate	100 %
		Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Loosen clothing as necessary and position individual in a comfortable position.Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult give oxygen.Seek medical attention.Do NOT use mouth - to - mouth resuscitation.

After skin contact: Wash affected area with soap and water. Rinse exposed skin with water for 20 minutes.Enter emergency shower rinsing while removing contaminated clothing and shoes.Transport victim to the hospital.

After eye contact: Protect unexposed eye. Rinse or flush exposed eye gently using water for 15-20 minutes. Occasionally lift the upper and lower eyelids while rinsing.Immediately seek medical attention.

After swallowing: Rinse mouth thoroughly. Do not induce vomiting. Do not perform mouth-to-mouth on an unconscious person.Never give anything by mouth to an unconscious person.Call Poison Control Center or a physician immediately.

Most important symptoms and effects, both acute and delayed:

Irritation.Nausea.Headache.Shortness of breath.;Eye, Skin, & Gastrointestinal irritation.Muscular stimulation

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention provide SDS document to physician.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: Use water, dry chemical, chemical foam, or alcohol-resistant foam.

For safety reasons unsuitable extinguishing agents:

Special hazards arising from the substance or mixture:

Substance is noncombustible; use agent most appropriate to extinguish surrounding fire.Decomposes at high temperatures, resulting in toxic and corrosive products.

Advice for firefighters:

Protective equipment: Wear protective eyeware, gloves, and clothing.

Additional information (precautions): Normal ventilation is adequate.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Ensure that air-handling systems are operational.Ensure adequate ventilation.

Environmental precautions:

Prevent from reaching drains, sewer, or waterway. Should not be released into environment.

Methods and material for containment and cleaning up:

Wear protective eyeware, gloves, and clothing. Refer to Section 8.Always obey local regulations.If necessary use trained response staff or contractor.Evacuate personnel to safe areas. Containerize for disposal. Refer to Section 13.Keep in suitable closed containers for disposal.

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Avoid contact with skin, eyes, and clothing.Follow good hygiene procedures when handling chemical materials. Refer to Section 8.Follow proper disposal methods. Refer to Section 13.Do not eat, drink, smoke, or use personal products when handling chemical substances.Avoid ingestion and inhalation.

Conditions for safe storage, including any incompatibilities:

Store in a cool location.Store in a cool location.Protect from freezing and physical damage.Provide ventilation for containers.Keep container tightly sealed. Store away from incompatible materials.

SECTION 8 : Exposure controls/personal protection

Control Parameters:	10326-27-9, Barium chloride dihydrate, TWA 0.5 mg/m3 USA. NIOSH 10326-27-9 , Barium chloride dihydrate, WA 0.5 mg/m3 USA. OSHA 10326-27-9, Barium chloride dihydrate, TWA 0.5 mg/m3 USA. ACGIH
Appropriate Engineering controls:	Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling. Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor and mists below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above.
Respiratory protection:	Normal ventilation is adequate.

Protection of skin:	Select glove material impermeable and resistant to the substance.Select glove material based on rates of diffusion and degradation. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves.Wear protective clothing.
Eye protection:	Safety glasses with side shields or goggles.Wear equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
General hygienic measures:	Wash hands before breaks and at the end of work. Avoid contact with skin, eyes, and clothing.Remove contaminated clothing and shoes.Before wearing wash contaminated clothing.Perform routine housekeeping.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	White solid	**Explosion limit lower**: **Explosion limit upper**:	Not Determined Not Determined
Odor:	Odorless	**Vapor pressure**:	Not Determined
Odor threshold:	Not Determined	**Vapor density**:	Not Determined
pH-value:	5.0 - 8.0 at 50 g/l at 25 °C	**Relative density**:	3.100 g/cm3
Melting/Freezing point:	962 °C	**Solubilities**:	Soluble in water
Boiling point/Boiling range:	1560 °C	**Partition coefficient (n-octanol/water)**:	Not Determined
Flash point (closed cup):	Not Determined	**Auto/Self-ignition temperature**:	Not Determined
Evaporation rate:	Not Determined	**Decomposition temperature**:	> 100°C
Flammability (solid,gaseous):	Not Determined	**Viscosity**:	a. Kinematic:Not Determined b. Dynamic: Not Determined
Density: Not Determined			

SECTION 10 : Stability and reactivity

Reactivity: Nonreactive under normal conditions.
Chemical stability: Stable under normal conditions.
Possible hazardous reactions: None under normal processing
Conditions to avoid: Excessive heat.Incompatible materials.Dust formation.
Incompatible materials: Oxidizing Agents
Hazardous decomposition products: Hydrogen chloride gas, chlorine.

SECTION 11 : Toxicological information

Acute Toxicity:		
Oral:	10326-27-9	LD50 oral - rat: 118 mg/kg

Chronic Toxicity: No additional information.	
Corrosion Irritation: No additional information.	
Sensitization:	Irritation: Irritating to eyes and skin
Single Target Organ (STOT):	No additional information.
Numerical Measures:	No additional information.
Carcinogenicity:	No additional information.
Mutagenicity:	No additional information.
Reproductive Toxicity:	No additional information.

SECTION 12 : Ecological information

Ecotoxicity Persistence and degradability: Readily degradable in the environment.
Bioaccumulative potential:
Mobility in soil:
Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Product or containers must not be disposed together with household garbage. Contact a licensed professional waste disposal service to dispose of this material.Consult federal, state, provincial, and local regulations regarding the proper disposal of waste material that may incorporate some amount of this product. Dilute with water and flush to sewer.

SECTION 14 : Transport information

UN-Number

1564

UN proper shipping name

Barium Compounds, N.O.S.

Transport hazard class(es)

Class:
6.1 Toxic substances

Packing group:III
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Acute, Chronic

SARA Section 313 (Specific toxic chemical listings):

10326-27-9 Barium chloride dihydrate

RCRA (hazardous waste code):

10326-27-9, Not applicable

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

None of the ingredients is listed

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

None of the ingredients is listed

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

None of the ingredients is listed

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.Note:. The responsibility to provide a safe workplace remains with the user.The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate.However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material.It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:
IMDG: International Maritime Code for Dangerous Goods
PNEC: Predicted No-Effect Concentration (REACH)
CFR: Code of Federal Regulations (USA)
SARA: Superfund Amendments and Reauthorization Act (USA)
RCRA: Resource Conservation and Recovery Act (USA)
TSCA: Toxic Substances Control Act (USA)

NPRI: National Pollutant Release Inventory (Canada)
DOT: US Department of Transportation
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)
DNEL: Derived No-Effect Level (REACH)

Effective date : 12.21.2014
Last updated : 03.23.2015

SAFETY DATA SHEET

Benzene

Section 1. Identification

GHS product identifier : Benzene

Chemical name : benzene

Other means of identification : benzene, purebenzol; cyclohexatriene; phenyl hydride; phene; coal naphtha; pyrobenzol

Product type : Liquid.

Product use : Synthetic/Analytical chemistry.

Synonym : benzene, purebenzol; cyclohexatriene; phenyl hydride; phene; coal naphtha; pyrobenzol

SDS # : 001062

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE LIQUIDS - Category 2
SKIN IRRITATION - Category 2
EYE IRRITATION - Category 2A
GERM CELL MUTAGENICITY - Category 1
CARCINOGENICITY - Category 1
SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) - Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Highly flammable liquid and vapor.
Causes skin irritation.
Causes serious eye irritation.
May cause genetic defects.
May cause cancer.
Causes damage to organs through prolonged or repeated exposure.
May form explosive mixtures with air.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Obtain special instructions before use. Wear protective gloves. Wear protective clothing. Wear eye or face protection. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use explosion-proof electrical, ventilating or lighting equipment. Use non-sparking tools. Take action to prevent static discharges. Keep container tightly closed. Do not breathe vapor. Do not eat, drink or smoke when using this product. Wash thoroughly after handling.

Section 2. Hazards identification

Response : IF exposed or concerned: Get medical advice or attention. Take off contaminated clothing and wash it before reuse. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice or attention.

Storage : Store locked up. Store in a well-ventilated place. Keep cool.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : benzene

Other means of identification : benzene, purebenzol; cyclohexatriene; phenyl hydride; phene; coal naphtha; pyrobenzol

Product code : 001062

CAS number/other identifiers

CAS number : 71-43-2

Ingredient name	%	CAS number
benzene	100	71-43-2

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Get medical attention. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Section 4. First aid measures

Eye contact : Causes serious eye irritation.

Inhalation : No known significant effects or critical hazards.

Skin contact : Causes skin irritation.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : No known significant effects or critical hazards.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:, pain or irritation, watering, redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:, irritation, redness

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media : Do not use water jet.

Specific hazards arising from the chemical : Highly flammable liquid and vapor. Runoff to sewer may create fire or explosion hazard. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

Section 6. Accidental release measures

For emergency responders	: If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".
Environmental precautions	: Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill	: Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.
Large spill	: Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures	: Put on appropriate personal protective equipment (see Section 8). Do not get in eyes or on skin or clothing. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Use only non-sparking tools. Take precautionary measures against electrostatic discharges. Do not ingest. Empty containers retain product residue and can be hazardous. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Do not reuse container. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Do not breathe vapor or mist. Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood.
Advice on general occupational hygiene	: Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.
Conditions for safe storage, including any incompatibilities	: Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Eliminate all ignition sources. Store locked up. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination. See Section 10 for incompatible materials before handling or use.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Section 8. Exposure controls/personal protection

Ingredient name	Exposure limits
benzene	**ACGIH TLV (United States, 3/2019). Absorbed through skin.** STEL: 8 mg/m³ 15 minutes. STEL: 2.5 ppm 15 minutes. TWA: 1.6 mg/m³ 8 hours. TWA: 0.5 ppm 8 hours. **NIOSH REL (United States, 10/2016).** STEL: 1 ppm 15 minutes. TWA: 0.1 ppm 10 hours. **OSHA PEL (United States, 5/2018).** STEL: 5 ppm 15 minutes. TWA: 1 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** STEL: 5 ppm 15 minutes. TWA: 1 ppm 8 hours. **OSHA PEL Z2 (United States, 2/2013).** AMP: 50 ppm 10 minutes. CEIL: 25 ppm TWA: 10 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Section 8. Exposure controls/personal protection

Respiratory protection : Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use.

Section 9. Physical and chemical properties

Appearance

Physical state : Liquid. [Watery liquid.]

Color : Colorless. Yellowish.

Odor : Characteristic.

Odor threshold : Not available.

pH : Not available.

Melting point : 5.49°C (41.9°F)

Boiling point : 80.09°C (176.2°F)

Critical temperature : 288.95°C (552.1°F)

Flash point : Closed cup: -11°C (12.2°F)

Evaporation rate : 3.5 (butyl acetate = 1)

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Lower: 1.2%
Upper: 7.8%

Vapor pressure : 10 kPa (75.01 mm Hg) [room temperature]

Vapor density : 2.7 (Air = 1)

Specific Volume (ft ^{3}/lb) : 1.1403

Gas Density (lb/ft ^{3}) : 0.877 (20°C / 68 to °F)

Relative density : 0.88

Solubility : Not available.

Solubility in water : 1.88 g/l

Partition coefficient: n-octanol/water : 2.13

Auto-ignition temperature : 498°C (928.4°F)

Decomposition temperature : Not available.

Viscosity : Dynamic (room temperature): 0.6 mPa·s (0.6 cP)

Flow time (ISO 2431) : Not available.

Molecular weight : 78.12 g/mole

Aerosol product

Heat of combustion : -40611960 J/kg

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow vapor to accumulate in low or confined areas.

Incompatible materials : Reactive or incompatible with the following materials:
oxidizing materials

Section 10. Stability and reactivity

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
benzene	LC50 Inhalation Gas. LD50 Oral	Rat Rat	10000 ppm 930 mg/kg	7 hours -

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
benzene	Eyes - Moderate irritant	Rabbit	-	88 mg	-
	Eyes - Severe irritant	Rabbit	-	24 hours 2 mg	-
	Skin - Mild irritant	Rat	-	8 hours 60 Ul	-
	Skin - Mild irritant	Rabbit	-	24 hours 15 mg	-
	Skin - Moderate irritant	Rabbit	-	24 hours 20 mg	-

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Classification

Product/ingredient name	OSHA	IARC	NTP
benzene	+	1	Known to be a human carcinogen.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Name	Category	Route of exposure	Target organs
benzene	Category 1	-	-

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Section 11. Toxicological information

Potential acute health effects

Eye contact	: Causes serious eye irritation.
Inhalation	: No known significant effects or critical hazards.
Skin contact	: Causes skin irritation.
Ingestion	: No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact	: Adverse symptoms may include the following:, pain or irritation, watering, redness
Inhalation	: No specific data.
Skin contact	: Adverse symptoms may include the following:, irritation, redness
Ingestion	: No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects	: Not available.
Potential delayed effects	: Not available.

Long term exposure

Potential immediate effects	: Not available.
Potential delayed effects	: Not available.

Potential chronic health effects

Not available.

General	: Causes damage to organs through prolonged or repeated exposure.
Carcinogenicity	: May cause cancer. Risk of cancer depends on duration and level of exposure.
Mutagenicity	: May cause genetic defects.
Teratogenicity	: No known significant effects or critical hazards.
Developmental effects	: No known significant effects or critical hazards.
Fertility effects	: No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
benzene	Acute EC50 29000 µg/l Fresh water	Algae - Pseudokirchneriella subcapitata	72 hours
	Acute EC50 1600000 µg/l Fresh water	Algae - Selenastrum sp.	96 hours
	Acute EC50 9.23 mg/l Fresh water	Daphnia - Daphnia magna - Neonate	48 hours
	Acute LC50 21 mg/l Marine water	Crustaceans - Artemia salina	48 hours
	Acute LC50 5.28 ul/L Fresh water	Fish - Oncorhynchus gorbuscha - Fry	96 hours
	Chronic EC10 >1360 mg/l Fresh water	Algae - Scenedesmus subspicatus	96 hours
	Chronic NOEC 98 mg/l Fresh water	Daphnia - Daphnia magna	21 days
	Chronic NOEC 1.5 to 5.4 ul/L Marine water	Fish - Morone saxatilis - Juvenile (Fledgling, Hatchling, Weanling)	4 weeks

Section 12. Ecological information

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	**$LogP_{ow}$**	**BCF**	**Potential**
benzene	2.13	11	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

United States - RCRA Toxic hazardous waste "U" List

Ingredient	**CAS #**	**Status**	**Reference number**
Benzene (I,T)	71-43-2	Listed	U019

Section 14. Transport information

	DOT	**TDG**	**Mexico**	**IMDG**	**IATA**
UN number	UN1114	UN1114	UN1114	UN1114	UN1114
UN proper shipping name	BENZENE	BENZENE	BENZENE	BENZENE	BENZENE
Transport hazard class(es)	3  	3  	3  	3  	3 
Packing group	II	II	II	II	II
Environmental hazards	No.	No.	No.	No.	No.

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Section 14. Transport information

Additional information

DOT Classification : **Reportable quantity** 10 lbs / 4.54 kg [1.3675 gal / 5.1767 L]. Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements.
Limited quantity Yes.
Quantity limitation Passenger aircraft/rail: 5 L. Cargo aircraft: 60 L.

TDG Classification : Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.18-2.19 (Class 3).
Explosive Limit and Limited Quantity Index 1
Passenger Carrying Road or Rail Index 5

IATA : **Quantity limitation** Passenger and Cargo Aircraft: 5 L. Cargo Aircraft Only: 60 L. Limited Quantities - Passenger Aircraft: 1 L.

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to IMO instruments : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

Clean Water Act (CWA) 307: benzene

Clean Water Act (CWA) 311: benzene

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Refer to Section 2: Hazards Identification of this SDS for classification of substance.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	benzene	71-43-2	100
Supplier notification	benzene	71-43-2	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.

Section 15. Regulatory information

New York : This material is listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

California Prop. 65

⚠ **WARNING**: This product can expose you to Benzene, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

Ingredient name	No significant risk level	Maximum acceptable dosage level
Benzene	Yes.	Yes.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Informed Consent (PIC)

Not listed.

UNECE Aarhus Protocol on POPs and Heavy Metals

Not listed.

Inventory list

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : **Japan inventory (ENCS)**: This material is listed or exempted.
Japan inventory (ISHL): This material is listed or exempted.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Taiwan : This material is listed or exempted.

Thailand : Not determined.

Turkey : This material is listed or exempted.

United States : This material is active or exempted.

Viet Nam : This material is listed or exempted.

Section 16. Other information

Hazardous Material Information System (U.S.A.)

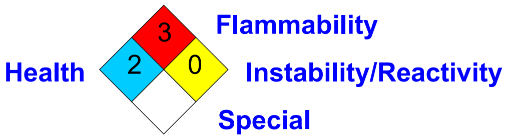
Health	*	2
Flammability		3
Physical hazards		0

Section 16. Other information

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings and the associated label are not required on SDSs or products leaving a facility under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered trademark and service mark of the American Coatings Association, Inc.

The customer is responsible for determining the PPE code for this material. For more information on HMIS® Personal Protective Equipment (PPE) codes, consult the HMIS® Implementation Manual.

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



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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
FLAMMABLE LIQUIDS - Category 2	Expert judgment
SKIN IRRITATION - Category 2	Expert judgment
EYE IRRITATION - Category 2A	Expert judgment
GERM CELL MUTAGENICITY - Category 1	Expert judgment
CARCINOGENICITY - Category 1	Expert judgment
SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) - Category 1	Expert judgment

History

Date of printing : 6/1/2020

Date of issue/Date of revision : 6/1/2020

Date of previous issue : No previous validation

Version : 1

Key to abbreviations :
ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

Version 6.5
Revision Date 10/30/2021
Print Date 07/29/2023

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : Biphenyl

Product Number : W312908
Brand : Aldrich
Index-No. : 601-042-00-8
CAS-No. : 92-52-4

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 SPRUCE ST
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone

Emergency Phone # : 800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Skin irritation (Category 2), H315
Eye irritation (Category 2A), H319
Specific target organ toxicity - single exposure (Category 3), Respiratory system, H335
Short-term (acute) aquatic hazard (Category 1), H400
Long-term (chronic) aquatic hazard (Category 1), H410

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Warning

Hazard statement(s)

H315	Causes skin irritation.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation.
H410	Very toxic to aquatic life with long lasting effects.

Precautionary statement(s)

P261	Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P273	Avoid release to the environment.
P280	Wear protective gloves/ eye protection/ face protection.
P302 + P352	IF ON SKIN: Wash with plenty of soap and water.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P332 + P313	If skin irritation occurs: Get medical advice/ attention.
P337 + P313	If eye irritation persists: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before reuse.
P391	Collect spillage.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

---

SECTION 3: Composition/information on ingredients

3.1 Substances

Formula : $C_{12}H_{10}$
Molecular weight : 154.21 g/mol
CAS-No. : 92-52-4
EC-No. : 202-163-5
Index-No. : 601-042-00-8

Component	Classification	Concentration
biphenyl		
	Skin Irrit. 2; Eye Irrit. 2A; STOT SE 3; Aquatic Acute 1; Aquatic Chronic 1; H315, H319, H335, H400, H410 M-Factor - Aquatic Acute: 1 - Aquatic Chronic: 1	<= 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice
Show this material safety data sheet to the doctor in attendance.

If inhaled
After inhalation: fresh air.

In case of skin contact
In case of skin contact: Take off immediately all contaminated clothing. Rinse skin with water/ shower.

In case of eye contact
After eye contact: rinse out with plenty of water. Call in ophthalmologist. Remove contact lenses.

If swallowed
After swallowing: immediately make victim drink water (two glasses at most). Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Water Foam Carbon dioxide (CO_2) Dry powder

Unsuitable extinguishing media
For this substance/mixture no limitations of extinguishing agents are given.

5.2 Special hazards arising from the substance or mixture

Nature of decomposition products not known.
Combustible.
Vapors are heavier than air and may spread along floors.
Forms explosive mixtures with air on intense heating.
Development of hazardous combustion gases or vapours possible in the event of fire.

5.3 Advice for firefighters

Stay in danger area only with self-contained breathing apparatus. Prevent skin contact by keeping a safe distance or by wearing suitable protective clothing.

5.4 Further information

Prevent fire extinguishing water from contaminating surface water or the ground water system.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Avoid inhalation of dusts. Avoid substance contact. Ensure adequate ventilation. Evacuate the danger area, observe emergency procedures, consult an expert.
For personal protection see section 8.

6.2 Environmental precautions

Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills. Observe possible material restrictions (see sections 7 and 10). Take up dry. Dispose of properly. Clean up affected area. Avoid generation of dusts.

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions

Tightly closed. Dry.

Storage class

Storage class (TRGS 510): 13: Non Combustible Solids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Ingredients with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
biphenyl	92-52-4	TWA	0.2 ppm	USA. ACGIH Threshold Limit Values (TLV)
		TWA	0.2 ppm 1 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	0.2 ppm 1 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		TWA	0.2 ppm 1 mg/m3	USA. NIOSH Recommended Exposure Limits
		PEL	0.2 ppm 1.5 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)

8.2 Exposure controls

Appropriate engineering controls

Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance.

Personal protective equipment

Eye/face protection

Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU). Safety glasses

Skin protection

This recommendation applies only to the product stated in the safety data sheet, supplied by us and for the designated use. When dissolving in or mixing with other substances and under conditions deviating from those stated in EN374 please contact the supplier of CE-approved gloves (e.g. KCL GmbH, D-36124 Eichenzell, Internet: www.kcl.de).
Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:KCL 741 Dermatril® L

This recommendation applies only to the product stated in the safety data sheet, supplied by us and for the designated use. When dissolving in or mixing with other substances and under conditions deviating from those stated in EN374 please contact the supplier of CE-approved gloves (e.g. KCL GmbH, D-36124 Eichenzell, Internet: www.kcl.de).
Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:KCL 741 Dermatril® L

Body Protection

protective clothing

Respiratory protection
required when dusts are generated. Our recommendations on filtering respiratory protection are based on the following standards: DIN EN 143, DIN 14387 and other accompanying standards relating to the used respiratory protection system.

Control of environmental exposure
Do not let product enter drains.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: crystalline Color: light yellow
b)	Odor	characteristic
c)	Odor Threshold	0.009 ppm
d)	pH	5.5
e)	Melting point/freezing point	Melting point/range: 68 - 70 °C (154 - 158 °F) - lit.
f)	Initial boiling point and boiling range	255 °C 491 °F - lit.
g)	Flash point	110 °C (230 °F) - closed cup
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	The product is not flammable. - Flammability (solids)
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 5.8 %(V) Lower explosion limit: 0.6 %(V)
k)	Vapor pressure	0.04 hPa at 20 °C (68 °F)
l)	Vapor density	No data available
m)	Density	0.992 g/cm3
	Relative density	No data available
n)	Water solubility	0.00713 g/l at 24.6 °C (76.3 °F) - Regulation (EC) No. 440/2008, Annex, A.6 - slightly soluble
o)	Partition coefficient: n-octanol/water	log Pow: 4.008 at 25 °C (77 °F) - Potential bioaccumulation
p)	Autoignition temperature	566 °C (1051 °F) at 1013.0 hPa
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	none

9.2 Other safety information

No data available

SECTION 10: Stability and reactivity

10.1 Reactivity

Forms explosive mixtures with air on intense heating.
A range from approx. 15 Kelvin below the flash point is to be rated as critical.
The following applies in general to flammable organic substances and mixtures: in correspondingly fine distribution, when whirled up a dust explosion potential may generally be assumed.

10.2 Chemical stability

The product is chemically stable under standard ambient conditions (room temperature) .

10.3 Possibility of hazardous reactions

increased reactivity with:
Oxidizing agents

10.4 Conditions to avoid

Strong heating.

10.5 Incompatible materials

No data available

10.6 Hazardous decomposition products

In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - 2,140 mg/kg
Symptoms: Irritations of mucous membranes in the mouth, pharynx, oesophagus and gastrointestinal tract.
Remarks: (RTECS)
Symptoms: mucosal irritations, Cough, Shortness of breath, Inhalation may lead to the formation of oedemas in the respiratory tract., Possible damages:, damage of respiratory tract
LD50 Dermal - Rabbit - > 5,010 mg/kg
Remarks: (RTECS)
No data available

Skin corrosion/irritation
Skin - Rabbit
Result: Severe irritations - 24 h
(Draize Test)
Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)

Serious eye damage/eye irritation
Causes serious eye irritation. Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)

Respiratory or skin sensitization
Maximization Test - Guinea pig

Result: negative
(OECD Test Guideline 406)

Germ cell mutagenicity
Test Type: Ames test
Result: negative
Remarks: (HSDB)
Test Type: In vitro mammalian cell gene mutation test
Test system: mouse lymphoma cells
Metabolic activation: without metabolic activation
Method: OECD Test Guideline 476
Result: positive

Test Type: Micronucleus test
Species: Mouse

Application Route: Oral
Method: OECD Test Guideline 474
Result: negative

Carcinogenicity

IARC:	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
NTP:	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation. - Respiratory system
Remarks: Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

11.2 Additional Information

RTECS: DU8050000
Liver injury may occur., Gastrointestinal disturbance
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Systemic effects:

After uptake:

muscular weakness
Drowsiness
Diarrhea
ataxia (impaired locomotor coordination)

After long-term exposure to the chemical:

Damage to:

Liver
Kidney
Cardiac

Other dangerous properties can not be excluded.

Handle in accordance with good industrial hygiene and safety practice.

Stomach - Irregularities - Based on Human Evidence

Stomach - Irregularities - Based on Human Evidence

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	flow-through test LC50 - Pimephales promelas (fathead minnow) - 3 mg/l - 96 h (OECD Test Guideline 203)
Toxicity to daphnia and other aquatic invertebrates	flow-through test EC50 - Daphnia magna (Water flea) - 0.36 mg/l - 48 h (US-EPA)

12.2 Persistence and degradability

Biodegradability	aerobic - Exposure time 28 d Result: 64.4 % - Readily biodegradable. (OECD Test Guideline 301F)

12.3 Bioaccumulative potential

Bioaccumulation	Oncorhynchus mykiss (rainbow trout) - 4 d (biphenyl) Bioconcentration factor (BCF): 1,900 (OECD Test Guideline 305)

12.4 Mobility in soil

No data available

12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Endocrine disrupting properties

No data available

12.7 Other adverse effects

Discharge into the environment must be avoided.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product
Waste material must be disposed of in accordance with the national and local regulations. Leave chemicals in original containers. No mixing with other waste. Handle uncleaned containers like the product itself. See www.retrologistik.com for processes regarding the return of chemicals and containers, or contact us there if you have further questions.

SECTION 14: Transport information

DOT (US)
UN number: 3077 Class: 9 Packing group: III
Proper shipping name: Environmentally hazardous substance, solid, n.o.s. (biphenyl)
Reportable Quantity (RQ): 100 lbs
1) Marine pollutant: yesPoison Inhalation Hazard: No

IMDG
UN number: 3077 Class: 9 Packing group: III EMS-No: F-A, S-F
Proper shipping name: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (biphenyl)
Marine pollutant : yes

IATA
UN number: 3077 Class: 9 Packing group: III
Proper shipping name: Environmentally hazardous substance, solid, n.o.s. (biphenyl)

SECTION 15: Regulatory information

SARA 302 Components
This material does not contain any components with a section 302 EHS TPQ.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
biphenyl	92-52-4	1993-04-24

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

SECTION 16: Other information

Further information
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the

The branding on the header and/or footer of this document may temporarily not visually match the product purchased as we transition our branding. However, all of the information in the document regarding the product remains unchanged and matches the product ordered. For further information please contact mlsbranding@sial.com.

Version: 6.5 Revision Date: 10/30/2021 Print Date: 07/29/2023

SAFETY DATA SHEET

Revision Date 17-Jan-2018 **Revision Number** 3

1. Identification

Product Name	**Cadmium**
Cat No. :	**C3-500**
CAS-No	7440-43-9
Synonyms	No information available
Recommended Use	Laboratory chemicals.
Uses advised against	Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable solids	Category 2
Acute oral toxicity	Category 4
Acute dermal toxicity	Category 4
Acute Inhalation Toxicity - Dusts and Mists	Category 2
Germ Cell Mutagenicity	Category 2
Carcinogenicity	Category 1A
Reproductive Toxicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	
Specific target organ toxicity - (repeated exposure)	Category 1
Target Organs - Kidney, Blood.	
Combustible dust	Yes

Label Elements

Signal Word
Danger

Hazard Statements
Flammable solid
May form combustible dust concentrations in air
Fatal if inhaled
Harmful if swallowed
Harmful in contact with skin
May cause respiratory irritation
Suspected of causing genetic defects
May cause cancer
Suspected of damaging fertility. Suspected of damaging the unborn child
Causes damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting/equipment
Response
IF exposed or concerned: Get medical attention/advice
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
Skin
IF ON SKIN: Wash with plenty of soap and water
Wash contaminated clothing before reuse
Call a POISON CENTER or doctor/physician if you feel unwell
Ingestion
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth
Fire
Fight fire with normal precautions from a reasonable distance
Evacuate area
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Very toxic to aquatic life with long lasting effects
WARNING. Cancer and Reproductive Harm - https://www.p65warnings.ca.gov/.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %

Cadmium	7440-43-9	100

4. First-aid measures

General Advice	Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Move to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.
Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Most important symptoms and effects	None reasonably foreseeable. . Kidney disorders: May cause harm to the unborn child: Blood disorders
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. Fine dust dispersed in air may ignite. Dust can form an explosive mixture in air. Pyrophoric properties of solids and liquids. Do not allow run-off from fire fighting to enter drains or water courses.

Hazardous Combustion Products

Highly toxic fumes

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
4	1	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas.
Environmental Precautions	Do not flush into surface water or sanitary sewer system. Do not allow material to contaminate ground water system. Prevent product from entering drains. Local authorities should be advised if significant spillages cannot be contained.

Methods for Containment and Clean Up	Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation.

7. Handling and storage

Handling	Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Avoid dust formation. Use only under a chemical fume hood. Do not breathe vapors/dust. Do not ingest.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place. Store under an inert atmosphere.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Cadmium	TWA: 0.01 mg/m^3 TWA: 0.002 mg/m^3	Ceiling: 0.3 mg/m^3 Ceiling: 0.6 mg/m^3 (Vacated) STEL: 0.3 ppm TWA: 0.1 mg/m^3 TWA: 0.2 mg/m^3 TWA: 5 µg/m^3	IDLH: 9 mg/m^3	TWA: 0.01 mg/m^3 TWA: 0.002 mg/m^3

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures	Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	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 and body protection	Long sleeved clothing.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	When using, do not eat, drink or smoke. Provide regular cleaning of equipment, work area and clothing. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product. Keep away from food, drink and animal feeding stuffs.

9. Physical and chemical properties

Physical State	Solid
Appearance	Silver
Odor	Odorless
Odor Threshold	No information available
pH	No information available
Melting Point/Range	321 °C / 609.8 °F

Boiling Point/Range	765 °C / 1409 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	Not applicable
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	Not applicable
Specific Gravity	8.64 @ 25°C
Solubility	Insoluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	Not applicable
Molecular Formula	Cd
Molecular Weight	112.40

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under recommended storage conditions. Moisture sensitive. Air sensitive.
Conditions to Avoid	Incompatible products. Excess heat. Avoid dust formation. Exposure to air or moisture over prolonged periods.
Incompatible Materials	Strong oxidizing agents, Strong acids, Sulfur oxides
Hazardous Decomposition Products	Highly toxic fumes
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Cadmium	LD50 = 2330 mg/kg (Rat)	Not listed	LC50 = 25 mg/m³ (Rat) 30 min

Toxicologically Synergistic Products	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	No information available
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Cadmium	7440-43-9	Group 1	Known	A2	X	A2

IARC: (International Agency for Research on Cancer)	*IARC: (International Agency for Research on Cancer)* *Group 1 - Carcinogenic to Humans* *Group 2A - Probably Carcinogenic to Humans* *Group 2B - Possibly Carcinogenic to Humans*
NTP: (National Toxicity Program)	*NTP: (National Toxicity Program)*

ACGIH: (American Conference of Governmental Industrial Hygienists)

Known - Known Carcinogen
Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen
A1 - Known Human Carcinogen
A2 - Suspected Human Carcinogen
A3 - Animal Carcinogen
ACGIH: (American Conference of Governmental Industrial Hygienists)

Mutagenic Effects	Possible risk of irreversible effects
Reproductive Effects	Possible risk of impaired fertility. May cause harm to the unborn child.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Respiratory system
STOT - repeated exposure	Kidney Blood
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Kidney disorders: May cause harm to the unborn child: Blood disorders
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

The product contains following substances which are hazardous for the environment. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Cadmium	Not listed	LC50: 0.0004 - 0.003 mg/L, 96h (Pimephales promelas) LC50: = 0.016 mg/L, 96h (Oryzias latipes) LC50: = 21.1 mg/L, 96h flow-through (Lepomis macrochirus) LC50: = 0.24 mg/L, 96h static (Cyprinus carpio) LC50: = 4.26 mg/L, 96h semi-static (Cyprinus carpio) LC50: = 0.002 mg/L, 96h (Cyprinus carpio) LC50: = 0.006 mg/L, 96h static (Oncorhynchus mykiss) LC50: = 0.003 mg/L, 96h	Not listed	EC50: = 0.0244 mg/L, 48h Static (Daphnia magna)

		flow-through (Oncorhynchus mykiss)		

Persistence and Degradability	No information available
Bioaccumulation/ Accumulation	No information available.
Mobility	No information available.

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN2930
Proper Shipping Name	TOXIC SOLIDS, FLAMMABLE, ORGANIC, N.O.S.
Proper technical name	Cadmium
Hazard Class	6.1
Subsidiary Hazard Class	4.1
Packing Group	I

TDG

UN-No	UN2930
Proper Shipping Name	TOXIC SOLID, FLAMMABLE, ORGANIC, N.O.S.
Hazard Class	6.1
Subsidiary Hazard Class	4.1
Packing Group	I

IATA

UN-No	UN2930
Proper Shipping Name	TOXIC SOLID, FLAMMABLE, ORGANIC, N.O.S.
Hazard Class	6.1
Subsidiary Hazard Class	4.1
Packing Group	I

IMDG/IMO

UN-No	UN2930
Proper Shipping Name	TOXIC SOLID, FLAMMABLE, ORGANIC, N.O.S.
Hazard Class	6.1
Subsidiary Hazard Class	4.1
Packing Group	I

15. Regulatory information

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Cadmium	X	X	-	231-152-8	-		X	-	X	X	KE-04397

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.

Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Cadmium	7440-43-9	100	0.1

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Cadmium	-	-	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Cadmium	X		-

OSHA Occupational Safety and Health Administration
Not applicable

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Cadmium	5 µg/m³ TWA 2.5 µg/m³ Action Level	-

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Cadmium	10 lb	-

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Cadmium	7440-43-9	Carcinogen Developmental Male Reproductive	0.05 µg/day	Developmental Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Cadmium	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Revision Date	17-Jan-2018
Print Date	17-Jan-2018
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

End of SDS

Copper, Granular, 50 Mesh,

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name : **Copper, Granular, 50 Mesh,**

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: **S25268**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Toxic
Acute toxicity (oral, dermal, inhalation), category 2

Irritant
Eye irritation, category 2A
Skin sensitization, category 1

Health hazard
Germ cell mutagenicity, category 1A
Specific target organ toxicity following repeated exposure, category 2

Acute toxicity - Oral - Category 2: H300 Fatal if swallowed.
Acute toxicity - Inhalation - Category 2: H330 Fatal if inhaled.
Specific target organ toxicity - Repeated exposure - (Oral,Inhalation) - Category 2: H373 May cause damage to digestive system, hematopoietic system, kidneys, nose, respiratory system, and/or skin through prolonged or repeated exposure if inhaled
Hazards Not Otherwise Classified - Combustible Dust
Not classified for physical or health hazards under GHS.
Hazards Not Otherwise Classified - Combustible Dust
Serious Eye Damage/Eye Irritation - Category 2: H319 Causes serious eye irritation.
Skin sensitizers - Category 1: H317 May cause allergic skin reaction.
Germ cell mutagenicity - Category 1: H340 May cause genetic defects.
Hazardous to aquatic environment - acute hazard - Category 1: H400 Very toxic to aquatic life.

Signal word :Danger

Hazard statements:
Fatal if swallowed
Fatal if inhaled

May cause an allergic skin reaction
Causes serious eye irritation
May cause genetic defects
May cause damage to organs through prolonged or repeated exposure
Very toxic to aquatic life
Precautionary statements:
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
Wash skin thoroughly after handling
Avoid release to the environment
Do not eat, drink or smoke when using this product
Do not eat, drink or smoke when using this product
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Avoid breathing dust/fume/gas/mist/vapours/spray
Use only outdoors or in a well-ventilated area
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
Wash contaminated clothing before reuse
IF exposed or concerned: Get medical advice/attention
Collect spillage
Specific treatment (see supplemental first aid instructions on this label)
Rinse mouth
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do.
Continue rinsing
If eye irritation persists get medical advice/attention
IF ON SKIN: Wash with soap and water
If skin irritation or a rash occurs: Get medical advice/attention
Store locked up
Dispose of contents and container as instructed in Section 13

Combustible Dust Hazard: :
May form combustible dust concentrations in air (during processing).
Combustible Dust Hazard: :
May form combustible dust concentrations in air (during processing).

Other Non-GHS Classification:

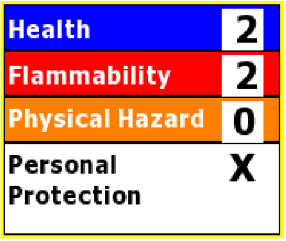
WHMIS

D2B

B4

NFPA/HMIS

NFPA SCALE (0-4)



Health	2
Flammability	2
Physical Hazard	0
Personal Protection	X

HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:		
CAS 7440-50-8	Copper	100 %
		Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Loosen clothing as necessary and position individual in a comfortable position.Move exposed to fresh air. Give artificial respiration if necessary. If breathing is difficult give oxygen.Get medical assistance if cough or other symptoms appear.

After skin contact: Rinse/flush exposed skin gently using soap and water for 15-20 minutes.Seek medical advice if discomfort or irritation persists.

After eye contact: Protect unexposed eye. Rinse/flush exposed eye(s) gently using water for 15-20 minutes. Remove contact lens(es) if able to do so during rinsing. Seek medical attention if irritation persists or if concerned.

After swallowing: Rinse mouth thoroughly. Do not induce vomiting. Have exposed individual drink sips of water. Seek medical attention if irritation, discomfort or vomiting persists.Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed:

Irritation, Nausea,Headache, Shortness of breath.;

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention, provide SDS document to physician.Physician should treat symptomatically.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition. Use water, dry chemical, chemical foam, carbon dioxide, or alcohol-resistant foam.

For safety reasons unsuitable extinguishing agents: None identified.

Special hazards arising from the substance or mixture:

Oxides of copper.Combustion products may include carbon oxides or other toxic vapors.Thermal decomposition can lead to release of irritating gases and vapors. Dust can be an explosion hazard when exposed to heat or flame. Noncombustible solid in bulk form, but powdered form may ignite.

Advice for firefighters:

Protective equipment: Use NIOSH-approved respiratory protection/breathing apparatus.

Additional information (precautions): Move product containers away from fire or keep cool with water spray as a protective measure, where feasible.Use spark-proof tools and explosion-proof equipment.Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.Avoid inhaling gases, fumes, dust, mist, vapor, and aerosols.Avoid contact with skin, eyes, and clothing.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Wear protective equipment. Use spark-proof tools and explosion-proof equipment.Ensure that air-handling systems are operational.Ensure adequate ventilation.

Environmental precautions:

Prevent from reaching drains, sewer or waterway. Collect contaminated soil for characterization per Section 13. Should not be released into environment.

Methods and material for containment and cleaning up:

Keep in suitable closed containers for disposal.Wear protective eyeware, gloves, and clothing. Refer to Section 8.Always obey local regulations.Dust deposits should not be allowed to accumulate on surfaces, as these may form an explosive mixture if they are released into the atmosphere in sufficient concentration. Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air). Collect solids in powder form using vacuum with (HEPA filter). Evacuate personnel to safe areas.Clean up spills immediately, observing precautions in the Protective Equipment section. Sweep up, then place into a suitable container for disposal. Avoid generating dusty conditions.

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Minimize dust generation and accumulation. Follow good hygiene procedures when handling chemical materials. Refer to Section 8.Do not eat, drink, smoke, or use personal products when handling chemical substances. Avoid contact with eyes, skin, and clothing.

Conditions for safe storage, including any incompatibilities:

Store away from incompatible materials.Protect from freezing and physical damage.Keep away from food and beverages.Provide ventilation for containers. Avoid storage near extreme heat, ignition sources or open flame. Store in cool, dry conditions in well sealed containers. Store with like hazards

SECTION 8 : Exposure controls/personal protection

Control Parameters:	7440-50-8 , Copper , OSHA PEL TWA (Total Dust) TWA 1 mg/m3 7440-50-8, Copper, ACGIH TLV: 0.2 mg/m3 TWA (fume); 1 mg/m3 TWA (dusts and mists) 7440-50-8, Copper, OSHA PEL: 0.1 mg/m3 TWA (fume)

Appropriate Engineering controls:	Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use/handling.Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor or dusts (total/respirable) below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above.It is recommended that all dust control equipment such as local exhaust ventilation and material transport systems involved in handling of this product contain explosion relief vents or an explosion suppression system or an oxygen deficient environment.Ensure that dust-handling systems (such as exhaust ducts, dust collectors, vessels, and processing equipment) are designed in a manner to prevent the escape of dust into the work area (i.e., there is no leakage from the equipment).Use under a fume hood
Respiratory protection:	Not required under normal conditions of use. Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls.When necessary use NIOSH approved breathing equipment.
Protection of skin:	Select glove material impermeable and resistant to the substance.Select glove material based on rates of diffusion and degradation.Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves.Wear protective clothing.
Eye protection:	Wear equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).Safety glasses or goggles are appropriate eye protection.
General hygienic measures:	Perform routine housekeeping.Wash hands before breaks and at the end of work.Avoid contact with skin, eyes, and clothing.Before wearing wash contaminated clothing.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	Red to brown solid	**Explosion limit lower**: **Explosion limit upper**:	Not determined Not determined
Odor:	Odorless	**Vapor pressure**:	Not determined
Odor threshold:	Not determined	**Vapor density**:	Not determined
pH-value:	Not determined	**Relative density**:	Not determined
Melting/Freezing point:	1083°C (1981.4°F)	**Solubilities**:	Insoluble
Boiling point/Boiling range:	2595°C (4703°F)	**Partition coefficient (n-octanol/water)**:	Not determined
Flash point (closed cup):	Not determined	**Auto/Self-ignition temperature**:	Not determined
Evaporation rate:	Not determined	**Decomposition temperature**:	Not determined
Flammability (solid,gaseous):	Not determined	**Viscosity**:	a. Kinematic:Not determined b. Dynamic: Not determined
Density: 8.94 (Water = 1)			

SECTION 10 : Stability and reactivity

Reactivity: Stable at room temperature in closed containers under normal storage and handling conditions.
Chemical stability: Stable under normal conditions.
Possible hazardous reactions: None under normal processing
Conditions to avoid: Incompatible Materials.Dust formation.Moisture.Exposure to air.
Incompatible materials: Liquid copper explodes on contact with water. Reacts violently with ammonium nitrate, bromates, iodates, chlorates, ethylene oxide, hydrazoic acid, potassium oxide, dimethyl sulfoxide Page 3 of 4 CU4500 + trichloroacetic acid, hydrogen peroxide, sodium peroxide, sodium azide, sulfuric acid, hydrogen sulfide + air, and lead azide. Ignites on contact with chlorine, fluorine (above 121C), chlorine trifluoride, and hydrazinium nitrate (above 70C). Incompatible with 1-bromo-2-propyne, potassium dioxide, and actylenic compounds.
Hazardous decomposition products: Oxides of copper.

SECTION 11 : Toxicological information

Acute Toxicity:		
Oral:	7440-50-8	LD50, Rat 472mg/KG
Chronic Toxicity:		
Oral:	7440-50-8	Chronic copper poisoning is typified by hepatic cirrhosis, brain damage and demyelination, kidney defects, and copper deposition in the cornea as exemplified by humans with Wilson's disease. It has also been reported that copper poisoning has led to hemolytic anemia and accelerates arteriosclerosis.
Corrosion Irritation:		
Dermal:	7440-50-8	Dust is irritating to the respiratory tract. Inhalation of fumes may cause metal fume fever, which is characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increased white blood cell count.
Sensitization:		No additional information.
Single Target Organ (STOT):		No additional information.
Numerical Measures:		No additional information.
Carcinogenicity:		No additional information.
Mutagenicity:		Please refer to RTECS# BO9000000 for specific informaton.
Reproductive Toxicity:		Fertility: Post-implantation mortality, oral-rat TDLo=40mg/kg.

SECTION 12 : Ecological information

Ecotoxicity

Freshwater fish: 96 Hr LC50 Pimephales promelas: 0.0068 - 0.0156 mg/L; 96 Hr LC50 Pimephales promelas:

<0.3 mg/L [static]; 96 Hr LC50 Pimephales promelas: 0.2 mg/L [flow-through]; 96 Hr LC50 Oncorhynchus mykiss: 0.052 mg/L [flow-through]; 96 Hr LC50 Lepomis macrochirus: 1.25 mg/L [static]; 96 Hr LC50 Cyprinus carpio: 0.3 mg/L [semi-static]; 96 Hr LC50 Cyprinus carpio: 0.8 mg/L [static]; 96 Hr LC50 Poecilia reticulata: 0.112 mg/L [flow-through]

Water flea: 48 Hr EC50 Daphnia magna: 0.03 mg/L [Static]

Persistence and degradability: No information available.
Bioaccumulative potential: No information available.
Mobility in soil:
Other adverse effects: No information available.

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Contact a licensed professional waste disposal service to dispose of this material.Dispose of empty containers as unused product.Product or containers must not be disposed with household garbage.It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11).Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations. Ensure complete and accurate classification.

SECTION 14 : Transport information

UN-Number

3089

UN proper shipping name

Metal Powder, Flammable, NOS (Copper Sulfate)

Transport hazard class(es)

Class:
4.1 Flammable solids, self-reactive substances and solid desensitized explosives

Packing group:II
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Acute, Chronic, Fire

SARA Section 313 (Specific toxic chemical listings):

None of the ingredients is listed

RCRA (hazardous waste code):

None of the ingredients is listed

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

7440-50-8 Copper Sulfate 5000 Lbs

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

None of the ingredients is listed

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

None of the ingredients is listed

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.Note:. The responsibility to provide a safe workplace remains with the user.The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate.However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material.It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:
IMDG: International Maritime Code for Dangerous Goods
PNEC: Predicted No-Effect Concentration (REACH)
CFR: Code of Federal Regulations (USA)
SARA: Superfund Amendments and Reauthorization Act (USA)
RCRA: Resource Conservation and Recovery Act (USA)
TSCA: Toxic Substances Control Act (USA)
NPRI: National Pollutant Release Inventory (Canada)
DOT: US Department of Transportation
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)
DNEL: Derived No-Effect Level (REACH)

Effective date : 03.02.2015
Last updated : 03.19.2015

SAFETY DATA SHEET

Preparation Date: 4/13/2018 **Revision Date:** 4/13/2018 **Revision Number:** G1

1. IDENTIFICATION

Product identifier

Product code: E1033
Product Name: ETHYLBENZENE, REAGENT

Other means of identification

Synonyms: Ethyl benzene
Ethylbenzol
Etilbenzene (Italian)
Phenylethane
CAS #: 100-41-4
RTECS # DA0700000
CI#: Not available

Recommended use of the chemical and restrictions on use

Recommended use: Solvent. Chemical intermediate.
Uses advised against No information available

Supplier:
Spectrum Chemical Mfg. Corp
14422 South San Pedro St.
Gardena, CA 90248
(310) 516-8000

Order Online At: https://www.spectrumchemical.com
Emergency telephone number Chemtrec 1-800-424-9300
Contact Person: Martin LaBenz (West Coast)
Contact Person: Ibad Tirmiz (East Coast)

2. HAZARDS IDENTIFICATION

Classification

This chemical is considered hazardous according to the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Considered a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Acute toxicity - Inhalation (Gases)	Category 4
Acute toxicity - Inhalation (Vapors)	Category 4
Acute toxicity - Inhalation (Dusts/Mists)	Category 4
Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 2
Carcinogenicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 2
Aspiration toxicity	Category 1
Flammable liquids	Category 2

Label elements

Danger

Hazard statements
Harmful if inhaled
Causes skin irritation
Causes serious eye irritation
Suspected of causing cancer
May cause respiratory irritation. May cause drowsiness or dizziness
May cause damage to organs through prolonged or repeated exposure
May be fatal if swallowed and enters airways
Highly flammable liquid and vapor

Hazards not otherwise classified (HNOC)
Not Applicable

Other hazards
May be harmful if swallowed

Precautionary Statements - Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Wash face, hands and any exposed skin thoroughly after handling
Do not breathe dust/fume/gas/mist/vapors/spray
Keep away from heat/sparks/open flames/hot surfaces. — No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting/.../equipment
Use only non-sparking tools
Take precautionary measures against static discharge
Keep cool

Precautionary Statements - Response
Call a POISON CENTER or doctor/physician if you feel unwell
In case of fire: Use CO2, dry chemical, or foam to extinguish.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.
If skin irritation occurs: Get medical advice/attention
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
IF INHALED: Remove person to fresh air and keep comfortable for breathing.
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
Do NOT induce vomiting

Precautionary Statements - Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed

Precautionary Statements - Disposal
Dispose of contents/container to an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS-No.	Weight %
Ethylbenzene	100-41-4	100

4. FIRST AID MEASURES

First aid measures

General Advice:	National Capital Poison Center in the United States can provide assistance if you have a poison emergency and need to talk to a poison specialist. Call 1-800-222-1222.
Skin Contact:	Wash off immediately with soap and plenty of water removing all contaminated clothing and shoes. Get medical attention. If skin irritation persists, call a physician.
Eye Contact:	Flush eyes with water for 15 minutes. Get medical attention.
Inhalation:	Move to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:	Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Obtain medical attention.

Most important symptoms and effects, both acute and delayed

Symptoms	Causes skin irritation Causes serious eye irritation Irritating to respiratory system Aspiration hazard if swallowed - can enter the lungs and cause damage Aspiration into the lungs may cause chemical pneumonitis May cause digestive (gastrointestinal) tract irritation Abdominal pain May cause nausea and vomiting May affect the blood May affect the liver It may affect the kidneys Central nervous system effects Headache Drowsiness Dizziness Ataxia Irritability Fatigue Weakness Lightheadedness Tremors Insomnia

Indication of any immediate medical attention and special treatment needed

Notes to Physician:	Treat symptomatically.

Protection of first-aiders
First-Aid Providers: Avoid exposure to blood or body fluids. Wear gloves and other necessary protective clothing. Dispose of contaminated clothing and equipment as bio-hazardous waste.

5. FIRE-FIGHTING MEASURES

Extinguishing Media

Suitable Extinguishing Media:	Dry chemical. Carbon dioxide (CO2). Water spray mist or foam.

Unsuitable Extinguishing Media: Do not use a solid (straight) water stream as it may scatter and spread fire.

Specific hazards arising from the chemical

Hazardous Combustion Products: Carbon Monoxide, Carbon Dioxide.

Specific hazards: Highly flammable. May be ignited by heat, sparks or flames. Vapor may travel considerable distance to source of ignition and flash back. Vapors may form explosive mixtures with air. Most vapors are heavier than air. They will spread along the ground and collect in low or confined areas (sewers, basements, tanks). Container explosion may occur under fire conditions or when heated. Fire may produce irritating, corrosive and/or toxic gases.

Special Protective Actions for Firefighters

Specific Methods: Water mist may be used to cool closed containers. For larger fires, use water spray or fog. Cool containers with flooding quantities of water until well after fire is out.

Special Protective Equipment for Firefighters: As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal Precautions: Ensure adequate ventilation. Avoid contact with skin, eyes and clothing. Use personal protective equipment. Keep people away from and upwind of spill/leak. Remove all sources of ignition. Pay attention to flashback. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Use spark-proof tools and explosion-proof equipment. In case of large spill, water spray or vapor suppressing foam may be used to reduce vapors, but may not prevent ignition in closed spaces.

Environmental precautions Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Prevent entry into waterways, sewers, basements or confined areas.

Methods and material for containment and cleaning up

Methods for containment Stop leak if you can do it without risk. Absorb spill with inert material (e.g. vermiculite, dry sand or earth). In case of large spill, dike if needed. Dike far ahead of liquid spill for later disposal.

Methods for cleaning up Use appropriate tools to put the spilled material in a suitable chemical waste disposal container. Use clean non-sparking tools to collect absorbed material. Clean contaminated surface thoroughly.

7. HANDLING AND STORAGE

Precautions for safe handling

Technical Measures/Precautions:
Provide sufficient air exchange and/or exhaust in work rooms. Remove all sources of ignition. To avoid ignition of vapors by static electricity discharge, all metal parts of the equipment must be grounded. Keep away from

incompatible materials.

Safe Handling Advice
Wear personal protective equipment. Use only in well-ventilated areas. Avoid contact with skin, eyes and clothing. Keep away from heat and sources of ignition. Do not breathe vapors or spray mist. Do not ingest. Take precautionary measures against static discharges. When using do not smoke. Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Technical Measures/Storage Conditions:
Keep container tightly closed. Keep in a well-ventilated place. Store at room temperature in the original container. Keep away from heat and sources of ignition. Protect from light. Sensitive to light. Store in light-resistant containers. Store away from incompatible materials. Store in a segregated and approved area.

Incompatible Materials:
Oxidizing agents
chlorates
Nitrates
Peroxides

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

National occupational exposure limits

United States

Components	CAS-No.	OSHA	NIOSH	ACGIH	AIHA WEEL
Ethylbenzene	100-41-4	100 ppm TWA 435 mg/m³ TWA	100 ppm TWA 435 mg/m³ TWA 125 ppm STEL 545 mg/m³ STEL	20 ppm TWA	None

Canada

Components	CAS-No.	Canada - Alberta	Canada - British Columbia	Canada - Ontario	Canada - Quebec
Ethylbenzene	100-41-4	100 ppm TWA 434 mg/m³ TWA 125 ppm STEL 543 mg/m³ STEL	20 ppm TWA	None	100 ppm TWAEV 434 mg/m³ TWAEV 125 ppm STEV 543 mg/m³ STEV

Australia and Mexico

Components	CAS-No.	Australia	Mexico
Ethylbenzene	100-41-4	125 ppm STEL 543 mg/m³ STEL 100 ppm TWA 434 mg/m³ TWA	100 ppm TWA 435 mg/m³ TWA 125 ppm STEL 545 mg/m³ STEL

Appropriate engineering controls

Engineering measures to reduce exposure: Ensure adequate ventilation. Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors and mist below their respective threshold limit value.

Individual protection measures, such as personal protective equipment

Personal Protective Equipment

Eye protection:	Goggles
Skin and body protection:	Chemical resistant apron Long sleeved clothing Gloves
Respiratory protection:	Vapor respirator. Be sure to use an approved/certified respirator or equivalent.
Hygiene measures:	Avoid contact with skin, eyes and clothing. When using, do not eat, drink or smoke. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Liquid	**Appearance:** No information available.	**Color:** Colorless.
Odor: Aromatic. Sweet. Gasoline-like.	**Taste** No information available.	**Formula:** C8H10
Molecular/Formula weight: 106.16	**Flammability:** Highly flammable	**Flash point (°C):** -11
Flashpoint (°C/°F): 15-21 °C/59-70 °F	**Flash Point Tested according to:** Closed cup	**Autoignition Temperature (°C/°F):** 432 °C/809.6 °F
Lower Explosion Limit (%): 0.8%	**Upper Explosion Limit (%):** 6.7-7%	**Melting point/range(°C/°F):** -94.9 °C/-138.8 °F
Decomposition temperature(°C/°F): No information available	**Boiling point/range(°C/°F):** 136 °C/276.8 °F	**Bulk density:** No information available
Density (g/cm3): No information available	**Specific gravity:** 0.8626-0.867	**pH:** No information available
Vapor pressure @ 20°C (kPa): 0.9 @ 20 deg. C 1.28 at 25 deg. C	**Evaporation rate:** No information available	**Vapor density:** 3.66
VOC content (g/L): 879	**Odor threshold (ppm):** 140	**Partition coefficient (n-octanol/water):** log Kow = 3.1
Viscosity: No information available	**Miscibility:** No information available	**Solubility:** Very slightly soluble in water Soluble in Alcohol Soluble in Benzene Soluble in Carbon tetrachloride Soluble in Ether Slightly soluble in chloroform

10. STABILITY AND REACTIVITY

Reactivity

No information available

Chemical stability

Stability: Stable under recommended storage conditions.

Possibility of Hazardous Reactions: Hazardous polymerization does not occur

Conditions to avoid: Heat. Ignition sources. Incompatible materials.

Incompatible Materials:
Oxidizing agents
chlorates
Nitrates
Peroxides

Hazardous decomposition products: Carbon monoxide. Carbon dioxide.

Other Information
Corrosivity: No information available

Special Remarks on Corrosivity: No information available

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Principal Routes of Exposure:
Ingestion. Inhalation. Skin.

Acute Toxicity

The following values are calculated based on chapter 3.1 of the GHS document
Component Information

Ethylbenzene	
CAS-No.	100-41-4

LD50/oral/rat = 3500 mg/kg Oral LD50 Rat
LD50/oral/mouse = No information available
LD50/dermal/rabbit = 15354-15400 mg/kg Dermal LD50Rabbit
LD50/dermal/rat = No information available
LC50/inhalation/rat = 17.4 mg/L Inhalation LC50 Rat 4 h
LC50/inhalation/mouse = 35500 mg/m^3 2H
Other LD50 or LC50information = No information available

Product Information

LD50/oral/rat =
VALUE- Acute Tox Oral = 3500 mg/kg

LD50/oral/mouse =
Value - Acute Tox Oral = No information available

LD50/dermal/rabbit
VALUE-Acute Tox Dermal = 15354 mg/kg

LD50/dermal/rat
VALUE -Acute Tox Dermal = No information available

LC50/inhalation/rat
VALUE-Vapor = 17.4 mg/l (4-hr)
VALUE-Gas = No information available
VALUE-Dust/Mist = No information available

LC50/Inhalation/mouse
VALUE-Vapor = 35500 mg/m³ 2 h
VALUE - Gas = No information available
VALUE - Dust/Mist = No information available

Symptoms

Skin Contact:	Causes skin irritation. Mildly to moderately irritating to the skin.
Eye Contact:	Causes serious eye irritation. 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	Irritating to respiratory system. Inhalation of vapors may cause drowsiness and dizziness. 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	May be harmful if swallowed. Aspiration hazard if swallowed. Aspiration may lead to pulmonary edema. Aspiration into the lungs can cause chemical pneumonitis. May cause central nervous system effects (affect behavior). May cause digestive (gastointestinal) tract irritation. May cause abdominal pain. Ingestion may cause nausea, vomiting.
Aspiration hazard	May be fatal if swallowed and enters airways.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Chronic Toxicity	Skin: Prolonged or repeated skin contact may cause redness, drying, scaling, dermatitis, and even blistering of the skin. Inhalation: Prolonged or repeated inhalation may cause lung, liver and kidney changes, and affect the blood(leukocytosis, increased platelet counts).
Sensitization:	No information available.
Mutagenic Effects:	No information available
Carcinogenic effects:	Suspected of causing cancer. Possibly carcinogenic to humans.

Components	CAS-No.	IARC	ACGIH - Carcinogens	NTP	OSHA HCS - Carcinogens	Australia - Notifiable Carcinogenic	Australia - Prohibited Carcinogenic

						Substances	Substances
Ethylbenzene	100-41-4	Group 2B - Possibly carcinogenic to humans - Monograph 77 [2000]	A3 Confirmed Animal Carcinogen with Unknown Relevance to Humans	Not listed	Present	Not listed	Not listed

ACGIH (American Conference of Governmental Industrial Hygienists)

IARC (International Agency for Research on Cancer)

NTP (National Toxicology Program)

OSHA (Occupational Safety and Health Administration of the US Department of Labor)

Reproductive toxicity No data is available

Reproductive Effects: No information available
Developmental Effects: No information available
Teratogenic Effects: No information available

Specific Target Organ Toxicity

STOT - single exposure Respiratory system. central nervous system.
STOT - repeated exposure May cause damage to organs through prolonged or repeated exposure.
Target Organs: Skin. Liver. Kidneys.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Ecotoxicity effects: Aquatic environment.

Ethylbenzene - 100-41-4

Freshwater Algae Data: 4.6 mg/L EC50 Pseudokirchneriella subcapitata 72 h 438 mg/L EC50 Pseudokirchneriella subcapitata 96 h 2.6 - 11.3 mg/L EC50 Pseudokirchneriella subcapitata 72 h 1.7 - 7.6 mg/L EC50 Pseudokirchneriella subcapitata 96 h

Freshwater Fish Species Data: 11.0 - 18.0 mg/L LC50 Oncorhynchus mykiss 96 h static 1 4.2 mg/L LC50 Oncorhynchus mykiss 96 h semi-static 1 7.55 - 11 mg/L LC50 Pimephales promelas 96 h flow-through 1 32 mg/L LC50 Lepomis macrochirus 96 h static 1 9.1 - 15.6 mg/L LC50 Pimephales promelas 96 h static 1 9.6 mg/L LC50 Poecilia reticulata 96 h static 1

Water Flea Data: 1.8 - 2.4 mg/L EC50 Daphnia magna 48 h

Persistence and degradability: No information available

Bioaccumulative potential: Potential for bioconcentration in aquatic organisms is low.

Mobility: Medium/moderate mobility.

13. DISPOSAL CONSIDERATIONS

Disposal Methods

Waste from residues / unused products:
Waste must be disposed of in accordance with Federal, State and Local regulation.

Contaminated packaging:

Empty containers should be taken for local recycling, recovery or waste disposal

Components	CAS-No.	**RCRA - F Series Wastes**	**RCRA - K Series Wastes**	**RCRA - P Series Wastes**	**RCRA - U Series Wastes**
Ethylbenzene	100-41-4	None	None	None	None

14. TRANSPORT INFORMATION

DOT

UN-No:	UN1175
Proper Shipping Name:	Ethylbenzene
Hazard Class:	3
Subsidiary Class	No information available
Packing group:	II
Emergency Response Guide Number	130
Marine Pollutant	No data available
DOT RQ (lbs):	No information available
Special Provisions	IB2, T4, TP1
Symbol(s):	No information available
Description:	UN1175, ETHYLBENZENE, 3, II

TDG (Canada)

UN-No:	UN1175
Proper Shipping Name:	Ethylbenzene
Hazard Class:	3
Subsidiary Risk:	No information available
Packing Group:	II
Marine Pollutant	No Information available
Description:	UN1175, ETHYLBENZENE, 3, II

ADR

UN-No:	UN1175
Proper Shipping Name:	Ethylbenzene
Hazard Class:	3
Packing Group:	II
Subsidiary Risk:	No information available
Description:	UN1175, ETHYLBENZENE, 3, II

IMO / IMDG

UN-No:	UN1175
Proper Shipping Name:	Ethylbenzene
Hazard Class:	3
Subsidiary Risk:	No information available
Packing Group:	II
Marine Pollutant	No information available
EMS:	F-E
Description	UN1175, ETHYLBENZENE, 3, II

RID

UN-No:	UN1175
Proper Shipping Name:	Ethylbenzene
Hazard Class:	3
Subsidiary Risk:	No information available
Packing Group:	II
Description:	UN1175, ETHYLBENZENE, 3, II

ICAO

UN-No: UN1175
Proper Shipping Name: Ethylbenzene
Hazard Class: 3
Subsidiary Risk: No information available
Packing Group: II
Description: UN1175, ETHYLBENZENE, 3, II

IATA
UN-No: UN1175
Proper Shipping Name: Ethylbenzene
Hazard Class: 3
Subsidiary Risk: No information available
Packing Group: II
ERG Code: 3L
Special Provisions No information available
Description: UN1175, ETHYLBENZENE, 3, II

15. REGULATORY INFORMATION

International Inventories

Components	CAS-No.	U.S. TSCA	KOREA KECL	Philippines (PICCS)	Japan ENCS	CHINA	Australia (AICS)	EINECS-No.
Ethylbenzene	100-41-4	PresentACTIVE	Present KE-13532	Present	Present (3)-60,(3)-28	Present	Present	Present 202-849-4

U.S. Regulations

Ethylbenzene
Massachusetts RTK: Present
New Jersey RTK Hazardous Substance List: 0851
New Jersey (EHS) List: 0851 500 lb TPQ
New Jersey - Discharge Prevention - List of Hazardous Substances: Present
Pennsylvania RTK: Environmental hazard
Pennsylvania RTK - Environmental Hazard List Present
Minnesota - Hazardous Substance List: Present
New York Release Reporting - List of Hazardous Substances:
1000 lb RQ
1 lb RQ
Louisana Reportable Quantity List for Pollutants: 1000lbfinal RQ
454kgfinal RQ
California Directors List of Hazardous Substances: Present

California Prop. 65: Safe Drinking Water and Toxic Enforcement Act of 1986.

Chemicals Known to the State of California to Cause Cancer:
⚠WARNING: This product can expose you to chemicals including (see table below) which is (are) known to the State of California to cause cancer. For more information go to www.p65warnings.ca.gov.

Chemicals Known to the State of California to Cause Reproductive Toxicity:
This product does not contain a chemical requiring a warning under California Prop. 65. (See table below)

Components	CAS-No.	Carcinogen	Developmental Toxicity	Male Reproductive Toxicity	Female Reproductive Toxicity:
Ethylbenzene	100-41-4	carcinogen	Not Listed	Not Listed	Not Listed

CERCLA/SARA

Components	CAS-No.	CERCLA - Hazardous Substances and	Section 302 Extremely Hazardous	Section 302 Extremely Hazardous	Section 313 - Chemical Category	Section 313 - Reporting de minimis

		their Reportable Quantities	Substances and TPQs	Substances and RQs		
Ethylbenzene	100-41-4	1000 lb final RQ 454 kg final RQ	None	None	None	0.1 % de minimis concentration

U.S. TSCA

Components	CAS-No.	**TSCA Section 5(a)2 - Chemicals With Significant New Use Rules (SNURS)**	**TSCA 8(d) -Health and Safety Reporting**
Ethylbenzene	100-41-4	Not Applicable	Not Applicable

Canada

WHIMIS 2015 - GHS Classifications

WHMIS 2015 Hazard Classification Information: .

Component	WHMIS 2015 Hazard Classification
Ethylbenzene 100-41-4 (100)	Flammable liquids - Category 2: H225 Highly flammable liquid and vapour.; Acute toxicity - Inhalation - Category 4: H332 Harmful if inhaled.; Skin corrosion/irritation - Category 2: H315 Causes skin irritation.; Carcinogenicity - Category 2: H351 Suspected of causing cancer.; Aspiration hazard - Category 1: H304 May be fatal if swallowed and enters airways.

Canada Hazardous Products Regulation This product has been classified according to the hazard criteria of the HPR (Hazardous Products Regulation) and the SDS contains all of the information required by the HPR

WHMIS 1988 Hazard Class

B2 Flammable liquid
D2A Very toxic materials
D2B Toxic materials

Components	WHMIS 1988
Ethylbenzene	B2,D2A,D2B

Canada Controlled Products Regulation:

This product has been classified according to the hazard criteria of the CPR (Controlled Products Regulation) and the MSDS contains all of the information required by the CPR.

Components	**WHMIS Ingredient Disclosure List -**
Ethylbenzene	0.1 %

Inventory

Components	CAS-No.	Canada (DSL)	Canada (NDSL)
Ethylbenzene	100-41-4	Present	Not Listed

Components	CAS-No.	CEPA Schedule I - Toxic Substances
Ethylbenzene	100-41-4	Not listed
Components	CAS-No.	CEPA - 2010 Greenhouse Gases Subject to Mandatory Reporting
Ethylbenzene	100-41-4	Not listed

EU Classification

EU GHS - SV - CLP 1272/2008

Components	CAS-No.	EU GHS - SV - CLP (1272/2008)
Ethylbenzene	100-41-4	Flammable liquids - Flam. Liq. 2: H225 Highly flammable liquid and vapour.;

		Acute toxicity - Inhalation - Acute Tox. 4: H332 Harmful if inhaled. (Minimum classification); Specific target organ toxicity - Repeated exposure - STOT RE 2: H373 May cause damage to ears through prolonged or repeated exposure.; Aspiration hazard - Asp. Tox. 1: H304 May be fatal if swallowed and enters airways.601-023-00-4

EU - CLP (1272/2008)

R-phrase(s)
R11 - Highly flammable.
R20 - Harmful by inhalation.
R65 - Harmful: may cause lung damage if swallowed.
R48/20 - Harmful: danger of serious damage to health by prolonged exposure through inhalation.

S -phrase(s)
S 2 - Keep out of the reach of children.
S16 - Keep away from sources of ignition - No smoking.
S29 - Do not empty into drains.
S62 - If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.
S24/25 - Avoid contact with skin and eyes.

Components	CAS-No.	**Classification**	**Concentration Limits:**	**Safety Phrases**
Ethylbenzene	100-41-4	F; R11 Xn; R20-48/20-65	No information	S2 S16 S24/25 S29

The product is classified in accordance with Annex VI to Directive 67/548/EEC

Indication of danger:
F - Highly flammable.
Xn - Harmful.

16. OTHER INFORMATION

Preparation Date: 4/13/2018
Revision Date: 4/13/2018
Prepared by: Sonia Owen

Disclaimer: All chemicals may pose unknown hazards and should be used with caution. This Safety Data Sheet (SDS) applies only to the material as packaged. If this product is combined with other materials, deteriorates, or becomes contaminated, it may pose hazards not mentioned in this SDS. The physical properties reported in this SDS are obtained from the literature and do not constitute product specifications. Information contained herein does not constitute a warranty, whether expressed or implied, as to the safety, merchantability or fitness of the goods for a particular purpose. Spectrum Chemicals & Laboratory Products, Inc. assumes no responsibility for results obtained or for incidental or consequential damages, including lost profits, arising from the use of these data. No warranty against infringement of any patent, copyright or trademark is made or implied. It shall be the user's responsibility to develop proper methods of handling and personal protection based on the actual conditions of use. While this SDS is based on technical data judged to be reliable, Spectrum assumes no responsibility for the completeness or accuracy of the information contained herein.

End of Safety Data Sheet

Lead

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 12/15/2014 Revision date: 12/15/2014 Version: 1.1

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Substance

CAS No : 7439-92-1

Formula : Pb

Synonyms : C.I. 77575, in massive state / elemental lead, in massive state / glover, in massive state

BIG no : 10073

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Solder
Battery: component
Construction
Electrodes

1.3. Details of the supplier of the safety data sheet

GSC International, Inc.
1747 N. Deffer Drive
Nixa,
MO 65714
United States of America

Tel: 417-374-7431
Fax: 417-374-7442
Email: info@gscinternationalinc.com

1.4. Emergency telephone number

Country	Organization/Company	Address	Emergency number
MEXICO	Servicio de Informacion Toxicologica Sintox	Tintoreto #32 Edif. a Desp. Col. Nochebuena Mixcoac México, D.F.	1 800 009 2800 +52 55 5611 2634 /+52 55 5598 9095
UNITED STATES OF AMERICA	American Association of Poison Control Centers		1-800-222-1222

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification (GHS-US)

Acute Tox. 4 (Oral)	H302
Acute Tox. 4 (Inhalation)	H332
Carc. 1B	H350
Repr. 1A	H360
STOT RE 2	H373
Aquatic Acute 1	H400
Aquatic Chronic 1	H410

Full text of H-phrases: see section 16

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US) :

GHS07

GHS08

GHS09

Signal word (GHS-US) : Danger

Hazard statements (GHS-US) : H302+H332 - Harmful if swallowed or if inhaled
H350 - May cause cancer
H360 - May damage fertility or the unborn child
H373 - May cause damage to organs through prolonged or repeated exposure

H400 - Very toxic to aquatic life
H410 - Very toxic to aquatic life with long lasting effects

Precautionary statements (GHS-US) : P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe dust, fume
P264 - Wash hands thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P273 - Avoid release to the environment
P304+P340 - If inhaled: Remove person to fresh air and keep comfortable for breathing
P308+P313 - If exposed or concerned: Get medical advice/attention
P314 - Get medical advice/attention if you feel unwell
P501 - Dispose of contents/container to a licensed hazardous-waste disposal contractor or collection site except for empty clean containers which can be disposed of as non-hazardous waste

2.3. Other hazards

No additional information available

2.4. Unknown acute toxicity (GHS-US)

Not applicable

SECTION 3: Composition/information on ingredients

3.1. Substance

Name	Product identifier	%	Classification (GHS-US)
Lead (Main constituent)	(CAS No) 7439-92-1	> 99,9	Acute Tox. 4 (Oral), H302 Acute Tox. 4 (Inhalation), H332 Carc. 1B, H350 Repr. 1A, H360 STOT RE 2, H373 Aquatic Acute 1, H400 Aquatic Chronic 1, H410

Full text of H-phrases: see section 16

3.2. Mixture

Not applicable

4.1. Description of first aid measures

First-aid measures general : If you feel unwell, seek medical advice. IF exposed or concerned: Get medical advice/attention. Call a poison center/doctor/physician if you feel unwell.

First-aid measures after inhalation : Remove person to fresh air and keep comfortable for breathing. Not applicable. Call a poison center/doctor/physician if you feel unwell.

First-aid measures after skin contact : Not applicable. Wash skin with plenty of water.

First-aid measures after eye contact : Not applicable. Rinse eyes with water as a precaution.

First-aid measures after ingestion : Not applicable. Rinse mouth. Call a poison center/doctor/physician if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries after inhalation : No effects known.

Symptoms/injuries after skin contact : No effects known.

Symptoms/injuries after eye contact : No effects known.

Symptoms/injuries after ingestion : No effects known.

Chronic symptoms : No effects known.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Adapt extinguishing media to the environment.

Unsuitable extinguishing media : No unsuitable extinguishing media known.

5.2. Special hazards arising from the substance or mixture

Fire hazard : DIRECT FIRE HAZARD. Non combustible.

Explosion hazard	: DIRECT EXPLOSION HAZARD. No data available on direct explosion hazard. INDIRECT EXPLOSION HAZARD. No data available on indirect explosion hazard.
Reactivity	: On burning: formation of metallic fumes. Oxidizes on exposure to air.

5.3. Advice for firefighters

Precautionary measures fire	: Exposure to fire/heat: keep upwind. Exposure to fire/heat: consider evacuation. Exposure to heat: have neighborhood close doors and windows.
Firefighting instructions	: Dilute toxic gases with water spray. Take account of toxic fire-fighting water. Use water moderately and if possible collect or contain it.
Protection during firefighting	: Heat/fire exposure: compressed air/oxygen apparatus. Do not attempt to take action without suitable protective equipment. Self-contained breathing apparatus. Complete protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment	: Gloves. Protective clothing. See "Material-Handling" to select protective clothing.
Emergency procedures	: Mark the danger area. No naked flames.

6.1.2. For emergency responders

Protective equipment	: Do not attempt to take action without suitable protective equipment. For further information refer to section 8: "Exposure controls/personal protection".

6.2. Environmental precautions

Avoid release to the environment. Prevent soil and water pollution. Prevent spreading in sewers. Notify authorities if product enters sewers or public waters.

6.3. Methods and material for containment and cleaning up

For containment	: Not applicable. Collect spillage.
Methods for cleaning up	: Recover mechanically the product. Pick-up the material. Take collected spill to manufacturer/competent authority. Notify authorities if product enters sewers or public waters.
Other information	: Dispose of materials or solid residues at an authorized site.

6.4. Reference to other sections

For further information refer to section 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling	: Meet the legal requirements. Do not discharge the waste into the drain. Handle unclean empty containers as full ones. Observe strict hygiene. Measure the concentration in the atmosphere. Carry out operations in the open/under local exhaust/ventilation or with respiratory protection. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not breathe dust, fume. Use only outdoors or in a well-ventilated area. Take all necessary technical measures to avoid or minimize the release of the product on the workplace. Limit quantities of product at the minimum necessary for handling and limit the number of exposed workers. Provide local exhaust or general room ventilation. Wear personal protective equipment. Floors, walls and other surfaces in the hazard area must be cleaned regularly.
Hygiene measures	: Separate working clothes from town clothes. Launder separately. Do not eat, drink or smoke when using this product. Always wash hands after handling the product.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures	: Does not require any specific or particular technical measures. Comply with applicable regulations.
Storage conditions	: Store locked up. Store in a well-ventilated place. Keep cool.
Incompatible materials	: Strong acids, strong bases and oxidation agents.
Heat-ignition	: KEEP SUBSTANCE AWAY FROM: heat sources.
Prohibitions on mixed storage	: KEEP SUBSTANCE AWAY FROM: oxidizing agents. Strong acids. Strong bases.
Storage area	: Meet the legal requirements.
Special rules on packaging	: SPECIAL REQUIREMENTS: closing. correctly labeled. meet the legal requirements. Secure fragile packaging in solid containers.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Lead (7439-92-1)		
ACGIH	ACGIH TWA (mg/m^3)	0,05 mg/m^3
ACGIH	Remark (ACGIH)	CNS & PNS impair
OSHA	Not applicable	

8.2. Exposure controls

Appropriate engineering controls : Provide adequate general and local exhaust ventilation. Ensure good ventilation of the work station.

Personal protective equipment : Protective goggles. Gloves.

Materials for protective clothing : GIVE EXCELLENT RESISTANCE: No data available. GIVE GOOD RESISTANCE: butyl rubber. PVC. GIVE LESS RESISTANCE: No data available. GIVE POOR RESISTANCE: No data available.

Hand protection : protective gloves.

Eye protection : Safety glasses.

Skin and body protection : Not required for normal conditions of use.

Respiratory protection : Wear respiratory protection.

Environmental exposure controls : Avoid release to the environment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state : Solid

Appearance : Metal.

Molecular mass : 207,20 g/mol

Color : White to blue-grey

Odor : Odorless

Odor threshold : No data available

pH : No data available

Relative evaporation rate (butyl acetate=1) : No data available

Melting point : 327 °C

Freezing point : No data available

Boiling point : 1740 °C

Flash point : Not applicable

Auto-ignition temperature : No data available

Decomposition temperature : No data available

Flammability (solid, gas) : No data available

Vapor pressure : < 0,1 hPa

Relative vapor density at 20 °C : No data available

Relative density : 11,3

Specific gravity / density : 11340 kg/m^3

Solubility : insoluble in water. Substance sinks in water. Soluble in nitric acid. Insoluble in organic solvents. Water: < 0,1 g/100ml

Log Pow : 0,73 (Estimated value)

Log Kow : No data available

Viscosity, kinematic	: Not applicable
Viscosity, dynamic	: No data available
Explosive properties	: No data available
Oxidizing properties	: No data available
Explosive limits	: No data available

9.2. Other information

VOC content	: Not applicable (inorganic)

SECTION 10: Stability and reactivity

10.1. Reactivity

On burning: formation of metallic fumes. Oxidizes on exposure to air.

10.2. Chemical stability

Unstable on exposure to air.

10.3. Possibility of hazardous reactions

No additional information available

10.4. Conditions to avoid

No additional information available

10.5. Incompatible materials

Acids. Bases.

10.6. Hazardous decomposition products

Thermal decomposition generates : fume.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Oral: Harmful if swallowed. Inhalation: Harmful if inhaled.

Lead (\f)7439-92-1	
LD50 oral rat	> 2000 mg/kg body weight (Rat; Weight of evidence)
LD50 dermal rat	> 2000 mg/kg body weight (Rat; Experimental value; OECD 402: Acute Dermal Toxicity)
ATE US (oral)	500,000 mg/kg body weight
ATE US (gases)	4500,000 ppmV/4h
ATE US (vapors)	11,000 mg/l/4h
ATE US (dust, mist)	1,500 mg/l/4h
Additional information	Lead massive metal is not considered to be acutely toxic. It is not easily inhaled or ingested, and if it is accidentally ingested normally passes through the gastrointestinal system without significant absorption into the body. Lead is not easily absorbed through the skin.

Skin corrosion/irritation	: Not classified (Based on available data, the classification criteria are not met)
Serious eye damage/irritation	: Not classified (Based on available data, the classification criteria are not met)
Respiratory or skin sensitization	: Not classified (Based on available data, the classification criteria are not met)
Germ cell mutagenicity	: Not classified (Based on available data, the classification criteria are not met)
Carcinogenicity	: May cause cancer.

Lead (7439-92-1)	
Additional information	There is some evidence that inorganic lead compounds may have a carcinogenic effect, and they have been classified by IARC as probably carcinogenic to humans. However, it is considered that this classification does not apply to lead in articles, given the very low bioavailability of metallic lead. Carcinogenicity studies of lead metal powder have been negative. Epidemiology studies of workers exposed to inorganic lead compounds have found a limited association with stomach cancer. IARC has concluded that lead metal is possibly carcinogenic to humans (Group aB).
IARC group	2B - Possibly carcinogenic to humans
National Toxicology Program (NTP) Status	3 - Reasonably anticipated to be Human Carcinogen

Reproductive toxicity : May damage fertility or the unborn child.

Specific target organ toxicity (single exposure) : Not classified
(Based on available data, the classification criteria are not met)

Specific target organ toxicity (repeated exposure) : May cause damage to organs through prolonged or repeated exposure.

Lead (7439-92-1)	
Additional information	Lead is a cumulative poison and may be absorbed into the body through ingestion or inhalation. Although inhalation and ingestion of lead in massive form are unlikely, poor hygiene practises may result in hand to mouth transfer which maybe significant over a prolonged period of time. Inorganic lead compounds have been documented in observational human studies to produce toxicity in multiple organ systems and body function including the haemotopoetic (blood) system, kidney function, reproductive function and the central nervous system.

Aspiration hazard : Not classified
(Based on available data, the classification criteria are not met)

Symptoms/injuries after inhalation : No effects known.

Symptoms/injuries after skin contact : No effects known.

Symptoms/injuries after eye contact : No effects known.

Symptoms/injuries after ingestion : No effects known.

Chronic symptoms : No effects known.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : Dangerous for the environment. Very toxic to aquatic life with long lasting effects.

Ecology - air : Not dangerous for the ozone layer (Regulation (EC) No 1005/2009). Not included in the list of fluorinated greenhouse gases (Regulation (EC) No 842/2006). TA-Luft Klasse 5.2.2/II.

Ecology - water : No water pollutant (surface water). Maximum concentration in drinking water: 0.010 mg/l (lead) (Directive 98/83/EC). Highly toxic to aquatic organisms.

Lead (7439-92-1)	
LC50 fish 1	2,8 (0,44 - 542) mg/l (96h) Coughlan, D.J., S.P. Gloss, and J. Kubota 1986. Acute and Sub-Chronic Toxicity of Lead to the Early Life Stages of Small mouth Bass (Micropterus dolomieui). Water Air Soil Pollut. 28(3/4):265-275
EC50 Daphnia 1	4,46 (0,53 - 5,1) mg/l (48h) Govindarajan, S., C.P. Valsaraj, R. Mohan, V. Hariprasad, and R. Ramasubramanian 1993. Toxicity of Heavy Metals in Aquaculture Organisms: Penaeus indicus, Perna viridis, Artemia salina and Skeletonema costatum. Pollut.Res. 12(3):187-189

12.2. Persistence and degradability

Lead (7439-92-1)	
Persistence and degradability	Biodegradability: Not applicable. No (test)data available on mobility of the substance.
ThOD	Not applicable (inorganic)

12.3. Bioaccumulative potential

Lead (7439-92-1)	
Log Pow	0,73 (Estimated value)
Bioaccumulative potential	Low bioaccumulation potential (Log Kow < 4).

12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

Effect on ozone layer :

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Dispose in a safe manner in accordance with local/national regulations. Hazardous waste shall not be mixed together with other waste. Different types of hazardous waste shall not be mixed together if this may entail a risk of pollution or create problems for the further management of the waste. Hazardous waste shall be managed responsibly. All entities that store, transport or handle hazardous waste shall take the necessary measures to prevent risks of pollution or damage to people or animals. Reuse or recycle following decontamination. Remove to an authorized dump (Class I). Do not discharge into surface water (2000/60/EC, Council decision 2455/2001/EC, O.J. L331 of 15/12/2001).

Additional information : LWCA (the Netherlands): KGA category 05. Hazardous waste according to Directive 2008/98/EC.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN3077 Environmentally hazardous substances, solid, n.o.s. Lead(7439-92-1), 9, III

UN-No.(DOT) : UN3077

Proper Shipping Name (DOT) : Environmentally hazardous substances, solid, n.o.s.
Lead(7439-92-1)

Department of Transportation (DOT) Hazard Classes : 9 - Class 9 - Miscellaneous hazardous material 49 CFR 173.140

Hazard labels (DOT) : 9 - Class 9 (Miscellaneous dangerous materials)

DOT Symbols : G - Identifies PSN requiring a technical name

Packing group (DOT) : III - Minor Danger

DOT Special Provisions (49 CFR 172.102)	: 8 - A hazardous substance that is not a hazardous waste may be shipped under the shipping description “Other regulated substances, liquid or solid, n.o.s.”, as appropriate. In addition, for solid materials, special provision B54 applies. 146 - This description may be used for a material that poses a hazard to the environment but does not meet the definition for a hazardous waste or a hazardous substance, as defined in 171.8 of this subchapter, or any hazard class as defined in Part 173 of this subchapter, if it is designated as environmentally hazardous by the Competent Authority of the country of origin, transit or destination. 335 - Mixtures of solids that are not subject to this subchapter and environmentally hazardous liquids or solids may be classified as “Environmentally hazardous substances, solid, n.o.s,” UN3077 and may be transported under this entry, provided there is no free liquid visible at the time the material is loaded or at the time the packaging or transport unit is closed. Each transport unit must be leak-proof when used as bulk packaging. A112 - Notwithstanding the quantity limits shown in Column (9A) and (9B) for this entry, the following IBCs are authorized for transportation aboard passenger and cargo-only aircraft. Each IBC may not exceed a maximum net quantity of 1,000 kg: a. Metal: 11A, 11B, 11N, 21A, 21B and 21N b. Rigid plastics: 11H1, 11H2, 21H1 and 21H2 c. Composite with plastic inner receptacle: 11HZ1, 11HZ2, 21HZ1 and 21HZ2 d. Fiberboard: 11G e. Wooden: 11C, 11D and 11F (with inner liners) f. Flexible: 13H2, 13H3, 13H4, 13H5, 13L2, 13L3, 13L4, 13M1 and 13M2 (flexible IBCs must be sift-proof and water resistant or must be fitted with a sift-proof and water resistant liner). B54 - Open-top, sift-proof rail cars are also authorized. IB8 - Authorized IBCs: Metal (11A, 11B, 11N, 21A, 21B, 21N, 31A, 31B and 31N); Rigid plastics (11H1, 11H2, 21H1, 21H2, 31H1 and 31H2); Composite (11HZ1, 11HZ2, 21HZ1, 21HZ2, 31HZ1 and 31HZ2); Fiberboard (11G); Wooden (11C, 11D and 11F); Flexible (13H1, 13H2, 13H3, 13H4, 13H5, 13L1, 13L2, 13L3, 13L4, 13M1 or 13M2). IP3 - Flexible IBCs must be sift-proof and water-resistant or must be fitted with a sift-proof and water-resistant liner. N20 - A 5M1 multi-wall paper bag is authorized if transported in a closed transport vehicle. T1 - 1.5 178.274(d)(2) Normal............ 178.275(d)(2) TP33 - The portable tank instruction assigned for this substance applies for granular and powdered solids and for solids which are filled and discharged at temperatures above their melting point which are cooled and transported as a solid mass. Solid substances transported or offered for transport above their melting point are authorized for transportation in portable tanks conforming to the provisions of portable tank instruction T4 for solid substances of packing group III or T7 for solid substances of packing group II, unless a tank with more stringent requirements for minimum shell thickness, maximum allowable working pressure, pressure-relief devices or bottom outlets are assigned in which case the more stringent tank instruction and special provisions shall apply. Filling limits must be in accordance with portable tank special provision TP3. Solids meeting the definition of an elevated temperature material must be transported in accordance with the applicable requirements of this subchapter.
DOT Packaging Exceptions (49 CFR 173.xxx)	: 155
DOT Packaging Non Bulk (49 CFR 173.xxx)	: 213
DOT Packaging Bulk (49 CFR 173.xxx)	: 240
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	: No limit
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	: No limit
DOT Vessel Stowage Location	: A - The material may be stowed ‘‘on deck’’ or ‘‘under deck’’ on a cargo vessel and on a passenger vessel.

Additional information

Other information : No supplementary information available.

ADR

No additional information available

Transport by sea

UN-No. (IMDG) : 3077

Proper Shipping Name (IMDG) : ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S.

Class (IMDG) : 9 - Miscellaneous dangerous compounds

Packing group (IMDG) : III - substances presenting low danger

Air transport

UN-No.(IATA)	: 3077
Proper Shipping Name (IATA)	: Environmentally hazardous substance, solid, n.o.s.
Class (IATA)	: 9 - Miscellaneous Dangerous Goods
Packing group (IATA)	: III - Minor Danger

SECTION 15: Regulatory information

15.1. US Federal regulations

Lead (7439-92-1)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory Listed on United States SARA Section 313 Not listed on the United States SARA Section 313	
RQ (Reportable quantity, section 304 of EPA's List of Lists)	10 lb

15.2. International regulations

CANADA

No additional information available

EU-Regulations

No additional information available

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Repr. 1A	H360Df
Acute Tox. 4 (Inhalation)	H332
Acute Tox. 4 (Oral)	H302
STOT RE 2	H373
Aquatic Acute 1	H400
Aquatic Chronic 1	H410

Full text of H-phrases: see section 16

Classification according to Directive 67/548/EEC [DSD] or 1999/45/EC [DPD]

Repr.Cat.1; R61
Repr.Cat.3; R62
Xn; R20/22
R33
N; R50/53

Full text of R-phrases: see section 16

15.2.2. National regulations

Lead (7439-92-1)
Listed on IARC (International Agency for Research on Cancer) Listed as carcinogen on NTP (National Toxicology Program)

15.3. US State regulations

No additional information available

SECTION 16: Other information

Revision date : 12/15/2014

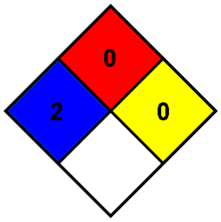
Full text of H-phrases:

Acute Tox. 4 (Inhalation)	Acute toxicity (inhalation) Category 4
Acute Tox. 4 (Oral)	Acute toxicity (oral) Category 4
Aquatic Acute 1	Hazardous to the aquatic environment - Acute Hazard Category 1
Aquatic Chronic 1	Hazardous to the aquatic environment - Chronic Hazard Category 1
Carc. 1B	Carcinogenicity Category 1B
Repr. 1A	Reproductive toxicity Category 1A
STOT RE 2	Specific target organ toxicity (repeated exposure) Category 2
H302	Harmful if swallowed
H332	Harmful if inhaled
H350	May cause cancer
H360	May damage fertility or the unborn child
H373	May cause damage to organs through prolonged or repeated exposure
H400	Very toxic to aquatic life
H410	Very toxic to aquatic life with long lasting effects

NFPA health hazard : 2 - Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical attention is given.

NFPA fire hazard : 0 - Materials that will not burn.

NFPA reactivity : 0 - Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health : * Chronic Hazard - Chronic (long-term) health effects may result from repeated overexposure

Flammability : 0 Minimal Hazard

Physical : 0 Minimal Hazard

Personal Protection : B

SDS US (GHS HazCom 2012)

SAFETY DATA SHEET

Creation Date 24-Nov-2010 **Revision Date** 19-Jan-2018 **Revision Number** 3

1. Identification

Product Name	**Manganese, powder, -325 mesh**
Cat No. :	**AC317440000; AC317440010; AC317442500**
CAS-No	7439-96-5
Synonyms	No information available
Recommended Use	Laboratory chemicals.
Uses advised against	Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable solids	Category 2
Serious Eye Damage/Eye Irritation	Category 2

Label Elements

Signal Word
Warning

Hazard Statements
Flammable solid
Causes serious eye irritation

Precautionary Statements
Prevention
Wash face, hands and any exposed skin thoroughly after handling
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting/equipment
Wear protective gloves/protective clothing/eye protection/face protection
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Fire
In case of fire: Use CO2, dry chemical, or foam for extinction
Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Manganese	7439-96-5	>95

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get medical attention.
Inhalation	Remove from exposure, lie down. Remove to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.
Ingestion	Clean mouth with water. Get medical attention.
Most important symptoms and effects	No information available.
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Dry chemical.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	

Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Combustible material.

Hazardous Combustion Products
None known.
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	2	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment as required.
Environmental Precautions	See Section 12 for additional Ecological Information.
Methods for Containment and Clean Up	Remove all sources of ignition. Use spark-proof tools and explosion-proof equipment. Sweep up and shovel into suitable containers for disposal.

7. Handling and storage

Handling	Avoid contact with skin and eyes. Do not breathe dust. Use spark-proof tools and explosion-proof equipment. Use only non-sparking tools.
Storage	Keep in a dry, cool and well-ventilated place. Refer product specification and/or product label for specific storage temperature requirement. Keep container tightly closed. Keep away from heat, sparks and flame. Keep under nitrogen.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Manganese	TWA: 0.02 mg/m³ TWA: 0.1 mg/m³	(Vacated) TWA: 1 mg/m³ Ceiling: 5 mg/m³ (Vacated) STEL: 3 mg/m³ (Vacated) Ceiling: 5 mg/m³	IDLH: 500 mg/m³ TWA: 1 mg/m³ STEL: 3 mg/m³	TWA: 0.2 mg/m³ TWA: 1 mg/m³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: NIOSH - National Institute for Occupational Safety and Health

Engineering Measures	Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye/face Protection	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 and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection	No protective equipment is needed under normal use conditions.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Powder Solid
Appearance	Dark brown
Odor	No information available
Odor Threshold	No information available
pH	No information available
Melting Point/Range	1260 °C / 2300 °F
Boiling Point/Range	1900 °C / 3452 °F
Flash Point	No information available
Evaporation Rate	Not applicable
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	Not applicable
Specific Gravity	No information available
Solubility	No information available
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	Not applicable
Molecular Formula	Mn
Molecular Weight	54.94

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Moisture sensitive.
Conditions to Avoid	Incompatible products. Exposure to moisture.
Incompatible Materials	Acids, Bases, Halogens
Hazardous Decomposition Products	None under normal use conditions
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Manganese	LD50 = 9 g/kg (Rat)	Not listed	Not listed

Toxicologically Synergistic Products	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	No information available

Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Manganese	7439-96-5	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	None known
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	No information available
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated. See actual entry in RTECS for complete information.

12. Ecological information

Ecotoxicity
Do not empty into drains.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Manganese	Not listed	LC50: > 3.6 mg/L, 96h semi-static (Oncorhynchus mykiss)	Not listed	Not listed

Persistence and Degradability	Insoluble in water
Bioaccumulation/ Accumulation	No information available.
Mobility	Is not likely mobile in the environment due its low water solubility.

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN3089
Proper Shipping Name	Metal powder, flammable, n.o.s.
Technical Name	Manganese
Hazard Class	4.1
Packing Group	III

TDG

UN-No	UN3089
Proper Shipping Name	Metal powder, flammable, n.o.s.
Hazard Class	4.1
Packing Group	III

IATA

UN-No	UN3089
Proper Shipping Name	Metal powder, flammable, n.o.s.
Hazard Class	4.1
Packing Group	III

IMDG/IMO

UN-No	UN3089
Proper Shipping Name	Metal powder, flammable, n.o.s.
Hazard Class	4.1
Packing Group	III

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Manganese	7439-96-5	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories
Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Manganese	7439-96-5	X	-	231-105-1	X	X	X	X	KE-22999

U.S. Federal Regulations

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Manganese	7439-96-5	>95	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act) Not applicable

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Manganese	X		-

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA Not applicable

California Proposition 65 This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Manganese	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security	This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade	No information available

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	24-Nov-2010
Revision Date	19-Jan-2018
Print Date	19-Jan-2018
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

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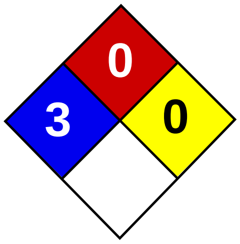
Chemicals & Laboratory Equipment



Health	3
Fire	0
Reactivity	0
Personal Protection	

Material Safety Data Sheet

Mercury MSDS

Section 1: Chemical Product and Company Identification

Product Name: Mercury

Catalog Codes: SLM3505, SLM1363

CAS#: 7439-97-6

RTECS: OV4550000

TSCA: TSCA 8(b) inventory: Mercury

CI#: Not applicable.

Synonym: Quick Silver; Colloidal Mercury; Metallic Mercury; Liquid Silver; Hydragyrum

Chemical Name: Mercury

Chemical Formula: Hg

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
Mercury	7439-97-6	100

Toxicological Data on Ingredients: Mercury LD50: Not available. LC50: Not available.

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 (corrosive, permeator). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in 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:
Hazardous in case of skin contact (permeator). CARCINOGENIC EFFECTS: Classified A5 (Not suspected for human.) 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, liver, brain, peripheral nervous system, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation.

Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. 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. WARM water MUST 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. 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 immediately.

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:
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: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: Not applicable.

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: Not applicable.

Special Remarks on Fire Hazards:
When thrown into mercury vapor, boron phosphodiiodide ignites at once. Flame forms with chlorine jet over mercury surface at 200 deg to 300 deg C. Mercury undergoes hazardous reactions in the presence of heat and sparks or ignition.

Special Remarks on Explosion Hazards:
A violent exothermic reaction or possible explosion occurs when mercury comes in contact with lithium and rubidium. CHLORINE DIOXIDE & LIQUID HG, WHEN MIXED, EXPLODE VIOLENTLY. Mercury and Ammonia can produce an

explosive compound. A mixture of the dry carbonyl and oxygen will explode on vigorous shaking with mercury. Methyl azide in the presence of mercury was shown to be potentially explosive.

Section 6: Accidental Release Measures

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

Large Spill:
Corrosive liquid. Poisonous liquid. 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. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. 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 locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. 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, metals.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 25°C (77°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:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

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: 0.025 from ACGIH (TLV) [United States] SKIN TWA: 0.05 CEIL: 0.1 (mg/m3) from OSHA (PEL) [United States] Inhalation TWA: 0.025 (mg/m3) [United Kingdom (UK)] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Heavy liquid)

Odor: Odorless.

Taste: Not available.

Molecular Weight: 200.59 g/mole

Color: Silver-white

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

Boiling Point: 356.73°C (674.1°F)

Melting Point: -38.87°C (-38°F)

Critical Temperature: 1462°C (2663.6°F)

Specific Gravity: 13.55 (Water = 1)

Vapor Pressure: Not available.

Vapor Density: 6.93 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: Not available.

Solubility: Very slightly soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, metals.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Ground mixtures of sodium carbide and mercury, aluminum, lead, or iron can react vigorously. A violent exothermic reaction or possible explosion occurs when mercury comes in contact with lithium and rubidium. Incompatible with boron diiodophosphide; ethylene oxide; metal oxides, metals(aluminum, potassium, lithium, sodium, rubidium); methyl azide; methylsilane, oxygen; oxidants(bromine, peroxyformic acid, chlorine dioxide, nitric acid, tetracarbonynickel, nitromethane, silver perchlorate, chlorates, sulfuric acid, nitrates,); tetracarbonylnickel, oxygen, acetylinic compounds, ammonia, ethylene oxide, methylsiliane, calcium,

Special Remarks on Corrosivity:
The high mobility and tendency to dispersion exhibited by mercury, and the ease with which it forms alloys (amalga) with many laboratory and electrical contact metals, can cause severe corrosion problems in laboratories. Special precautions: Mercury can attack copper and copper alloy materials.

Polymerization: Will not occur.

Section 11: Toxicological Information

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

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified A5 (Not suspected for human.) by ACGIH. 3 (Not classifiable for human.) by IARC. May cause damage to the following organs: blood, kidneys, liver, brain, peripheral nervous system, 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 (corrosive, permeator).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:

May affect genetic material. May cause cancer based on animal data. Passes through the placental barrier in animal. May cause adverse reproductive effects(paternal effects- spermatogenesis; effects on fertility - fetotoxicity, post-implantation mortality), and birth defects.

Special Remarks on other Toxic Effects on Humans:

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 8: Corrosive material

Identification: : Mercury UNNA: 2809 PG: III

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: Mercury 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: Mercury Connecticut hazardous material survey.: Mercury Illinois toxic substances disclosure to employee act: Mercury Illinois chemical safety act: Mercury New York acutely hazardous substances: Mercury Rhode Island RTK hazardous substances: Mercury Pennsylvania RTK: Mercury Minnesota: Mercury Massachusetts RTK: Mercury New Jersey: Mercury New Jersey spill list: Mercury Louisiana spill reporting: Mercury California Director's List of Hazardous Substances.: Mercury TSCA 8(b) inventory: Mercury SARA 313 toxic chemical notification and release reporting: Mercury CERCLA: Hazardous substances.: Mercury: 1 lbs. (0.4536 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 D-1A: Material causing immediate and serious toxic effects (VERY TOXIC). CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

DSCL (EEC):
R23- Toxic by inhalation. R33- Danger of cumulative effects. R38- Irritating to skin. R41- Risk of serious damage to eyes. R50/53- Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. S2- Keep out of the

reach of children. S7- Keep container tightly closed. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. 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. S60- This material and its container must be disposed of as hazardous waste. S61- Avoid release to the environment. Refer to special instructions/Safety data sheets.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection:

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

Health: 3

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:22 PM

Last Updated: 05/21/2013 12:00 PM

SAFETY DATA SHEET (SDS)
MTBE

1. Identification

SDS Record Number : PCS95007
Date of SDS : 01 October 2013
Identity of the substance : Methyl Tert-Butyl Ether (MTBE)
Product Description : Ether
Other names/synonyms : Tert-Butyl Methyl Ether; 2-Methoxy-2-Methylpropane; Gasoline Octane Enhancer; S-400
Name of the supplier : Petrochemical Corporation of Singapore (Private) Limited
Recommended uses : Chemical Feedstock, Octane Booster, Fuel Additive
Contact detail of the supplier : 100 Ayer Merbau Road, Singapore 628277
+65 68672102

24-Hour Emergency contact :

Asia Pacific	+65 3158 1074 (Singapore)
China	+86 10 5100 3039 (Beijing)
Europe, Israel & Americas	+44 (0) 1235 239 670 (UK)
Middle East & Africa	+44 (0) 1235 239 671 (UK)

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2. Hazards Identification

GHS Classification

Hazard Class	Hazard Category
• Flammable Liquid	2
• Acute Toxicity (Oral)	5
• Skin Corrosion/Irritation	2
• Serious Eye Damage/Irritation	2B
• Carcinogenicity	2
• STOST (Single Exposure)	3 (narcotic effects, respiratory tract irritation)
• Aspiration Hazard	1

Pictograms

Signal Word: Danger

Hazard Statements

- Highly Flammable liquid and vapour
- May be harmful if swallowed
- Causes skin irritation
- Causes eye irritation
- Suspected of causing cancer
- May cause Respiratory Irritation
- May cause drowsiness or dizziness
- May be fatal if swallowed and enters airways

Precautionary Statements

Prevention

- Keep container tightly closed.
- Keep away from heat/sparks/open flames/hot surfaces. – No smoking.
- Wear protective gloves/protective clothing/eye protection/face protection
- Ground/Bond container and receiving equipment
- Use explosion-proof electrical/ventilating/lighting equipment.
- Take precautionary measures against static discharge.
- Use only non-sparking tools.
- Wear protective gloves
- Wash thoroughly after handling.
- Obtain special instructions before use.
- Do not handle until all safety precautions have been read and understood.
- Avoid breathing dust/fume/gas/mist/vapours/spray.
- Use only outdoors or in well-ventilated area.

Response

- IF ON SKIN (or hair): Remove/take off immediately all contaminated clothing. Rinse skin with water/ shower.
- Call a POISON CENTER/doctor/physician if you feel unwell.
- In case of fire: Use appropriate media for extinction.
- If INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
- IF ON SKIN: Wash with plenty of soap and water.
- Take off contaminated clothing and wash before re-use.
- If skin irritation occurs: Get medical advice/attention.
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists, get medical advice/attention.
- Wash hands after handling
- IF exposed or concerned: Get medical attention/advice.
- IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. Do NOT induce vomiting.

Storage

- Store in well-ventilated place. Keep cool. Keep container tightly closed.
- Store locked up.

Disposal

- Dispose of the contents in accordance to the local mandatory rules and regulations

3. Composition/Information On Ingredients

Chemical identification : Tert-Butyl Methyl Ether
Common name(s) / synonym(s) : Tert-Butyl Methyl Ether; 2-Methoxy-2-Methylpropane; 1,1- dimethylethylmethyl ether; methyl tert-butyl ether, Methyl 1,1-dimethylethyl ether; Tert-buthoxymethane; 2-methoxy-2-methylpropane; Mtbe; Gasoline Octane Enhancer; S-400
CAS number / EC number : 1634-04-4/216-653-1

Chemical Identification	Common name	CAS number	Concentration
MTBE			98 wt% min.
C4		Mixture	0.1 – 0.5 wt%
Tert-butyl alcohol		75-65-0	0.1 – 1.0 wt%
Di-isobutene	Diisobutylene	25167-70-8	0.1 – 1.0 wt%
Methanol	Methyl alcohol	67-56-1	0.1 –1.0 wt%

4. First-Aid Measures

Inhalation: This chemical is highly flammable. Take adequate precautions (e.g. do not introduce a source of ignition). If symptoms are experienced, remove source of contamination or have victim move to fresh air. If not breathing, ensure clear airway and institute cardiopulmonary resuscitation (CPR). If breathing is difficult, administer oxygen if available. Obtain medical advice immediately.

Skin Contact: As quickly as possible, flush with lukewarm, gently flowing water for at least 20 minutes, or until the chemical is removed. Under running water, remove contaminated clothing, shoes and leather goods (e.g. watchbands and belts). Obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before re-use or discard.

Eye Contact: Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for at least 5 minutes or until the chemical is removed, while holding the eyelid(s) open. Obtain medical advice immediately.
Ingestion: **Never** give anything by mouth if victim is rapidly losing consciousness, is unconscious or convulsing. Have victim rinse mouth thoroughly with water. **Do not induce vomiting**. Have victim drink 240 to 300 ml (8 to 10 ozs) of water. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Repeat administration of water. Rinse mouth. Give slurry of activated charcoal in water to drink. Obtain medical attention immediately.

First Aid Comments: Provide general supportive measures (comfort, warmth, rest). Consult a doctor and/or the nearest Poison Control Centre for all exposures, except minor instances of inhalation or skin contact. All first aid procedures should be periodically reviewed by a doctor familiar with the material and its conditions of use in the workplace.

Notes To Physician: Methyl tert-butyl ether (MTBE) is a mucosal and eye irritant. It has weak aesthetic properties, and prolonged exposure to high concentrations may cause signs or symptoms of CNS depression. In the unlikely event of ingestion of MTBE, appropriate lavage procedures should be considered to avoid accidental aspiration of the product. In this regard, note that the product may contain up to 0.5% methanol.

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5. Fire-Fighting Measures

Extinguishing media

- Use dry chemical, alcohol foam, all purpose AFFF or carbon dioxide to extinguish fire.
- Water may be ineffective but should be used to cool fire-exposed containers, structures and to protect personnel.
- If leak or spill has not ignited, ventilate area and use water spray to disperse gas or vapour and to protect personnel attempting to stop a leak.
- Use water to dilute spills and to flush them away from sources of ignition.
- Do not flush down public sewers or other drainage systems.
- **Small Fires:** - Dry chemical, CO2, water spray or alcohol-resistant foam.
- **Large Fires:** - Water spray, fog or alcohol-resistant foam.
  - Use water spray or fog; do not use straight streams.
  - Move containers from fire area if you can do it without risk.
- **Fire involving Tanks or Car/Trailer Loads:**
  - Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
  - Cool containers with flooding quantities of water until well after fire is out.
  - Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
  - **Always** stay away from tanks engulfed in fire.
  - For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.
  - In case of fire: keep drums, etc., cool by spraying with water.

Specific hazards arising from the chemical:

- Dangerous when exposed to heat or flame.
- Vapours form flammable or explosive mixtures with air at room temperature.
- Vapour or gas may spread to distant ignition sources and flash back.
- Vapours may concentrate in confined areas.
- Runoff to sewer may cause fire or explosion hazard.
- Containers may explode in heat of fire.
- Irritating or toxic substances may be emitted upon thermal decomposition.

Special protective equipment and precautions for fire fighters

- Exposed fire fighters must wear MSHA/NIOSH approved positive pressure self-contained breathing apparatus with full-face mask and full protective clothing.
- **Protective Clothing:** - Wear positive pressure self-contained breathing apparatus (SCBA).
  - Structural firefighters' protective clothing will only provide limited protection.
- **Evacuation**

  Large Spill: Consider initial downwind evacuation for at least 300 meters (1000 feet).

  Fire: If tank, rail car or tank truck is involved in a fire, **isolate** for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

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6. Accidental Release Measures

- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate closed spaces before entering.
- If your facility or operation has an "Oil or Hazardous Substance Contingency Plan", activate its procedures.
- Take immediate steps to stop and contain the spill. Caution should be exercised regarding personnel safety and exposure to the spilled material.
- For technical advice and assistance related to chemicals, contact your local fire/HAZMAT department.
- Notify appropriate state and local regulatory agencies
- Shut off ignition sources; no flares, smoking or flames in hazard area.
- Stop leak if you can do it without risk. Water spray may reduce vapor; but it may not prevent ignition in closed spaces.
- **Small Spills:** Take up with sand or other non-combustible absorbent material and place into containers for later disposal.
- **Large Spills:** Dike far ahead of liquid spill for later disposal.
- Collect leaking and spilled liquid in sealable containers as far as possible.
- Absorb remaining liquid in sand or inert absorbent and remove to safe place.
- **Do not** wash away into sewer.
- Personal protection: filter respirator for organic gases and vapours.
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- A vapor suppressing foam may be used to reduce vapors.
- Use clean non-sparking tools to collect absorbed material.

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7. Handling And Storage

- Use only with adequate ventilation.
- Store in tightly closed containers in cool, dry, isolated, well-ventilated area away from heat, sources of ignition and incompatibles.

- Ground lines and equipment used during transfer to reduce the possibility of static spark-initiated fire or explosion.

- Use non-sparking tools.
- Do not eat, drink or smoke in areas of use or storage.
- Use good personal hygiene practices.
- Wash hands before eating, drinking, smoking, or using toilet facilities.
- Remove contaminated clothing and clean before reuse.
- Shower after work using soap and water.
- Empty containers may contain toxic, flammable/combustible or explosive residue or vapors.
- Do not cut, grind, drill, weld, reuse or dispose containers unless adequate precautions are taken against these hazards.
- All equipment used when handling the product must be grounded.
- Storage should be Fireproof. Separated from strong oxidants, strong acids.
- Ground and bond shipping container, transfer line, and receiving container.
- Keep away from heat, sparks, flame, and other sources of ignition.

8. Exposure Controls/Personal Protection

Eye Protection: Avoid eye contact with this material. Wear safety glasses or chemical goggles. Provide an eyewash station in the work area. Do not wear contact lenses when working with this substance.

Skin Protection: Avoid skin contact. When working with this substance, wear appropriate chemical protective gloves. Depending upon conditions of use, additional protection may be necessary such as face shield, apron, armcovers, etc.

Respiratory Protection: If exposure limits are exceeded or if irritation is experienced, NIOSH approved respiratory protection should be worn. Normally, a NIOSH approved respirator for organic vapours are generally acceptable. For high concentrations and for oxygen-deficient atmospheres, use a NIOSH approved air-supplied respirator. Ventilation and other forms of engineering controls are often the preferred means for controlling chemical exposures. Respiratory protection may be needed for non-routine or emergency situations.

9. Physical And Chemical Properties

Property	Value, Description
Appearance (physical state, colour etc);	Clear ,colourless liquid
Odour;	Characteristic ethereal odour
Odour threshold;	Not available
pH;	Not available
Melting point/freezing point;	-109 C
Initial boiling point and boiling range;	55 deg C
Flash point;	–33 deg C (ASTM D56)
Evaporation rate;	8.04 (Normal Butyl Acetate = 1)
Upper/lower flammability or explosive limits;	2% to 15% [vol% in air]
Vapour pressure;	27.9 kPa at 20 deg C
Vapour density;	3.1 g/l
Relative density;	0.74
Solubility(ies);	4.8 G/100G OF WATER
Partition coefficient: n-octanol/water;	Not available
Auto-ignition temperature;	374 deg C
Decomposition temperature;	Not available

Viscosity.	Not Available
Molecular mass:	88.2

10. Stability And Reactivity

Reactivity/Chemical Stability: Stable under conditions of normal use. No hazardous polymerization.

Possibility Of Hazardous Reactions: Much less likely to form peroxides than other ethers.

Conditions To Avoid: Avoid high temperatures, open flames-sparks and the use of Un-grounded electrical equipment.

Incompatible Materials: Avoid contact with strong oxidizers, acids or bases. The use of Viton and Flourel elastomers in seals is not recommended.

Hazardous Decomposition Products: Combustion may produce CO, CO2 and reactive hydrocarbons.
The vapour is heavier than air and may travel along the ground; distant ignition possible.

11. Toxicological Information

Ingestion: Slightly Toxic (Acute Exposure).

Rat oral LD50 = 3866 mg/kg. May cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting and diarrhoea. Aspiration into lungs may cause pneumonitis. May cause harmful central nervous system effects. Effects may include excitation, euphoria, headache, dizziness, drowsiness, blurred vision, fatigue, tremors, and convulsions, loss of consciousness, coma, respiratory arrest and death.

Skin: Practically Non-Toxic (Acute Exposure). Rabbit dermal LD50 = >10.0 gm/kg.

Moderately Irritating. Rabbit dermal PSI = 2.2.
Repeated or prolonged contact may result in defatting, redness, itching, inflammation, cracking and possible secondary infection. Not readily absorbed through the skin in toxic amounts.

Eye: Slightly To Moderately Irritating. Direct contact and exposure to vapours, fumes or mists may cause irritation. May cause irritation, redness, pain, blurred vision, lacrimation and conjunctivitis.

Inhalation: May cause respiratory tract irritation. High vapour concentrations may cause harmful central nervous system effects. Exposure may also cause symptoms similar to those listed under "Ingestion" (see Ingestion section). Effects may include inflammation of the lung, chest pain, difficult breathing and coughing. May also cause liver changes.

Special Toxic Effects: This product was tested in a variety of mutagenicity assays and the results were generally negative. However, this product was positive in a Mouse Lymphoma Assay. Exposure to very high concentrations of MTBE has produced maternal and/or foetal toxicity and malformations in laboratory animals. Chronic exposure to high levels of MTBE has produced urinary system effects in laboratory animals. Mice exposed to 8000 ppm of MTBE vapours developed a slightly higher incidence of benign liver tumours. Rats developed an increasing incidence of chronic progressive kidney damage, an effect typically noted in aging rats. These effects in the 3000 and 8000 ppm groups were accompanied by an increased incidence of kidney tumours in the males. Benign testicular tumours were numerically increased in the high dose group. The significance of these findings for human health is unclear.

Persons with pre-existing eye, skin and respiratory disorders may be at increased risk from exposure to this product.

12. Ecological Information

Acute Toxicity
Fish: Low toxicity: LC/EC/IC50 > 100 mg/l
Aquatic Invertebrates: Low toxicity: LC/EC/IC50 > 100 mg/l
Algae: Expected to have low toxicity: LC/EC/IC50 > 100 mg/l
Microorganisms: Expected to have low toxicity: LC/EC/IC50 > 100 mg/l
Mobility: Floats on water. If product enters soil, it will be highly mobile and may contaminate groundwater.
Persistence/degradability: Expected to be inherently biodegradable. Oxidises rapidly by photo-chemical reactions in air.
Bioaccumulation: Does not bioaccumulate significantly. It is strongly advised not to let the chemical enter into the environment because it persists in the environment

13. Disposal Considerations

Recover or recycle if possible. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste classification and disposal methods in compliance with applicable regulations.
Disposal should be in accordance with applicable regional, national, and local laws and regulations.

14. Transport Information

UN Number: 2398
UN Proper Shipping Name:
F symbol
Xi symbol
R: 11-38
S: 2-9-16-24
UN Hazard Class: 3
UN Packing Group: II
Transport Emergency Card: TEC (R)-30GF1-I+II
ADR
Class: 3
Packing group: II
Classification code: F1
Hazard identification no.: 33
UN No.: 2398
Danger label (primary risk): 3
Proper shipping name: METHYL tert-BUTYL ETHER
RID
Class: 3
Packing group: II
Classification code: F1
Hazard identification no.: 33
UN No.: 2398
Danger label (primary risk): 3
Proper shipping name: METHYL tetra-BUTYL ETHER
IMDG
Identification number UN 2398
Proper shipping name METHYL BUTYL ETHER
Class / Division 3
Packing group II

Marine pollutant: No

IATA (Country variations may apply)
UN No.: 2398
Proper shipping name: Methyl-tert-butyl ether
Class / Division: 3
Packing group: II

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15. Regulatory Information

This material is listed as a hazardous air pollutant under U.S. Federal regulations. See 40 CFR Part 61 for restrictions, which may apply, to its use. There may be specific regulations at the local, regional or state level that pertain to this material.

All components of this product are listed on the TSCA inventory. This product contains Methyl tert-butyl ether and is subject to EPA TSCA Section 12(b) Export Notification Regulation. All components of this product are listed on the Canadian DSL Inventory.

Permissible Exposure Level (Long Term) in Singapore: 40ppm (144mg/m^3)
ICSC # 1164
CAS # 1634-04-4
UN # 2398
EC # 603-181-00-X
TLV: 50 ppm as TWA; A3; (ACGIH 2004).
MAK: 50 ppm, 180 mg/m^3;
Peak limitation category: I (1.5); Carcinogen category: 3B; Pregnancy risk group: C;
(DFG 2004).

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16. Other Information

Prepared By: Material Safety Committee
SDS Prepared on: 1/10/2010

CAUTION: The information given above ("**the Information**") relates only to the substance or mixture listed herein. The Information may not be valid when used in combination with any other substance or mixture or in any process. If the substance or mixture is to be used for a purpose other than that stated herein or under conditions other than specified herein, the Information cannot be relied upon as being complete or accurate, and the user is advised to consult the supplier before using the substance or mixture for such other purpose or under such other conditions. The Information is given based on information available at the indicated date of preparation and no representation or warranty is given that it will be correct as of any time after the indicated date of preparation.

Material Safety Data Sheet

Version 4.2
Revision Date 11/16/2012
Print Date 03/19/2014

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Nickel

Product Number : 577995
Brand : Aldrich

Supplier : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # (For both supplier and manufacturer) : (314) 776-6555
Preparation Information : Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Flammable solid, Carcinogen, Target Organ Effect, Skin sensitiser

Target Organs

Lungs

GHS Classification
Flammable solids (Category 2)
Skin sensitization (Category 1)
Carcinogenicity (Category 2)
Specific target organ toxicity - repeated exposure, Inhalation (Category 1)
Acute aquatic toxicity (Category 1)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H228	Flammable solid.
H317	May cause an allergic skin reaction.
H351	Suspected of causing cancer.
H372	Causes damage to organs through prolonged or repeated exposure if inhaled.
H400	Very toxic to aquatic life.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P273	Avoid release to the environment.
P280	Wear protective gloves.
P314	Get medical advice/ attention if you feel unwell.

HMIS Classification

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	0
Physical hazards:	3

NFPA Rating

Health hazard:	2
Fire:	0
Reactivity Hazard:	3

Potential Health Effects

Inhalation	May be harmful if inhaled. May cause respiratory tract irritation.
Skin	May be harmful if absorbed through skin. May cause skin irritation.
Eyes	May cause eye irritation.
Ingestion	May be harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula : Ni
Molecular Weight : 58.69 g/mol

Component		Concentration
Nickel, powder [particle diameter < 1 mm]		
CAS-No.	7440-02-0	-
EC-No.	231-111-4	
Index-No.	028-002-01-4	

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - Nickel/nickel oxides

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid dust formation. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Avoid breathing dust.

Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

Methods and materials for containment and cleaning up

Sweep up and shovel. Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13). Keep in suitable, closed containers for disposal. Contain spillage, pick up with an electrically protected vacuum cleaner or by wet-brushing and transfer to a container for disposal according to local regulations (see section 13).

7. HANDLING AND STORAGE

Precautions for safe handling

Avoid contact with skin and eyes. Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed. Keep away from sources of ignition - No smoking. Take measures to prevent the build up of electrostatic charge.

Conditions for safe storage

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

Handle and store under inert gas. Keep in a dry place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Basis
Nickel, powder [particle diameter < 1 mm]	7440-02-0	TWA	1.5 mg/m3	USA. ACGIH Threshold Limit Values (TLV)
Remarks	Dermatitis Pneumoconiosis Not suspected as a human carcinogen			
		TWA	1 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		TWA	1 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	0.015 mg/m3	USA. NIOSH Recommended Exposure Limits
	Potential Occupational Carcinogen See Appendix A			

Personal protective equipment

Respiratory protection

Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Eye protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection

Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	powder
Colour	white, silver, metallic

Safety data

pH	no data available
Melting point/freezing point	Melting point/range: 1,453 °C (2,647 °F) - lit.
Boiling point	2,732 °C (4,950 °F) - lit.
Flash point	not applicable
Flammability (solid, gas)	The substance or mixture is a flammable solid with the category 2.
Ignition temperature	no data available
Autoignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Vapour pressure	1 hPa (1 mmHg) at 1,810 °C (3,290 °F)
Density	8.9 g/cm3 at 25 °C (77 °F)
Water solubility	insoluble
Partition coefficient: n-octanol/water	no data available
Relative vapour density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

Materials to avoid
acids, Oxidizing agents, Sulphur compounds, Hydrogen gas, Oxygen, Methanol, organic solvents, Aluminium, Fluorine, Ammonia

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Nickel/nickel oxides
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
no data available

Inhalation LC50
no data available

Dermal LD50
no data available

Other information on acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitization
May cause allergic skin reaction.

Germ cell mutagenicity

no data available

Carcinogenicity

This product is or contains a component that has been reported to be possibly carcinogenic based on its IARC, ACGIH, NTP, or EPA classification.

Limited evidence of carcinogenicity in animal studies

IARC:	2B - Group 2B: Possibly carcinogenic to humans (Nickel, powder [particle diameter < 1 mm])
NTP:	Reasonably anticipated to be a human carcinogen (Nickel, powder [particle diameter < 1 mm])
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

no data available

Teratogenicity

no data available

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
Inhalation - Causes damage to organs through prolonged or repeated exposure.

Aspiration hazard
no data available

Potential health effects

Inhalation	May be harmful if inhaled. May cause respiratory tract irritation.
Ingestion	May be harmful if swallowed.
Skin	May be harmful if absorbed through skin. May cause skin irritation.
Eyes	May cause eye irritation.

Synergistic effects
no data available

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

Toxicity

Toxicity to fish	LC50 - Cyprinus carpio (Carp) - 1.3 mg/l - 96 h
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 1 mg/l - 48 h

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

Very toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 3089 Class: 4.1 Packing group: II
Proper shipping name: Metal powders, flammable, n.o.s.
Reportable Quantity (RQ): 100 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 3089 Class: 4.1 Packing group: II EMS-No: F-G, S-G
Proper shipping name: METAL POWDER, FLAMMABLE, N.O.S.
Marine pollutant: No

IATA

UN number: 3089 Class: 4.1 Packing group: II
Proper shipping name: Metal powder, flammable, n.o.s.

15. REGULATORY INFORMATION

OSHA Hazards
Flammable solid, Carcinogen, Target Organ Effect, Skin sensitiser

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

	CAS-No.	Revision Date
Nickel, powder [particle diameter < 1 mm]	7440-02-0	2007-07-01

SARA 311/312 Hazards
Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Nickel, powder [particle diameter < 1 mm]	7440-02-0	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Nickel, powder [particle diameter < 1 mm]	7440-02-0	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Nickel, powder [particle diameter < 1 mm]	7440-02-0	2007-07-01

California Prop. 65 Components

	CAS-No.	Revision Date
WARNING! This product contains a chemical known to the State of California to cause cancer. Nickel, powder [particle diameter < 1 mm]	7440-02-0	2007-09-28

16. OTHER INFORMATION

Further information

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name	**POLYCHLORINATED BIPHENYLS (PCB)**
Synonym(s)	CHLOREXTOL • CHLORINATED BIPHENYL • MONTAR • PCB • PHENOCHLOR

1.2 Uses and uses advised against

Use(s)	INSULATION • PLASTICISER • TRANSFORMER LUBRICANT

1.3 Details of the supplier of the safety data sheet

Supplier name	**GENERIC REPORT - FOR REFERENCE PURPOSES ONLY**
Address	PO Box 21, West Perth, WA, Australia, 6872
Telephone	(08) 9322 1711
Fax	(08) 9322 1794
Email	Not supplied
Website	Not supplied

1.4 Emergency telephone number(s)

Emergency	(08) 9322 1711

2. HAZARDS IDENTIFICATION

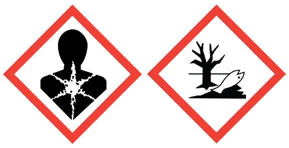
2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

GHS Classification(s)	Specific Target Organ Systemic Toxicity (Repeated Exposure): Category 2 Aquatic Toxicity (Chronic): Category 1

2.2 Label elements

Signal word	**WARNING**
Pictograms	



Hazard statement(s)

H373	May cause damage to organs through prolonged or repeated exposure.
H410	Very toxic to aquatic life with long lasting effects.

Prevention statement(s)

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P273	Avoid release to the environment. This statement does not apply where this is the intended use.

Response statement(s)

P314	Get medical advice/attention if you feel unwell.
P391	Collect spillage.

Disposal statement(s)

P501	Dispose of contents/container in accordance with relevant regulations.

2.3 Other Hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS number	EC number	Content
POLYCHLORINATED BIPHENYLS (PCB)	1336-36-3	215-648-1	100%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye	If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.
Inhalation	If inhaled, remove from contaminated area. To protect rescuer, use a Type A (Organic vapour) respirator or an Air-line respirator (in poorly ventilated areas). Apply artificial respiration if not breathing.
Skin	If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.
Ingestion	For advice, contact a Poison Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.
First aid facilities	No information provided.

4.2 Most important symptoms and effects, both acute and delayed

No information provided.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Dry agent, carbon dioxide or foam. Prevent contamination of drains and waterways.

5.2 Special hazards arising from the substance or mixture

Combustible. May evolve toxic gases (carbon oxides, dibenzofurans, dioxins, hydrogen chloride, phenols, chlorides, hydrocarbons) when heated to decomposition.

5.3 Advice for firefighters

Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

2X

2	Water Fog (or fine water spray if fog unavailable)
X	Full protective clothing including Self Contained Breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Contact emergency services where appropriate.

6.2 Environmental precautions

Prevent product from entering drains and waterways.

6.3 Methods of cleaning up

Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal. Only trained personnel should undertake clean up.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities

Store in segregated, locked and signposted compound with bunded floor. Drums may be plastic lined. Ensure area is cool, dry, well ventilated removed from direct sunlight, incompatible substances, heat or ignition sources and foodstuffs. Ensure each container is adequately labelled, protected from physical damage & sealed when not in use. Check regularly for leaks or spills.

7.3 Specific end use(s)

No information provided.

8. EXPOSURE CONTROLS/ PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

Substance	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
PCBs (42% Chlorine)	SWA (AUS)	--	1	--	2
PCBs (54% Chlorine)	SWA (AUS)	--	0.5	--	1

Biological limits

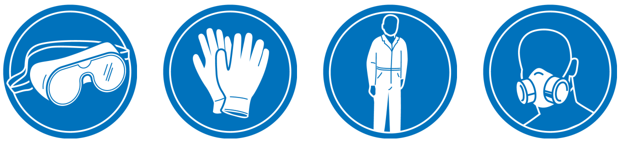
No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering Controls	Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain vapour levels below the recommended exposure standard.

PPE

Eye/Face	Wear splash-proof goggles.
Hand	Wear viton (R) or neoprene gloves.
Body	Wear coveralls.
Respiratory	Wear a Type A (Organic vapour) respirator. If using product in a confined area, wear an Air-line respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	VARY FROM OILY LIQUID TO WHITE CRYSTALLINE SOLID AND NON CRYSTALLINE RESIN
Odour	MILD AROMATIC ODOUR
Odour Threshold	NOT AVAILABLE
pH	NOT AVAILABLE
Melting Point	NOT AVAILABLE
Boiling Point	340°C to 375°C
Flash Point	NOT AVAILABLE
Evaporation Rate	NOT AVAILABLE
Flammability	COMBUSTIBLE
Upper Explosion Limit	NOT AVAILABLE
Lower Explosion Limit	NOT AVAILABLE
Vapour Pressure	NOT AVAILABLE
Vapour Density	NOT AVAILABLE
Solubility (water)	INSOLUBLE
Partition Coefficient	NOT AVAILABLE
Autoignition Temperature	NOT AVAILABLE
Decomposition Temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive Properties	NOT AVAILABLE
Oxidising Properties	NOT AVAILABLE
Specific Gravity	1.44

9.2 Other information

% Volatiles	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information in sections 10.2 to 10.6.

10.2 Chemical stability

No information provided.

10.3 Possibility of hazardous reactions

No information provided.

10.4 Conditions to avoid

No information provided.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), acids (e.g. nitric acid), alkalis (e.g. sodium hydroxide), heat and ignition sources.

10.6 Hazardous decomposition products

May evolve toxic gases (carbon oxides, dibenzofurans, dioxins, hydrogen chloride, phenols, chlorides, hydrocarbons) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Health hazard summary	Toxic. This product has the potential to cause adverse health effects. Use safe work practices to avoid eye or skin contact and inhalation. PCBs are classified as probably carcinogenic to humans (IARC Group 2A). Chronic exposure may result in liver and skin damage. Chronic exposure may result in birth defects. Cumulative poison.
Eye	Irritant. Contact may result in irritation, lacrimation, pain and redness.
Inhalation	Toxic. Over exposure may result in irritation of the nose and throat, coughing, loss of appetite, nausea and vomiting. Chronic exposure may result in liver damage. PCBs are classified as probably carcinogenic to humans (IARC Group 2A).
Skin	Toxic - irritant. Contact may result in irritation, redness, rash, brown-grey pigmentation and chloracne. May be absorbed through skin with harmful effects.
Ingestion	Toxic. Ingestion may result in nausea, vomiting, abdominal pain, diarrhoea, dizziness and drowsiness. Chronic exposure may result in liver damage and skin pigmentation.
Toxicity data	POLYCHLORINATED BIPHENYLS (PCB) (1336-36-3) LD50 (Ingestion): 1900 mg/kg (mouse) LDLo (Skin): 1148 mg/kg/38 days intermittently (rabbit) TCLo (Inhalation): 0.93 mg/m³/8 hours/20 weeks intermittently (rat) TDLo (Ingestion): 400 mg/kg (female rat) TDLo (Intraperitoneal): 700 mg/kg (female rat)

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Results of PBT and vPvB assessment

No information provided.

12.6 Other adverse effects

Current evidence suggests that the major source of Polychlorinated biphenyls (PCBs) released to the environment is an environmental cycling process of PCBs previously introduced into the environment. This cycling process involves volatilisation from ground surfaces (water, soil) into the atmosphere with subsequent removal from the atmosphere via wet/dry deposition and then revolatilisation. Monochlorinated biphenyls, dichlorinated biphenyls and trichlorinated biphenyls biodegrade relatively rapidly, tetrachlorinated biphenyls biodegrade slowly, & higher chlorinated biphenyls are resistant to biodegradation.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal	PCBs may only be disposed of by authorised methods or organisations. Contact your state EPA or the manufacturer for additional information.
Legislation	Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

	Land Transport (ADG)	Sea Transport (IMDG/IMO)	Air Transport (IATA/ICAO)
14.1 UN number	2315	-	-
14.2 UN proper shipping name	POLYCHLORINATED BIPHENYLS	-	-
14.3 Transport hazard classes			
DG Class	9	-	-
Subsidiary risk(s)	None Allocated	-	-
14.4 Packing group	II	-	-
14.5 Environmental hazards		None Allocated	
14.6 Special precautions for user			
Hazchem Code	2X		

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications N - Dangerous for the environment
Xn - Harmful

Risk phrases	R33:	Danger of cumulative effects.
	R50/53:	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Safety phrases	S2:	Keep out of reach of children.
	S35:	This material and its container must be disposed of in a safe way.
	S60:	This material and its container must be disposed of as hazardous waste.
	S61:	Avoid release to the environment. Refer to special instructions/safety data sheets.

Inventory listing(s) **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

15.2 Chemical safety assessment

No information provided.

16. OTHER INFORMATION

Additional information

This ChemAlert report is for informational purposes in case of accidental exposure to Polychloinated Biphenyls (PCBs)

IARC - GROUP 2A - PROBABLE HUMAN CARCINOGEN. This product contains an ingredient which has demonstrated sufficient evidence to have been classified by the International Agency for Research into Cancer (IARC) as a probable human carcinogen and whose use should be strictly monitored and controlled.

POLYCHLORINATED BIPHENYLS: The use of PCBs has been banned in industry for some time, however problems may occur due to their use in the past. PCBs have been reported to be present within construction jointing sealants and capacitors. Special precautions are required when handling materials which may contain PCBs. Please consult Risk Management Technologies for further information.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a ChemAlert report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

COLOUR RATING SYSTEM: RMT has assigned all ChemAlert reports a colour rating of Green, Amber or Red for the sole purpose of providing users with a quick and easy means of determining the hazardous nature of a product. Safe handling recommendations are provided in all ChemAlert reports so as to clearly identify how users can control the hazards and thereby reduce the risk (or likelihood) of adverse effects. As a general guideline, a Green colour rating indicates a low hazard, an Amber colour rating indicates a moderate hazard and a Red colour rating indicates a high hazard.

While all due care has been taken by RMT in the preparation of the Colour Rating System, it is intended as a guide only and RMT does not provide any warranty in relation to the accuracy of the Colour Rating System. As far as is lawfully possible, RMT accepts no liability or responsibility whatsoever for the actions or omissions of any person in reliance on the Colour Rating System.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m^3	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
PEL	Permissible Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
REACH	Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value

TWA	Time Weighted Average

Report Status

This ChemAlert report has been independently compiled by RMT's scientific department utilising the original Safety Data Sheet ('SDS') for the product provided to RMT by the manufacturer. The information is based on the latest chemical and toxicological research and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. It is an independent collation by RMT of information obtained from the original SDS for this product. Its content has not been authorised or verified by the manufacturer / distributor of the chemical to which it relates.

This ChemAlert report does not constitute the manufacturer's original SDS and is not intended to be a replacement for same. It is provided to subscribers of ChemAlert as a reference tool only, is not all-inclusive and does not represent any guarantee as to the properties of the product. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer.

While RMT has taken all due care to include accurate and up-to-date information in this ChemAlert report, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this ChemAlert report.

Prepared By

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Last Reviewed: 05 Feb 2013
Date Printed: 27 Apr 2015
Based on SDS dated: 05 Feb 2013

End of Report

SAFETY DATA SHEET

1. Identification

Product identifier	**PCE**	
Other means of identification		
Product code	804-0008	
Recommended use	Industrial Leak Sealant.	
Recommended restrictions	None known.	
Manufacturer/Importer/Supplier/Distributor information		
Company name	Team Industrial Services, Inc.	
Address	200 Hermann Drive, Alvin, Texas 77511	
Telephone	Not available.	
E-mail	Not available.	
Emergency phone number	CHEMTREC - 24 HOURS: International:	800-424-9300 (USA) +1 703-527-3887 (Collect)

2. Hazard(s) identification

Physical hazards	Not classified.	
Health hazards	Carcinogenicity	Category 2
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 2
	Hazardous to the aquatic environment, long-term hazard	Category 2
OSHA defined hazards	Not classified.	

Label elements

Signal word	Warning
Hazard statement	Suspected of causing cancer. Toxic to aquatic life with long lasting effects.
Precautionary statement	
Prevention	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves/protective clothing/eye protection/face protection. Avoid release to the environment.
Response	If exposed or concerned: Get medical advice/attention. Collect spillage.
Storage	Store locked up.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Tetrachloroethylene	127-18-4	> 50

Composition comments All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

4. First-aid measures

Inhalation	Remove victim to fresh air. Get medical attention if symptoms persist.
Skin contact	Wash the skin immediately with soap and water. Get medical attention if irritation develops or persists.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth and drink plenty of water. Do not induce vomiting. Get medical attention if any discomfort occurs.
Most important symptoms/effects, acute and delayed	Drowsiness and dizziness. Headache. Nausea. Weakness. Unconsciousness. Dry skin. Redness.
Indication of immediate medical attention and special treatment needed	Treat symptomatically.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water spray, foam, dry powder or carbon dioxide.
Unsuitable extinguishing media	No restrictions known.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Selection of respiratory protection for firefighting: follow the general fire precautions indicated in the workplace. Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Use standard firefighting procedures and consider the hazards of other involved materials. Cool material exposed to heat with water spray and remove it if no risk is involved.
General fire hazards	The product is not flammable.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Avoid inhalation of vapors and contact with skin and eyes. See Section 8 of the SDS for Personal Protective Equipment.
Methods and materials for containment and cleaning up	Stop the flow of material, if this is without risk. Dike far ahead of liquid spill for later disposal. Collect in containers and seal securely. Containers must be labeled. Small Spills: Absorb spillage with suitable absorbent material. Large Spills: Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. This material and its container must be disposed of as hazardous waste.
Environmental precautions	Do not discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Mechanical ventilation or local exhaust ventilation is required. Avoid inhalation of vapors/mist and contact with skin, eyes and clothing. Immediately change drenched clothing. Use appropriate Personal Protective Equipment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in closed original container in a dry place.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-2 (29 CFR 1910.1000)

Components	Type	Value
Tetrachloroethylene (CAS 127-18-4)	Ceiling	200 ppm
	TWA	100 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
Tetrachloroethylene (CAS 127-18-4)	STEL	100 ppm
	TWA	25 ppm

Biological limit values No biological exposure limits noted for the ingredient(s).

ACGIH Biological Exposure Indices

Components	Value	Determinant	Specimen	Sampling Time
Tetrachloroethylene (CAS 127-18-4)	0.5 mg/l	Tetrachloroethylene	Blood	*
	3 ppm	Tetrachloroethylene	End-exhaled air	*

* - For sampling details, please see the source document.

Exposure guidelines

US - Minnesota Haz Subs: Skin designation applies

Tetrachloroethylene (CAS 127-18-4)	Skin designation applies.

Appropriate engineering controls Mechanical ventilation or local exhaust ventilation is required. Observe Occupational Exposure Limits and minimize the risk of inhalation of vapors.

Individual protection measures, such as personal protective equipment

Eye/face protection Wear approved safety glasses or goggles.

Skin protection

Hand protection Wear protective gloves. Suitable gloves can be recommended by the glove supplier.

Other Wear suitable protective clothing.

Respiratory protection If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. In the United States of America, if respirators are used, a program should be instituted to assure compliance with OSHA 29 CFR 1910.134. If airborne concentrations are above the applicable exposure limits, use NIOSH approved respiratory protection.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Observe any medical surveillance requirements.

9. Physical and chemical properties

Appearance	Colorless liquid.
Physical state	Liquid.
Form	Liquid.
Color	Colorless.
Odor	Irritating odor.
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	Not available.
Initial boiling point and boiling range	250 °F (121.11 °C)
Flash point	Not applicable.
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not applicable.
Flammability limit - upper (%)	Not applicable.
Explosive limit - lower (%)	Not available.

Explosive limit - upper (%)	Not available.
Vapor pressure	13 mm Hg (20 °C)
Vapor density	Not available.
Relative density	1.619 (25 °C)
Solubility(ies)	
Solubility (water)	0,015 g / 100 g (25 °C)
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.

10. Stability and reactivity

Reactivity	The product is non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Will not occur.
Conditions to avoid	Avoid exposure to high temperatures or direct sunlight.
Incompatible materials	Strong oxidizing agents. Strong bases.
Hazardous decomposition products	Carbon monoxide. Carbon dioxide. Hydrogen chloride gas. Phosgene.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Inhalation of vapors or mists of the product may be irritating to the respiratory system. May cause central nervous system effects.
Skin contact	Causes skin irritation.
Eye contact	Mild eye irritation.
Ingestion	May cause discomfort if swallowed.
Symptoms related to the physical, chemical and toxicological characteristics	Drowsiness and dizziness. Headache. Nausea. Weakness. Unconsciousness. Dry skin. Redness.

Information on toxicological effects

Acute toxicity	May cause central nervous system effects.
Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	Mild eye irritation.
Respiratory or skin sensitization	
Respiratory sensitization	Not available.
Skin sensitization	Due to lack of data the classification is not possible.
Germ cell mutagenicity	Not available.
Carcinogenicity	Suspected of causing cancer by inhalation.

IARC Monographs. Overall Evaluation of Carcinogenicity

Tetrachloroethylene (CAS 127-18-4)	2A Probably carcinogenic to humans.

NTP Report on Carcinogens

Tetrachloroethylene (CAS 127-18-4)	Reasonably Anticipated to be a Human Carcinogen.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity	Not available.
Specific target organ toxicity - single exposure	Not available.
Specific target organ toxicity - repeated exposure	Not available.

Aspiration hazard	Not available.
Chronic effects	May cause damage to liver and kidney. May cause central nervous system effects.
Further information	No other specific acute or chronic health impact noted.

12. Ecological information

Ecotoxicity	Toxic to aquatic life with long lasting effects.
Persistence and degradability	Not readily degradable.
Bioaccumulative potential	The product is not expected to bioaccumulate.

Partition coefficient n-octanol / water (log Kow)

Tetrachloroethylene (CAS 127-18-4)	3.4

Mobility in soil	Expected to be moderately mobile in soil.
Mobility in general	The product is insoluble in water.
Other adverse effects	No data available.

13. Disposal considerations

Disposal instructions	Dispose of this material and its container to hazardous or special waste collection point. Disposal recommendations are based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.
Hazardous waste code	Not regulated.

US RCRA Hazardous Waste U List: Reference

Tetrachloroethylene (CAS 127-18-4)	U210

Waste from residues / unused products	Dispose of in accordance with local regulations.
Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN number	UN1897
UN proper shipping name	Tetrachloroethylene solution
Transport hazard class(es)	
Class	6.1
Subsidiary risk	-
Label(s)	6.1
Packing group	III
Environmental hazards	
Marine pollutant	Yes
Special precautions for user	Not available.
Special provisions	IB3, N36, T4, TP1
Packaging exceptions	153
Packaging non bulk	203
Packaging bulk	241

IATA

UN number	UN1897
UN proper shipping name	Tetrachloroethylene solution
Transport hazard class(es)	
Class	6.1
Subsidiary risk	-
Label(s)	6.1
Packing group	III
Environmental hazards	Yes
ERG Code	6L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1897
UN proper shipping name	TETRACHLOROETHYLENE SOLUTION
Transport hazard class(es)	
Class	6.1

Subsidiary risk	-
Label(s)	6.1
Packing group	III
Environmental hazards	
Marine pollutant	Yes
EmS	F-A, S-A
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not available.

15. Regulatory information

US federal regulations This product is hazardous according to OSHA 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Tetrachloroethylene (CAS 127-18-4) LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories
Immediate Hazard - Yes
Delayed Hazard - Yes
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Tetrachloroethylene	127-18-4	> 50

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Tetrachloroethylene (CAS 127-18-4)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Clean Water Act (CWA) Section 112(r) (40 CFR 68.130)
Priority pollutant
Toxic pollutant

Safe Drinking Water Act (SDWA)
0 mg/l
0.005 mg/l

US state regulations WARNING: This product contains a chemical known to the State of California to cause cancer.

US. Massachusetts RTK - Substance List

Tetrachloroethylene (CAS 127-18-4)

US. New Jersey Worker and Community Right-to-Know Act

Tetrachloroethylene (CAS 127-18-4)

US. Pennsylvania Worker and Community Right-to-Know Law

Tetrachloroethylene (CAS 127-18-4)

US. Rhode Island RTK

Tetrachloroethylene (CAS 127-18-4)

US. California Proposition 65

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

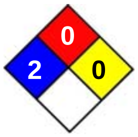
Tetrachloroethylene (CAS 127-18-4)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	17-February-2015
Revision date	-
Version #	01
Further information	HMIS® is a registered trade and service mark of the NPCA. G - Safety Glasses, Gloves, Vapor Respirator
HMIS® ratings	Health: 2* Flammability: 0 Physical hazard: 0 Personal protection: G
NFPA ratings	
References	ACGIH EPA: AQUIRE database NLM: Hazardous Substances Data Base US. IARC Monographs on Occupational Exposures to Chemical Agents HSDB® - Hazardous Substances Data Bank IARC Monographs. Overall Evaluation of Carcinogenicity National Toxicology Program (NTP) Report on Carcinogens ACGIH Documentation of the Threshold Limit Values and Biological Exposure Indices
Disclaimer	The information in the sheet was written based on the best knowledge and experience currently available.

ThermoFisher SCIENTIFIC

SAFETY DATA SHEET

Revision Date 24-Jan-2018 **Revision Number** 3

1. Identification

Product Name **Selenium**

Cat No. : **AC419270000; AC419271000; AC419275000**

Synonyms None

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use.
Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Acute oral toxicity	Category 3
Acute Inhalation Toxicity - Dusts and Mists	Category 3
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Liver.	

Label Elements

Signal Word
Danger

Hazard Statements
May cause damage to organs through prolonged or repeated exposure
Toxic if swallowed or if inhaled

Precautionary Statements
Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Use only outdoors or in a well-ventilated area
Do not breathe dust/fume/gas/mist/vapors/spray
Response
Get medical attention/advice if you feel unwell
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor/physician
Ingestion
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
Rinse mouth
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
May cause long lasting harmful effects to aquatic life

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Selenium	7782-49-2	> 99.5

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
Skin Contact	Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes.
Inhalation	Remove from exposure, lie down. Remove to fresh air. If not breathing, give artificial respiration. Immediate medical attention is required.
Ingestion	Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Drink plenty of water. Call a physician immediately. If possible drink milk afterwards.
Most important symptoms and effects	No information available.
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Water spray. Carbon dioxide (CO_2). Dry chemical. Chemical foam.

Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	Not applicable
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Dust can form an explosive mixture with air.

Hazardous Combustion Products
None known.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
3	0	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment as required.
Environmental Precautions	See Section 12 for additional Ecological Information. Avoid release to the environment. Collect spillage.
Methods for Containment and Clean Up	Sweep up and shovel into suitable containers for disposal.

7. Handling and storage

Handling	Avoid contact with skin and eyes. Do not breathe dust. Handle product only in closed system or provide appropriate exhaust ventilation.
Storage	Keep in a dry, cool and well-ventilated place. Refer product specification and/or product label for specific storage temperature requirement. Keep container tightly closed. Keep under nitrogen.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Selenium	TWA: 0.2 mg/m³	(Vacated) TWA: 0.2 mg/m³	IDLH: 1 mg/m³ TWA: 0.2 mg/m³	TWA: 0.2 mg/m³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: NIOSH - National Institute for Occupational Safety and Health

Engineering Measures	Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	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 and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	A NIOSH/MSHA approved air purifying dust or mist respirator or European Standard EN 149.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Powder Solid
Appearance	Grey
Odor	No information available
Odor Threshold	No information available
pH	No information available
Melting Point/Range	217 - 222 °C / 422.6 - 431.6 °F
Boiling Point/Range	685 °C / 1265 °F
Flash Point	No information available
Evaporation Rate	Not applicable
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	1 mmHg @ 345 °C
Vapor Density	Not applicable
Specific Gravity	4.810
Solubility	No information available
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	Not applicable
Decomposition Temperature	No information available
Viscosity	Not applicable
Molecular Formula	Se
Molecular Weight	78.96

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products.
Incompatible Materials	Acids, Strong oxidizing agents, Fluorine, oxygen, Metals
Hazardous Decomposition Products	None under normal use conditions
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Selenium	LD50 = 6700 mg/kg (Rat)	Not listed	>5.67 mg/l (Rat) 4hr

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Selenium	7782-49-2	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known
STOT - repeated exposure Liver

Aspiration hazard No information available

Symptoms / effects,both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

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Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Selenium	Not listed	LC50: > 100 mg/L, 96h semi-static (Oncorhynchus mykiss)	Not listed	Not listed

Persistence and Degradability Insoluble in water

Bioaccumulation/ Accumulation No information available.

Mobility Is not likely mobile in the environment due its low water solubility.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN3283
Hazard Class	6.1
Packing Group	III

TDG

UN-No	UN3283
Hazard Class	6.1
Packing Group	III

IATA

UN-No	UN3283
Proper Shipping Name	SELENIUM COMPOUND, SOLID, N.O.S.
Hazard Class	6.1
Packing Group	III

IMDG/IMO

UN-No	UN3283
Proper Shipping Name	SELENIUM COMPOUND, SOLID, N.O.S.
Hazard Class	6.1
Packing Group	III

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Selenium	7782-49-2	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Selenium	7782-49-2	X	-	231-957-4	X	X	X	X	KE-30924

U.S. Federal Regulations

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Selenium	7782-49-2	> 99.5	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Selenium	-	-	X	X

Clean Air Act Not applicable

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Selenium	X		-

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Selenium	100 lb	-

California Proposition 65 This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Selenium	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Revision Date 24-Jan-2018
Print Date 24-Jan-2018
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Trichloroethylene

Airgas
an Air Liquide company

Section 1. Identification

GHS product identifier : Trichloroethylene

Chemical name : trichloroethylene

Other means of identification : trichloroethene; Ethene, 1,1,2-trichloro-; Ethene, trichloro-; Trichlorethylene; Ethylene, trichloro-

Product use : Synthetic/Analytical chemistry.

Synonym : trichloroethene; Ethene, 1,1,2-trichloro-; Ethene, trichloro-; Trichlorethylene; Ethylene, trichloro-

SDS # : 001206

Supplier's details :
Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture :
SKIN CORROSION/IRRITATION - Category 2
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 2A
GERM CELL MUTAGENICITY - Category 2
CARCINOGENICITY - Category 1
AQUATIC HAZARD (LONG-TERM) - Category 3

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements :
Causes serious eye irritation.
Causes skin irritation.
May cause cancer.
Suspected of causing genetic defects.
Harmful to aquatic life with long lasting effects.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves. Wear eye or face protection. Wear protective clothing. Avoid release to the environment. Wash hands thoroughly after handling.

Response : IF exposed or concerned: Get medical attention. IF ON SKIN: Wash with plenty of soap and water. Take off contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical attention. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.

Storage : Store locked up.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Section 2. Hazards identification

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : trichloroethylene

Other means of identification : trichloroethene; Ethene, 1,1,2-trichloro-; Ethene, trichloro-; Trichlorethylene; Ethylene, trichloro-

CAS number/other identifiers

CAS number : 79-01-6

Product code : 001206

Ingredient name	%	CAS number
trichloroethylene	100	79-01-6

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Get medical attention. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : No known significant effects or critical hazards.

Skin contact : Causes skin irritation.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : No known significant effects or critical hazards.

Section 4. First aid measures

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:, pain or irritation, watering, redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:, irritation, redness

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : In a fire or if heated, a pressure increase will occur and the container may burst. This material is harmful to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide
halogenated compounds
carbonyl halides

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Section 6. Accidental release measures

Environmental precautions	: Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Methods and materials for containment and cleaning up

Small spill	: Stop leak if without risk. Move containers from spill area. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.
Large spill	: Stop leak if without risk. Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures	: Put on appropriate personal protective equipment (see Section 8). Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing vapor or mist. Avoid release to the environment. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.
Advice on general occupational hygiene	: Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.
Conditions for safe storage, including any incompatibilities	: Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

trichloroethylene	**ACGIH TLV (United States, 3/2016).** STEL: 25 ppm 15 minutes. TWA: 10 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** STEL: 1080 mg/m³ 15 minutes. STEL: 200 ppm 15 minutes. TWA: 270 mg/m³ 8 hours. TWA: 50 ppm 8 hours. **OSHA PEL Z2 (United States, 2/2013).** AMP: 300 ppm 5 minutes. CEIL: 200 ppm TWA: 100 ppm 8 hours.

Section 8. Exposure controls/personal protection

Appropriate engineering controls : If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state	Liquid. [Watery liquid.]
Color	Colorless.
Molecular weight	131.38 g/mole
Molecular formula	C2-H-Cl3
Boiling/condensation point	86.7°C (188.1°F)
Melting/freezing point	-84.8°C (-120.6°F)
Critical temperature	Not available.
Odor	Characteristic.
Odor threshold	Not available.
pH	Not available.
Flash point	Not available.
Burning time	Not applicable.
Burning rate	Not applicable.
Evaporation rate	6.39 (butyl acetate = 1)
Flammability (solid, gas)	Not available.

Section 9. Physical and chemical properties

Lower and upper explosive (flammable) limits	: Lower: 8% Upper: 10.5%
Vapor pressure	: 9.9 kPa (74.256033302 mm Hg) [room temperature]
Vapor density	: 4.5 (Air = 1)
Specific Volume (ft ^{3}/lb)	: 0.6849
Gas Density (lb/ft ^{3})	: 1.46
Relative density	: 1.5
Solubility	: Not available.
Solubility in water	: 1.1 g/l
Partition coefficient: n-octanol/water	: 2.53
Auto-ignition temperature	: 410°C (770°F)
Decomposition temperature	: Not available.
SADT	: Not available.
Viscosity	: Dynamic (room temperature): 0.58 mPa·s (0.58 cP)

Section 10. Stability and reactivity

Reactivity	: No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	: The product is stable.
Possibility of hazardous reactions	: Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	: No specific data.
Incompatible materials	: No specific data.
Hazardous decomposition products	: Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous polymerization	: Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
trichloroethylene	LC50 Inhalation Vapor LD50 Dermal LD50 Oral	Rat Rabbit Rat	140700 mg/m^3 >20 g/kg 4920 mg/kg	1 hours - -

IDLH : 1000 ppm

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
trichloroethylene	Eyes - Moderate irritant Skin - Severe irritant	Rabbit Rabbit	- -	24 hours 20 milligrams 24 hours 2 milligrams	- -

Sensitization

Not available.

Section 11. Toxicological information

Mutagenicity

Not available.

Carcinogenicity

Not available.

Classification

Product/ingredient name	**OSHA**	**IARC**	**NTP**
trichloroethylene	-	1	Reasonably anticipated to be a human carcinogen.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : No known significant effects or critical hazards.

Skin contact : Causes skin irritation.

Ingestion : No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:, pain or irritation, watering, redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:, irritation, redness

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : May cause cancer. Risk of cancer depends on duration and level of exposure.

Mutagenicity : Suspected of causing genetic defects.

Section 11. Toxicological information

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
trichloroethylene	Acute EC50 95000 µg/l Marine water	Algae - Skeletonema costatum	96 hours
	Acute EC50 36.5 mg/l Fresh water	Algae - Chlamydomonas reinhardtii - Exponential growth phase	72 hours
	Acute LC50 20 mg/l Marine water	Crustaceans - Elminius modestus	48 hours
	Acute LC50 18 mg/l Fresh water	Daphnia - Daphnia magna	48 hours
	Acute LC50 3100 µg/l Fresh water	Fish - Jordanella floridae - Juvenile (Fledgling, Hatchling, Weanling)	96 hours
	Chronic EC10 12.3 mg/l Fresh water	Algae - Chlamydomonas reinhardtii - Exponential growth phase	72 hours
	Chronic NOEC 10 mg/l Fresh water	Daphnia - Daphnia magna	21 days

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	LogP$_{ow}$	BCF	Potential
trichloroethylene	2.53	17	low

Mobility in soil

Soil/water partition coefficient (K$_{OC}$) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 13. Disposal considerations

United States - RCRA Toxic hazardous waste "U" List

Ingredient	CAS #	Status	Reference number
Trichloroethylene; Ethene, trichloro-	79-01-6	Listed	U228

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1710	UN1710	UN1710	UN1710	UN1710
UN proper shipping name	TRICHLOROETHYLENE	TRICHLOROETHYLENE	TRICHLOROETHYLENE	TRICHLOROETHYLENE	TRICHLOROETHYLENE
Transport hazard class(es)	6.1 	6.1 	6.1 	6.1 	6.1 
Packing group	III	III	III	III	III
Environment	No.	No.	No.	No.	No.
Additional information	**Reportable quantity** 100 lbs / 45.4 kg [8.2147 gal / 31.096 L] Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements. **Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 60 L **Cargo aircraft** Quantity limitation: 220 L **Special provisions** IB3, N36, T4, TP1, T1	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.26-2.36 (Class 6). **Explosive Limit and Limited Quantity Index** 5	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 60 L **Cargo Aircraft Only** Quantity limitation: 220 L **Limited Quantities - Passenger Aircraft** Quantity limitation: 2 L

“Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product.”

Special precautions for user : **Transport within user’s premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 5(a)2 final significant new use rules**: trichloroethylene

TSCA 8(a) CDR Exempt/Partial exemption: Not determined

TSCA 12(b) one-time export: trichloroethylene

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Water Act (CWA) 307: trichloroethylene

Clean Water Act (CWA) 311: trichloroethylene

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Immediate (acute) health hazard
Delayed (chronic) health hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
trichloroethylene	100	No.	No.	No.	Yes.	Yes.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	trichloroethylene	79-01-6	100
Supplier notification	trichloroethylene	79-01-6	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.

New York : This material is listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

California Prop. 65

WARNING: This product contains a chemical known to the State of California to cause cancer and birth defects or other reproductive harm.

Section 15. Regulatory information

Ingredient name	Cancer	Reproductive	No significant risk level	Maximum acceptable dosage level
trichloroethylene	Yes.	Yes.	14 µg/day (ingestion) 50 µg/day (inhalation)	No.

International regulations

International lists

National inventory

Australia	: This material is listed or exempted.
Canada	: This material is listed or exempted.
China	: This material is listed or exempted.
Europe	: This material is listed or exempted.
Japan	: This material is listed or exempted.
Malaysia	: This material is listed or exempted.
New Zealand	: This material is listed or exempted.
Philippines	: This material is listed or exempted.
Republic of Korea	: This material is listed or exempted.
Taiwan	: This material is listed or exempted.

Canada

WHMIS (Canada) : Class D-1B: Material causing immediate and serious toxic effects (Toxic).
Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class D-1B: Material causing immediate and serious toxic effects (Toxic).
Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

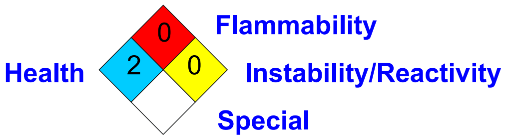
Hazardous Material Information System (U.S.A.)

Health	*	2
Flammability		0
Physical hazards		0

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

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



Section 16. Other information

Procedure used to derive the classification

Classification	Justification
Skin Irrit. 2, H315	Expert judgment
Eye Irrit. 2A, H319	Expert judgment
Muta. 2, H341	Expert judgment
Carc. 1, H350	Expert judgment
Aquatic Chronic 3, H412	Expert judgment

History

Date of printing : 11/21/2016

Date of issue/Date of revision : 11/21/2016

Date of previous issue : No previous validation

Version : 0.01

Key to abbreviations :

ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

◤ **Indicates information that has changed from previously issued version.**

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Safety Data Sheet

according to 29CFR1910/1200 and GHS Rev. 3

Effective date : 01.31.2015

Toluene, Reagent Grade

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name : **Toluene, Reagent Grade**

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: **S25611**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Flammable
Flammable liquids, category 2

Irritant
Skin irritation, category 2
Specific target organ toxicity following single exposure, category 3

Health hazard
Reproductive toxicity, category 2
Specific target organ toxicity following repeated exposure, category 2
Aspiration hazard, category 2

Flam. Liq. 2
Skin Irrit. 2
Repr. 2
STOT SE 3, Central nervous system
STOT RE 2
Asp. Tox. 1
Aquatic Acute 2

Signal word :Danger

Hazard statements:
Highly flammable liquid and vapour
May be harmful if swallowed and enters airways
Causes skin irritation
May cause drowsiness or dizziness
Suspected of damaging fertility or the unborn child
May cause damage to organs through prolonged or repeated exposure
Toxic to aquatic life

Precautionary statements:
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
Obtain special instructions before use
Wash skin thoroughly after handling
Use only outdoors or in a well-ventilated area
Avoid release to the environment
Wear protective gloves/protective clothing/eye protection/face protection
Do not handle until all safety precautions have been read and understood
Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/light/equipment
Use only non-sparking tools
Take precautionary measures against static discharge
Do not breathe dust/fume/gas/mist/vapours/spray
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
IF exposed or concerned: Get medical advice/attention
Specific treatment (see supplemental first aid instructions on this label)
Do NOT induce vomiting
If skin irritation occurs: Get medical advice/attention
Take off contaminated clothing and wash before reuse
In case of fire: Use agents recommended in section 5 for extinction
Store in a well ventilated place. Keep container tightly closed
Store in a well ventilated place. Keep cool
Store locked up
Dispose of contents and container to an approved waste disposal plant

Other Non-GHS Classification:

WHMIS

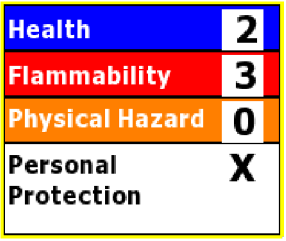
B2

D2A

D2B

NFPA/HMIS

NFPA SCALE (0-4)



Health	2
Flammability	3
Physical Hazard	0
Personal Protection	X

HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:
Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Move exposed to fresh air. Give artificial respiration if necessary. If breathing is difficult give oxygen.Loosen clothing and place exposed in a comfortable position.Seek immediate medical attention.

After skin contact: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.

After eye contact: Protect unexposed eye.Flush exposed eye gently using water for 15-20 minutes. Remove contact lenses while rinsing.IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

After swallowing: Rinse mouth with water.Never give anything by mouth to an unconscious person.DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

Most important symptoms and effects, both acute and delayed:

Irritation.Shortness of breath.Headache.Nausea.Dizziness.The substance is irritating to the eyes and respiratory tract. The substance may cause effects on the central nervous system. If this liquid is swallowed, aspiration into the lungs may result in chemical pneumonitis. Exposure at high levels could cause cardiac dysrhythmia and unconsciousness.;The substance defats the skin, which may cause dryness or cracking. The substance may have effects on the central nervous system. Exposure to the substance may increase noise-induced hearing loss. Animal tests show that this substance possibly causes toxicity to human reproduction or development.

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention provide SDS document to physician. Physician should treat symptomatically.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: Use foam, dry chemical, or carbon dioxide.

For safety reasons unsuitable extinguishing agents: Solid streams of water may spread fire.

Special hazards arising from the substance or mixture:

Thermal decomposition can lead to release of irritating gases and vapors.Vapors may ignited and cause explosion if in confined space. Vapors can flow across ignition source and flashback.

Advice for firefighters:

Protective equipment: Wear protective eyeware, gloves, and clothing. Refer to Section 8.

Additional information (precautions): Avoid inhaling gases, fumes, dust, mist, vapor, and aerosols. Avoid contact with skin, eyes, and clothing.Cool closed containers exposed to fire with water spray.Approach fire from upwind to avoid hazardous vapors and toxic decomposition. If material on fire or involved in fire: Do not extinguish fire unless flow can be stopped or safely confined. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Ensure adequate ventilation.Ensure that air-handling systems are operational. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.Remove all sources of ignition.

Environmental precautions:

Should not be released into environment.Prevent from reaching drains, sewer, or waterway.

Methods and material for containment and cleaning up:

Wear protective eyeware, gloves, and clothing. Refer to Section 8.Always obey local regulations.If necessary use trained response staff or contractor. Evacuate personnel to safe areas. Containerize for disposal. Refer to Section 13.Keep in suitable closed containers for disposal.Remove all sources of ignition.Have extinguishing agent available in case of fire. Use non-sparking equipment.

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Avoid contact with skin, eyes, and clothing.Follow good hygiene procedures when handling chemical materials. Refer to Section 8.Follow proper disposal methods. Refer to Section 13.Do not eat, drink, smoke, or use personal products when handling chemical substances.Use explosion-proof equipment.Keep away from open flames, hot surfaces and sources of ignition.

Conditions for safe storage, including any incompatibilities:

Store in a cool location.Keep away from food and beverages.Protect from freezing and physical damage.Provide ventilation for containers. Keep container tightly sealed. Store away from incompatible materials. Store as flammable. Keep away from sources of ignition.

SECTION 8 : Exposure controls/personal protection

Control Parameters:	108-88-3 , Toluene, ACGIH TLV TWA 20 ppm 108-88-3, Toluene, OSHA PEL TWA 200 ppm
Appropriate Engineering controls:	Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling. Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor and mists below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above.Use under a chemical fume hood.Use explosion-proof equipment.

Respiratory protection:	Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls.When necessary use NIOSH approved breathing equipment. Use under a chemical fume hood.
Protection of skin:	Select glove material impermeable and resistant to the substance.Select glove material based on rates of diffusion and degradation. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves.Wear protective clothing.
Eye protection:	Wear equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).Safety glasses or goggles are appropriate eye protection.
General hygienic measures:	Perform routine housekeeping.Wash hands before breaks and immediately after handling the product.Avoid contact with skin, eyes, and clothing.Before rewearing wash contaminated clothing.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	Clear, colorless liquid	**Explosion limit lower**: **Explosion limit upper**:	7 %(V) 1.2 %(V)
Odor:	Sweet, pungent, benzene-like odor.	**Vapor pressure**:	28.4 mm Hg @ 25 deg C
Odor threshold:	1.03 to 140 ug/cu m	**Vapor density**:	3.1
pH-value:	Not Determined	**Relative density**:	0.865 g/mL at 25 °C (77 °F)
Melting/Freezing point:	95°C (-139°F)	**Solubilities**:	Insoluble in water
Boiling point/Boiling range:	110 - 111 °C (230 - 232 °F)	**Partition coefficient (n-octanol/water)**:	log Kow 2.73
Flash point (closed cup):	4.0 °C (39.2 °F)	**Auto/Self-ignition temperature**:	535.0 °C (995.0 °F)
Evaporation rate:	2.4	**Decomposition temperature**:	Not Determined
Flammability (solid,gaseous):	Highly flammable	**Viscosity**:	a. Kinematic:Not determined b. Dynamic: Not Determined
Density: Not Determined			

SECTION 10 : Stability and reactivity

Reactivity: Nonreactive under normal conditions.Reacts violently with strong oxidants. This generates fire and explosion hazard.
Chemical stability: Stable under normal conditions.
Possible hazardous reactions: None under normal processing.Vapours may form explosive mixture with air.
Conditions to avoid: Incompatible materials.excess heat.Direct Sunlight
Incompatible materials: Oxidizing agents. Acids.

Hazardous decomposition products: Carbon oxides.

SECTION 11 : Toxicological information

Acute Toxicity:		
Dermal:	108-88-3 (Toluene)	LD50 Rabbit: 12,124 mg/kg
Oral:	108-88-3 (Toluene)	LD50 Rat: 5000mg/kg
Inhalation:	108-88-3 (Toluene)	LC50 Rat: 12,500 - 28,800 mg/m3/4 h
Chronic Toxicity: No additional information.		
Corrosion Irritation:		
Dermal:	108-88-3 (Toluene)	Rabbit: Skin Irritation - 24 h
Sensitization:		No additional information.
Single Target Organ (STOT):		No additional information.
Numerical Measures:		No additional information.
Carcinogenicity:		IARC:: Group 3: Not classifiable as to its carcinogenicity to humans (Toluene)
Mutagenicity:		rat Liver DNA damage
Reproductive Toxicity:		Suspected human reproductive toxicant. rat - Inhalation Paternal Effects: Spermatogenesis (including genetic material, sperm morphology,motility, and count).rat - Oral Effects on Embryo or Fetus: Fetotoxicity (except death, e.g., stunted fetus).

SECTION 12 : Ecological information

Ecotoxicity

Fish LC50 - Oncorhynchus mykiss (rainbow trout) - 7.63 mg/l - 96 h: 108-88-3 (Toluene)

Invertebrates EC50 - Daphnia magna (Water flea) - 6 mg/l - 48 h: 108-88-3 (Toluene)

Persistence and degradability: Readily biodegradable
Bioaccumulative potential: bioconcentration in aquatic organisms is low to moderate
Mobility in soil: toluene is expected to have high to moderate mobility in soil.2.65 log Pow
Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Contact a licensed professional waste disposal service to dispose of this material.Dispose of empty containers as unused product.Product or containers must not be disposed together with household garbage. It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations. Ensure complete and accurate classification.

SECTION 14 : Transport information

UN-Number

1294

UN proper shipping name

Toluene

Transport hazard class(es)

Class:
3 Flammable liquids

Packing group:II
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Acute, Chronic, Fire

SARA Section 313 (Specific toxic chemical listings):

None of the ingredients is listed

RCRA (hazardous waste code):

108-88-3 Toluene - U220

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

108-88-3 Toluene 1000 lb

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

108-88-3 Toluene

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

108-88-3 Toluene

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations. Note: . The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.
GHS Full Text Phrases:

Abbreviations and acronyms:

Effective date : 01.31.2015
Last updated : 03.19.2015

Xylenes, Reagent Grade

SECTION 1: Identification of the substance/mixture and of the supplier

Product name: **Xylenes, Reagent Grade**

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: **S25629**

Recommended uses of the product and restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific, Inc
9 Barnhart Drive, Hanover, PA 17331
(717) 632-1291

Supplier Details:

Fisher Science Education
6771 Silver Crest Road, Nazareth, PA 18064
(724)517-1954

Emergency telephone number:

Fisher Science Education
Emergency Telephone No.: 800-535-5053

SECTION 2: Hazards identification

Classification of the substance or mixture:

Flammable
Flammable liquids, category 3

Irritant
Acute toxicity (oral, dermal, inhalation), category 4
Skin irritation, category 2

Environmentally Damaging
Chronic hazards to the aquatic environment, category 2

Acute hazards to the aquatic environment, category 2

Flam. Liq. 3.
Acute inhalation tox. 4.
Acute Dermal Tox. 4.
Skin Irrit. 2.
Aquatic Acute 2.
Aquatic Chronic 2.

Signal word: Warning

Hazard statements:

Flammable liquid and vapour.
Harmful in contact with skin.
Harmful if inhaled.
Causes skin irritation.
Toxic to aquatic life with long lasting effects.

Precautionary statements:

If medical advice is needed, have product container or label at hand.
Keep out of reach of children.
Read label before use.
Keep away from heat/sparks/open flames/hot surfaces. No smoking.
Avoid release to the environment.
Wear protective gloves/protective clothing/eye protection/face protection.
Keep container tightly closed.
Ground/bond container and receiving equipment.
Use explosion-proof electrical/ventilating/light/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Avoid breathing dust/fume/gas/mist/vapours/spray.
Wash skin thoroughly after handling.
Use only outdoors or in a well-ventilated area.
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
Call a POISON CENTER or doctor/physician if you feel unwell.
Specific measures (see supplemental first aid instructions on this label).
If skin irritation occurs: Get medical advice/attention.
Take off contaminated clothing and wash before reuse.
In case of fire: Use agents recommended in section 5 for extinction.
Collect spillage.
Store in a well ventilated place. Keep cool.
Dispose of contents and container to an approved waste disposal plant.

Other Non-GHS Classification:

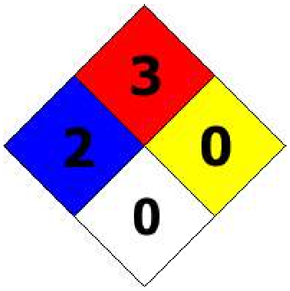
WHMIS

D2A


D2B


B2


NFPA/HMIS



NFPA SCALE (0-4)

Health	2
Flammability	3
Physical Hazard	0
Personal Protection	X

HMIS RATINGS (0-4)

SECTION 3: Composition/information on ingredients

Ingredients:		
CAS 1330-20-7	Xylenes	100 %
		Percentages are by weight

SECTION 4: First aid measures

Description of first aid measures

After inhalation:

Move exposed to fresh air. Give artificial respiration if necessary. If breathing is difficult give oxygen. Loosen clothing and place exposed in a comfortable position. Seek medical assistance if cough or other symptoms appear.

After skin contact:

Wash hands and exposed skin with soap and plenty of water. Seek medical attention if irritation persists or if concerned.

After eye contact:

Protect unexposed eye. Flush exposed eye gently using water for 15-20 minutes. Remove contact lenses while rinsing. Seek medical attention if irritation persists or concerned.

After swallowing:

Rinse mouth with water. Do not induce vomiting. Never give anything by mouth to an unconscious person. Seek medical attention if irritation, discomfort, or vomiting persists.

Most important symptoms and effects, both acute and delayed:

Irritation. Shortness of breath. Headache. Nausea. Dizziness. Blurred vision. Prolonged or repeated exposure to skin causes defatting and dermatitis.

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention provide SDS document to physician. Physician should treat symptomatically.

SECTION 5: Firefighting measures

Extinguishing media

Suitable extinguishing agents:

Use dry chemical, chemical foam, carbon dioxide, or alcohol-resistant foam. Use appropriate foam to blanket release and suppress vapors.

Unsuitable extinguishing agents:

Water may be ineffective.

Special hazards arising from the substance or mixture:

Thermal decomposition can lead to release of irritating gases and vapors. Containers may explode when heated. Vapors may travel to sources of ignition. Vapors may form explosive mixtures with air. Vapors may form an explosive mixture with air. 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. This liquid floats on water and may travel to a source of ignition and spread fire. May accumulate static electricity.

Advice for firefighters:

Protective equipment:

Wear protective eyeware, gloves, and clothing. Refer to Section 8.

Additional information (precautions):

Avoid inhaling gases, fumes, dust, mist, vapor, and aerosols. Avoid contact with skin, eyes, and clothing. Cool closed containers exposed to fire with water spray.

SECTION 6: Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Ensure adequate ventilation. Ensure that air-handling systems are operational. Remove all sources of ignition.

Environmental precautions:

Should not be released into environment. Prevent from reaching drains, sewer, or waterway.

Methods and material for containment and cleaning up:

Wear protective eyeware, gloves, and clothing. Refer to Section 8. Always obey local regulations. If necessary use trained response staff or contractor. Evacuate personnel to safe areas. Containerize for disposal. Refer to Section 13. Keep in suitable closed containers for disposal. Remove source from ignition. Absorb with inert material and place in chemical waste container. Ventilate spill area. Have extinguishing agent available in case of fire. Eliminate all ignition sources. Stop or control the leak, if this can be done without undue risk. Use appropriate foam to blanket release and suppress vapors. Control runoff and isolate discharged material for proper disposal.

Reference to other sections: None

SECTION 7: Handling and storage

Precautions for safe handling:

Avoid contact with skin, eyes, and clothing. Follow good hygiene procedures when handling chemical materials. Refer to Section 8. Follow proper disposal methods. Refer to Section 13. Do not eat, drink, smoke, or use personal products when handling chemical substances. Keep away from open flames, sources of ignition, hot surfaces. Use explosion-proof equipment and non-sparking tools.

Conditions for safe storage, including any incompatibilities:

Store in a cool location. Keep away from food and beverages. Protect from freezing and physical damage. Provide ventilation for containers. Keep container tightly sealed. Store away from incompatible materials. Store as flammable. Keep away from open flames, hot surfaces and sources of ignition.

SECTION 8: Exposure controls/personal protection

Control Parameters:	1330-20-7, Xylenes, ACGIH TLV TWA 435 mg/m3. 1330-20-7, Xylenes (o-, m-, p- isomers), OSHA PEL 100 ppm TWA; 435 mg/m3 TWA.
Appropriate Engineering controls:	Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling. Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor and mists below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above. Use under a chemical fume hood.
Respiratory protection:	Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. When necessary use NIOSH approved breathing equipment.
Protection of skin:	Select glove material impermeable and resistant to the substance. Select glove material based on rates of diffusion and degradation. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves. Wear protective clothing.

Eye protection:	Wear equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU). Safety glasses or goggles are appropriate eye protection.
General hygienic measures:	Perform routine housekeeping. Wash hands before breaks and immediately after handling the product. Avoid contact with skin, eyes, and clothing. Before rewearing wash contaminated clothing. Work clothing that becomes wet should be immediately removed due to its flammability hazard.

SECTION 9: Physical and chemical properties

Appearance (physical state, color):	Clear, colorless liquid	**Explosion limit lower**: **Explosion limit upper**:	0.9% (V) 6.7% (V)
Odor:	Sweet Aromatic	**Vapor pressure at 20°C**:	8 mbar @20C
Odor threshold:	0.05 ppm	**Vapor density**:	3.67
pH-value:	Not Determined	**Relative density**:	0.86 g/mL at 25 °C (77 °F)
Melting/Freezing point:	-34C	**Solubilities**:	Soluble in most organic solvents.
Boiling point/Boiling range:	137 - 140 °C (279 - 284 °F)	**Partition coefficient (n-octanol/water)**:	log Kow 3.12
Flash point (closed cup):	25 °C (77 °F)	**Auto/Self-ignition temperature**:	460C
Evaporation rate:	Not determined	**Decomposition temperature**:	Not Determined
Flammability (solid, gaseous):	flammable liquid	**Viscosity**:	a. Kinematic: Not determined b. Dynamic: Not Determined
Density at 20°C:	Not Determined		

SECTION 10: Stability and reactivity

Reactivity:

Nonreactive under normal conditions.

Chemical stability:

Stable under normal conditions.

Possible hazardous reactions:

None under normal processing. Vapours may form explosive mixture with air.

Conditions to avoid:

Incompatible materials. Ignition sources. excess heat. Open Flames. Hot surfaces.

Incompatible materials:

Oxidizing agents. Acids.

Hazardous decomposition products:

Carbon oxides.

SECTION 11: Toxicological information

Acute Toxicity:

Oral:

WorkCare®
Making Health Count

FACT SHEET

EARLY INCIDENT INTERVENTION®

Immediate Access to Medical Advice for Work Related Incidents

(888) 449-7787

INTRODUCTION

WorkCare, Inc. (WorkCare) and TRC have partnered together to promote Incident Intervention®, a resource designed to support company safety goals/targets—while reducing runaway-costs associated with workplace injuries and illnesses.

PURPOSE

Early Incident Intervention provides TRC employees with **IMMEDIATE** telephonic access to WorkCare clinicians at the time of a presumed, non-emergency workplace injury or illness. Clinicians provide expert guidance on the evaluation of symptoms, appropriate first aid, and the need for additional medical evaluation or treatment.

When utilizing this service within the first hour of an incident, known as the "Golden Hour," licensed medical staff can guide the case so that medical evaluation and treatment are rendered appropriately.

> *"…helps the worker traverse the unpredictable terrain of work-related injuries and illness."*

PRINCIPLES OF EARLY INCIDENT INTERVENTION

- Utilizes principles of the "Golden Hour."
- Provides workers immediate clinician support at the time of an incident.
- Focuses on providing the right care, at the right time in the proper setting.

BENEFITS FOR EMPLOYEES

- Instant access to a medically qualified professional for evaluation of symptoms and possible outcomes.
- Professional guidance on appropriate first aid measures and medications.
- Professional advice regarding the need for additional medical evaluation or treatment.

BENEFITS FOR TRC

- Point of contact for emergency and non-emergency medical clinicians.
- Triages the incident to determine risk and urgency, delivering interventions that are consistent with medical guidelines for the specified injury and illness.
- Maintains communication with clinicians to ensure accurate and timely reporting.

The Right Care - The Right Time - The Proper Setting

(888) 449-7787

1330-20-7 (Xylenes) LD50 Rat: 4,300 mg/kg

Dermal:

1330-20-7 (Xylenes) LD50 Rabbit: >1,700 mg/kg

Inhalation:

1330-20-7 (Xylenes) LD50 Rat: 5000 ppm - 4h

Chronic Toxicity: No additional information.
Corrosion Irritation:

Dermal:

1330-20-7 (Xylenes) Rabbit: Skin Irritation - 24 h

Ocular:

1330-20-7 (Xylenes) Rabbit: mild eye irritation

Sensitization: No additional information.
Numerical Measures: No additional information.
Carcinogenicity:

IARC:: Group 3: Not classifiable as to its carcinogenicity to humans (Xylene)
NTP (National Toxicology Program) : Evidence of Carcinogenicity - Male Rat - No Evidence; Female Rat - No Evidence; Male Mice - No Evidence; Female Mice - No Evidence (TR-327, mixed) (Xylenes 1330-20-7)
ACGIH - A4 -: Not Classifiable as a Human Carcinogen Xylene (o-, m-, p- isomers) 1330-20-7

Mutagenicity: No additional information.
Reproductive Toxicity: No additional information.

SECTION 12: Ecological information

Ecotoxicity: No additional information.
Persistence and degradability:

Readily biodegradable.

Bioaccumulative potential:

potential for bioconcentration in aquatic organisms is low.

Mobility in soil: No additional information.
Other adverse effects: No additional information.

SECTION 13: Disposal considerations

Waste disposal recommendations:

Contact a licensed professional waste disposal service to dispose of this material. Dispose of empty containers as unused product. Product or containers must not be disposed together with household garbage. It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations. Ensure complete and accurate classification. RCRA (40 CFR 261.33 Haz Waste Code): Xylenes, mixed isomers (1330-20-7) waste number U239. Included in waste stream: F039.

SECTION 14: Transport information

US DOT

UN Number:
ADR, ADN, DOT, IMDG, IATA

1307

Limited Quantity Exception: None

Bulk:
RQ (if applicable): None
Proper shipping Name: Xylenes.
Hazard Class: 3
Packing Group: III.
Marine Pollutant (if applicable): No additional information.
Comments: None

Non Bulk:
RQ (if applicable): None
Proper shipping Name: Xylenes.
Hazard Class: 3
Packing Group: III.
Marine Pollutant (if applicable): No additional information.
Comments: None

SECTION 15: Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Acute, Fire

SARA Section 313 (Specific toxic chemical listings):

1330-20-7 xylenes, mixed isomers 1.0 % de minimis concentration.

RCRA (hazardous waste code):

1330-20-7 Xylenes - U239.
1330-20-7 xylenes, mixed isomers RCRA waste code U239.

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

1330-20-7 xylenes, mixed isomers 100 lbs.

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for females:

None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for males:

None of the ingredients are listed.

Chemicals known to cause developmental toxicity:

None of the ingredients are listed.

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 1%):

None of the ingredients are listed.

SECTION 16: Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations. Note. The responsibility to provide a safe workplace remains with the user. The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment. The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material. It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases: None

Abbreviations and Acronyms: None

Effective date: 01.31.2015
Last updated: 06.17.2015

ZINC METAL
SAFETY DATA SHEET

SECTION 1. IDENTIFICATION

Product Identity: Zinc Metal

Trade Names and Synonyms: High Grade Zinc; Special High Grade Zinc; Zinc, Zn, CGG Alloy <1% Aluminum.

Manufacturer:	Supplier:	Preparer:
Teck Metals Ltd. Trail Operations Trail, British Columbia V1R 4L8 Emergency Telephone: 250-364-4214	In U.S.: Teck American Metal Sales Incorporated 501 North Riverpoint Blvd, Suite 300 Spokane, WA USA, 99202 Other than U.S.: Teck Metals Ltd. #1700 – 11 King Street West Toronto, Ontario M5H 4C7	Teck Metals Ltd. Suite 3300 – 550 Burrard Street Vancouver, British Columbia V6C 0B3

Date of Last Review: July 15, 2015.

Date of Last Edit: July 15, 2015.

Product Use: Zinc metal is used to coat steel for corrosion protection (galvanizing, electroplating, electrogalvanizing), as an alloying element in bronze, brass, aluminum and other metal alloys, for zinc die casting alloys, for zinc dry cell and zinc/air batteries, for the production of zinc sheet for architectural and coinage applications, as a reducing agent in organic chemistry and for other chemical applications.

SECTION 2. HAZARDS IDENTIFICATION

CLASSIFICATION:

NOTE: In the form in which it is sold this product is not regulated as a Hazardous Product in the U.S. or Canada. This Safety Data Sheet is provided for information purposes only.

Health		Physical	Environmental
Acute Toxicity (Oral, Inhalation)	– Does not meet criteria	Does not meet criteria for any Physical Hazard	Aquatic Toxicity – (Short Term/Long Term) Does not meet any criteria
Skin Corrosion/Irritation	– Does not meet criteria		
Eye Damage/Eye Irritation	– Does not meet criteria		
Respiratory or Skin Sensitization	– Does not meet criteria		
Mutagenicity	– Does not meet criteria		
Carcinogenicity	– Does not meet criteria		
Reproductive Toxicity	– Does not meet criteria		
Specific Target Organ Toxicity:			
Acute Exposure	– Does not meet criteria		
Chronic Exposure	– Does not meet criteria		

LABEL:

Symbols: None required	**Signal Word:** None required
Hazard Statements	**Precautionary Statements:**
None required	None required

Emergency Overview: A lustrous bluish-silver metal that does not burn in bulk but may form explosive mixtures if dispersed in air as a fine powder. Zinc oxide fume is formed when zinc metal is heated to or near the boiling point, or is burned. Contact with acids or alkalis generates flammable hydrogen gas which can accumulate in poorly ventilated areas. Do NOT use water or foam on burning zinc metal. Apply dry chemical, sand or special powder extinguishing media. Zinc is relatively non-toxic and poses little immediate hazard to the health of emergency response personnel or to the environment in an emergency situation.

Potential Health Effects: Zinc is essentially non-toxic to humans. However, zinc oxide fumes may cause mild local irritation to eyes, nose, throat and upper airways. Acute over-exposure to zinc oxide fume may cause metal fume fever, characterized by flu-like symptoms such as chills, fever, nausea, and vomiting which may be delayed 3 – 10 hours in onset. In most cases, dermal exposure to zinc or zinc compounds does not result in any noticeable toxic effects. Zinc is not listed as a carcinogen by OSHA, NTP, IARC, ACGIH or the EU (see Toxicological Information, Section 11).

Potential Environmental Effects: Zinc metal has relatively low bioavailability and poses no immediate ecological risks. Depending on physico-chemical characteristics (e.g., pH, water hardness), compounds of zinc metal can be toxic, particularly in the aquatic environment. Zinc also has the potential to bioaccumulate in plants and animals in both aquatic and terrestrial environments (see Ecological Information, Section 12).

SECTION 3. COMPOSITION / INFORMATION ON INGREDIENTS

COMPONENTS	CAS Registry No.	CONCENTRATION (% wgt/wgt)
Zinc	7440-66-6	99+%

Note: See Section 8 for Occupational Exposure Guidelines.

SECTION 4. FIRST AID MEASURES

Eye Contact: *Symptoms:* Mild eye irritation, redness. Do not rub eye(s). Let the eye(s) water naturally for a few minutes. Look right and left, then up and down. If particle/dust does not come out, cautiously rinse eye(s) with lukewarm, gently flowing water for 5 minutes or until particle/dust is removed, while holding eyelid(s) open. If eye irritation persists, get medical advice/attention. DO NOT attempt to manually remove anything from the eye.

Skin Contact: *Symptoms:* Soiling of skin. No health effects expected. If irritation does occur, rinse with lukewarm, gently flowing water for 5 minutes or until the product is removed. If skin irritation occurs or you feel unwell, get medical advice/attention. *Molten Metal:* Flush contact area to solidify and cool but do not attempt to remove encrusted material or clothing. Cover burns and seek medical attention immediately.

Inhalation: *Symptoms:* Coughing and irritation in heavy dust clouds. If symptoms are experienced remove source of contamination or move victim from exposure area to fresh air immediately and obtain medical advice. NOTE: Metal fume fever may develop 3-10 hours after exposure to zinc oxide fumes. If symptoms of metal fume fever (flu-like symptoms) develop, obtain medical attention.

Ingestion: *Symptoms:* Stomach upset, nausea, diarrhea. If swallowed, no specific intervention is indicated as this material is not likely to be hazardous by ingestion. However, if you are concerned or you feel unwell, obtain medical advice.

SECTION 5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: Massive metal is difficult to ignite and is not considered a serious fire hazard. However, finely-divided metallic dust may form flammable or explosive dust clouds when dispersed in the air at high concentrations and exposed to heat, flame, or other ignition sources. Bulk dust in a damp state may heat spontaneously and ignite on exposure to air. Contact with acids and alkali hydroxides results in evolution of hydrogen gas which is potentially explosive. Mixtures with potassium chlorate or fused ammonium nitrate may explode on impact.

Extinguishing Media: Apply dry chemical, dry sand, or special powder extinguishing (Class D) media. Do NOT use water, carbon dioxide or foam on molten metals. Water may be ineffective for extinguishing a fire but should be used to keep fire-exposed billets, ingots and castings cool.

Fire Fighting: If possible, move material not yet involved in the fire from the fire area. If this is not possible, cool fire-exposed zinc by applying hose streams or fogs. Apply only dry chemical, sand, or special powder extinguishing media to any molten or burning zinc metal. Take extreme caution to prevent contact of water with molten or burning zinc. Zinc foil in particular may ignite in the presence of water. Zinc oxide fumes may evolve in fires. Fire fighters should be fully trained and wear full protective clothing including an approved, self-contained breathing apparatus which supplies a positive air pressure within a full face-piece mask.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Procedures for Cleanup: Control source of release if possible to do so safely. Clean up spilled material immediately observing precautions in Section 8, Personal Protection. Molten metal should be allowed to cool and harden before cleanup. Once solidified wear gloves, pick up and return to process. Powder or dust should be cleaned up by sweeping/shoveling, etc. Solid metal is recyclable. Return uncontaminated spilled material to the process if possible. Place contaminated material in clean, dry, suitably labelled containers for later recovery or disposal. Treat or dispose of waste material in accordance with all local, state/provincial, and national requirements.

Personal Precautions: Protective clothing, gloves, and a respirator are recommended for persons responding to an accidental release (see also Section 8). Close-fitting safety goggles may be necessary in some circumstances to prevent eye contact with zinc dust and fume. Where molten metal is involved, wear heat-resistant gloves and suitable clothing for protection from hot-metal splash.

Environmental Precautions: Zinc metal has relatively low bioavailability and poses no immediate ecological risks. Depending on physico-chemical characteristics (e.g., pH, water hardness), compounds of zinc metal can be toxic, particularly in the aquatic environment. Zinc also has the potential to bioaccumulate in plants and animals in both aquatic and terrestrial environments. Releases of the product to water and soil should be prevented.

SECTION 7. HANDLING AND STORAGE

Store zinc in a DRY covered area, separate from incompatible materials. Zinc ingots suspected of containing moisture should be THOROUGHLY DRIED before being added to a molten bath. Ingots may contain cavities that collect moisture. Entrained moisture will expand explosively when immersed in a molten bath.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Guidelines: *(Time-Weighted Average (TWA) concentration over 8 hr unless otherwise indicated)*

Component	ACGIH TLV	OSHA PEL	NIOSH REL
Zinc	None established†	None established†	None established†

NOTE: OEGs for individual jurisdictions may differ from those given above. Check with local authorities for the applicable OEGs in your jurisdiction.

ACGIH - American Conference of Governmental Industrial Hygienists; OSHA - Occupational Safety and Health Administration; NIOSH - National Institute for Occupational Safety and Health. TLV – Threshold Limit Value, PEL – Permissible Exposure Limit, REL – Recommended Exposure Limit.

† NOTE: While there is no established OEL for zinc as such, there are OELs for zinc oxide which may be formed during burning, welding or other fuming processes.

The OSHA PEL final rule limits for zinc oxide dust are 10 mg/m^3 (total) and 5 mg/m^3 (respirable); the OSHA PEL final rule limit for zinc oxide fume is 5 mg/m^3. Note that the OSHA PEL final rule limits are currently non-enforceable due to a court decision. The OSHA PEL transitional limits therefore remain in force at present. They are 15 mg/m^3 (total) and 5 mg/m^3 (respirable) while the transitional PEL for zinc oxide fume is 5 mg/m^3. The ACGIH TLV for zinc oxide is 2 mg/m^3 (respirable fraction) with a Short Term Exposure Limit (STEL) of 10 mg/m^3 (respirable fraction). The NIOSH REL for zinc oxide (dust or fume) is 5 mg/m^3 10 hr TWA with a 15 mg/m^3 ceiling limit (15 minute sample) for zinc oxide dust and a 10 mg/m^3 STEL for zinc oxide fume (15 minute sample).

NOTE: The selection of the necessary level of engineering controls and personal protective equipment will vary depending upon the conditions of use and the potential for exposure. The following are therefore only general guidelines that may not fit all circumstances. Control measures to consider include:

Ventilation: Use adequate local or general ventilation to maintain the concentration of zinc oxide fumes in the working environment well below recommended occupational exposure limits. Supply sufficient replacement air to make up for air removed by the exhaust system. Where metallic particles of zinc are being collected and transported by a ventilation system, use a non-sparking, grounded ventilation system separate from other exhaust ventilation systems. Locate dust collectors and fans outdoors if possible and provide dust collectors with explosion vents or blow out panels. Refer to appropriate NFPA Standards 484, 654, and/or 68 for specific guidance.

Protective Clothing: Gloves and coveralls, shop coat or other work clothing are recommended to prevent prolonged or repeated direct skin contact when zinc is processed. Eye protection should be worn where fume or dust is generated. Respiratory protection may be required where zinc oxide fume is generated. Where hot or molten metal is handled, heat-resistant gloves, face shield, and clothing to protect from hot metal splash should be worn. Safety type boots are recommended.

Respirators: Where zinc oxide dust or fumes are generated and cannot be controlled to within acceptable levels, use appropriate NIOSH-approved respiratory protection equipment (a 42CFR84 Class N, R or P-95 particulate filter cartridge).

General Hygiene Considerations: Always practice good personal hygiene. Refrain from eating, drinking, or smoking in work areas. Thoroughly wash hands before eating, drinking, or smoking in appropriate designated areas. No special packaging materials are required.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:
Bluish-silver lustrous metal

Odour:
None

Odour Threshold:
None

pH:
Not Applicable

Vapour Pressure:
1 mm at 487°C
Negligible at 20°C

Vapour Density:
Not Applicable

Melting Point/Range:
420° C

Boiling Point/Range:
908° C

Relative Density (Water = 1)**:**
7.1

Evaporation Rate:
Not Applicable

Coefficient of Water/Oil Distribution:
Log P (oct) = -0.47 (estimated)

Solubility:
Insoluble in Water
(0.2 mg/l @ pH 7)

Flash Point:
Not Applicable.

Flammable Limits (LEL/UEL):
LEL (Zinc Dust): 500 g/m^3;
UEL Not Determined.

Auto-ignition Temperature:
Approx 680°C (dust cloud in air),
Approx 460°C (dust layer).

Decomposition Temperature:
Oxidation starts approx 450°C

SECTION 10. STABILITY AND REACTIVITY

Stability & Reactivity: Massive metal is stable and not considered reactive under normal temperatures and pressures. Hazardous polymerization or runaway reactions will not occur. Zinc metal slowly becomes covered with a white coating of a hydrated basic zinc carbonate on exposure to moist air. Fine, condensed zinc dust or powder may heat spontaneously and ignite on exposure to air when damp. Zinc metal will react with acids and strong alkalis to generate hydrogen gas. A violent, explosive reaction may occur when powdered zinc is heated with sulphur. Powdered zinc will become incandescent or ignite in the presence of fluorine, chlorine, bromine or interhalogens (e.g., chlorine trifluoride). Powdered zinc can also react explosively with halogenated hydrocarbons if heated. Mixtures with potassium chlorate or fused ammonium nitrate may explode on impact.

Incompatibilities: Contact with acids and alkalis will generate highly flammable hydrogen gas. Contact with acidic solutions of arsenic and antimony compounds may evolve highly toxic ARSINE or STIBINE gas. Incompatible with strong oxidizing agents such as chlorine, fluorine, bromine, sodium, potassium or barium peroxide, sodium or potassium chlorate, chromium trioxide and fused ammonium nitrate. Also incompatible with elemental sulphur dust, halogenated hydrocarbons or chlorinated solvents, chlorinated rubber, and ammonium sulphide or calcium disulphide.

Hazardous Decomposition Products: High temperature operations such as oxy-acetylene cutting, electric arc welding or overheating a molten bath will generate zinc oxide fume which, on inhalation in sufficient quantity, can produce metal fume fever, a transient influenza-like illness.

SECTION 11. TOXICOLOGICAL INFORMATION

General: Zinc, especially in the metal form, is relatively non-toxic. However, it can react with other materials, such as oxygen or acids, to form compounds that can be potentially toxic. The primary route of exposure would be through the generation and inhalation of zinc oxide fume.

Acute:
Skin/Eye: In most cases, dermal exposure to zinc or zinc compounds does not result in any noticeable toxic effects. Zinc metal is not chemically irritating to the eyes.

Inhalation: If excessive quantities of zinc oxide fume are inhaled, it can result in the condition called metal fume fever. The symptoms of metal fume fever will occur within 3 to 10 hours, and include immediate dryness and irritation of the throat, tightness of the chest and coughing, which may later be followed by flu-like symptoms of fever, malaise, perspiration, frontal headache, muscle cramps, low back pain, occasionally blurred vision, nausea, and vomiting. The symptoms are temporary and generally disappear, without medical intervention, within 24 to 48 hours of onset. There are no recognized complications, after affects, or chronic affects that result from this condition.

Ingestion: Zinc is not expected to be harmful if ingested. When ingested in excessive quantities, zinc can irritate the stomach resulting in nausea, vomiting, abdominal pain and diarrhea. Ingestion is not a typical route of occupational exposure.

Chronic:
There is no chronic form of metal fume fever but in rare instances an acute incident may be followed by complaints such as bronchitis or pneumonia. Some workers may develop a short-term immunity (resistance) so that repeated exposure to zinc oxide fumes does not cause metal fume fever. This immunity (resistance) however is quickly lost after short absences from work (weekends or vacations). Workers exposed to finely-divided metallic zinc for up to 35 years revealed no acute or chronic illnesses

attributable to zinc. Prolonged or repeated skin contact with zinc dust or powder may cause dryness, irritation and cracking (dermatitis) since zinc is astringent and may tend to draw moisture from the skin. Zinc is not listed as a human carcinogen by the Occupational Safety and Health Administration (OSHA), the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), the American Conference of Governmental Industrial Hygienists (ACGIH) or the European Union (EU).

Animal Toxicity:

Ingredient:	Acute Oral Toxicity:	Acute Dermal Toxicity:	Acute Inhalation Toxicity:
Zinc	>5,000 mg/kg†	No data	No data

† LD_{50}, Mouse, Oral,

SECTION 12. ECOLOGICAL INFORMATION

Zinc metal is relatively insoluble; however, processing of the product or extended exposure in aquatic and terrestrial environments may lead to the release of zinc compounds in bioavailable forms. Zinc is highly mobile, and can be toxic in the aquatic environment with water hardness, pH and dissolved organic carbon content being major regulating factors. Zinc also has the potential to bioaccumulate in plants and animals in both aquatic and terrestrial environments. In soils, zinc is moderately mobile in accordance with soil properties (e.g., cation exchange capacity, pH, redox potential, chemical species); these properties also influence its bioavailability to terrestrial plants.

SECTION 13. DISPOSAL CONSIDERATIONS

If material cannot be returned to process or salvage, dispose of in accordance with applicable regulations.

SECTION 14. TRANSPORT INFORMATION

PROPER SHIPPING NAME .... Not applicable – not regulated.
U.S. DOT AND TRANSPORT CANADA HAZARD CLASSIFICATION .... Not applicable
U.S. DOT AND TRANSPORT CANADA PID .... Not applicable
MARINE POLLUTANT... No
IMO CLASSIFICATION .... Not regulated

SECTION 15. REGULATORY INFORMATION

U.S.
INGREDIENTS LISTED ON TSCA INVENTORY.................................... Yes

HAZARDOUS UNDER HAZARD COMMUNICATION STANDARD......... No

CERCLA SECTION 103 HAZARDOUS SUBSTANCES .... Zinc.......Yes.........RQ: 1,000 lb. (454 kg.)*
* reporting not required when diameter of the pieces of solid metal released is equal to or exceeds 100 micrometers (0.004 inches).

EPCRA SECTION 302 EXTREMELY HAZARDOUS SUBSTANCE........ No

EPCRA SECTION 311/312 HAZARD CATEGORIES .... No Hazard Categories Apply

EPCRA SECTION 313 TOXIC RELEASE INVENTORY:......................... This product does not contain any toxic chemicals subject to the Toxic Release reporting requirements. However, potential by-products from working with this product - "Zinc (Fume or Dust)" CAS 7440-66-6 are reportable.

SECTION 16. OTHER INFORMATION

Date of Original Issue:	July 23, 1997	**Version:**	01 *(First edition)*
Date of Latest Revision:	July 15, 2015	**Version:**	14

The information in this Safety Data Sheet is based on the following references:

- American Conference of Governmental Industrial Hygienists, 2004, Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition plus updates.

- American Conference of Governmental Industrial Hygienists, 2015, Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.
- American Conference of Governmental Industrial Hygienists, 2015, Guide to Occupational Exposure Values.
- Bretherick's Handbook of Reactive Chemical Hazards, 20th Anniversary Edition (P. G. Urben, Ed), 1995.
- Canadian Centre for Occupational Health and Safety (CCOHS) Hamilton, ON, CHEMINFO Record No. 239 – Zinc Metal.
- European Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures, amending and repealing directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 (REACH).
- Health Canada, SOR/2015-17, Hazardous Products Regulations, 30 January 2015.
- International Agency for Research on Cancer (IARC), Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, 1972 – present, (multi-volume work), World Health Organization, Geneva.
- Merck & Co., Inc., 2001, The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals, 13th Edition.
- National Library of Medicine, National Toxicology Information Program, Hazardous Substance Data Bank (on-line version).
- Oak Ridge National Laboratory, Oak Ridge, Tennessee – Toxicity Summary for Zinc and Zinc Compounds, April 1992.
- Patty's Toxicology, 5th Edition, 2001 E. Bingham, B. Cohrssen & CH Powell (Eds.).
- U.S. Dept. of Health and Human Services, National Institute of Environmental Health Sciences, National Toxicology Program (NTP), 13th Report on Carcinogens, October 2014.
- U.S. Dept. of Health and Human Services, National Institute for Occupational Safety and Health, NIOSH Pocket Guide to Chemical Hazards (on-line edition).
- U.S. Dept. of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Toxicological Profile for Zinc - August 2005.
- U.S. Dept. of Health and Human Services, National Institute for Occupational Safety and Health, Registry of Toxic Effects of Chemical Substances (RTECS), CCOHS on-line version.
- U.S. Occupational Safety and Health Administration, 1989, Code of Federal Regulations, Title 29, Part 1910.

Notice to Reader

Although reasonable precautions have been taken in the preparation of the data contained herein, it is offered solely for your information, consideration and investigation. Teck American Metal Sales Incorporated and Teck Metals Ltd. extend no warranty and assume no responsibility for the accuracy of the content and expressly disclaim all liability for reliance thereon. This safety data sheet provides guidelines for the safe handling and processing of this product; it does not and cannot advise on all possible situations. Therefore, your specific use of this product should be evaluated to determine if additional precautions are required. Individuals exposed to this product should read and understand this information and be provided pertinent training prior to working with this product.

Appendix B
Glove Selection Guideline

APPENDIX B: GLOVE SELECTION GUIDELINE

HAZARD	EXAMPLE TASKS	ANSI CUT/ABRASION RATING*	REPRESENTATIVE GLOVE
Medium Duty Cut/Puncture Gloves with Oily Surface Grip	Light materials handling, wet service	ANSI Cut and Abrasion Resistance **Level 3** **EN 388 44xx**	Ansell® Cut Protective Glove 97-505
Med/Heavy Duty Cut/Puncture	Light Materials Handling. System O&M. Use of Hand Tools. Hand Augering. Heavy Equipment Operator.	ANSI Cut and Abrasion Resistance **Level 2** **EN 388 33xx**	Ansell® Cut Protective Glove 97-505
Light Duty Cut/Puncture Abrasion Only (used chemically resistant under nitrile gloves)	Handling soil and Groundwater Samples. Opening spoons. Well construction.	ANSI Cut and Abrasion Resistance **Level 2 - 4** **EN 388 21xx**	Ansell® Cut Protective Glove 97-505
Chemicals (to be worn over ANSI gloves)	Handling soils, groundwater, sample jars	NA (worn over ANSI gloves)	Nitrile Chemical Resistant Gloves
* Reference to ANSI and EN 388 glove testing standards. Listed gloves meet the standards in the table, but are not the only gloves that meet the standard.			
This selection chart is not intended to address all chemical hazards. Gloves used for chemical protection shall provide cut/puncture resistance, or be used in tandem with cut/puncture protection. Nitrile gloves used for environmental sampling must be used in tandem with a cut/puncture resistant glove.			
Gloves available in high visibility colors have shown to be effective and are preferred.			

Appendix C
Heat & Cold Stress

COLD STRESS

Ambient air temperatures during site activities may create cold stress for on-site workers. Procedures for recognizing and avoiding cold stress must be followed. Cold stress can range from frostbite to hypothermia. The signs and symptoms of cold stress are listed below.

Frostbite is defined as the actual freezing of one or more layers of skin. In severe cases, organs and structures below the skin can become frozen. Usually, body areas exposed to the most cold, and least body warmth, are affected first. These areas include fingers, toes, ears, and the tip of your nose. Frostbite is characterized by pain and loss of dexterity in the affected limb. The tissue initially appears reddened, but may progress to white, blue, or black.

> **FIRST AID:** Bring the affected employee indoors and call the local emergency clinic. Rewarming of frostbitten parts is best left to a medical doctor in a controlled setting.

Hypothermia is the condition that occurs when the body's natural warming mechanisms (muscle activity and shivering) cannot counteract the loss of body heat to the environment. The onset of hypothermia is greatly hastened by being wet. Hypothermia is marked by severe, uncontrollable shivering. The patient will show signs of excessive fatigue, drowsiness, irritability, or euphoria. As hypothermia progresses, the patient will begin to lose consciousness, blood pressure will drop, shivering will cease, and the patient may slip into a coma and possibly die.

> **FIRST AID:** If these symptoms occur, remove the patient to a warm, dry place. If clothing is wet, remove and replace with dry clothing. Keep the patient warm, but not overheated. The patient should be gradually rewarmed to prevent shock. If the patient is conscious and alert, warm liquids should be provided. Coffee and other caffeinated liquids should be avoided because of diuretic and circulatory effects. Notify the emergency clinic if conditions worsen, the patient loses consciousness, or the patient has an altered mental status. Have the patient transported to an emergency facility.

General Precautions. The reduction of adverse health effects from cold exposure can be achieved by adopting the following work practices.

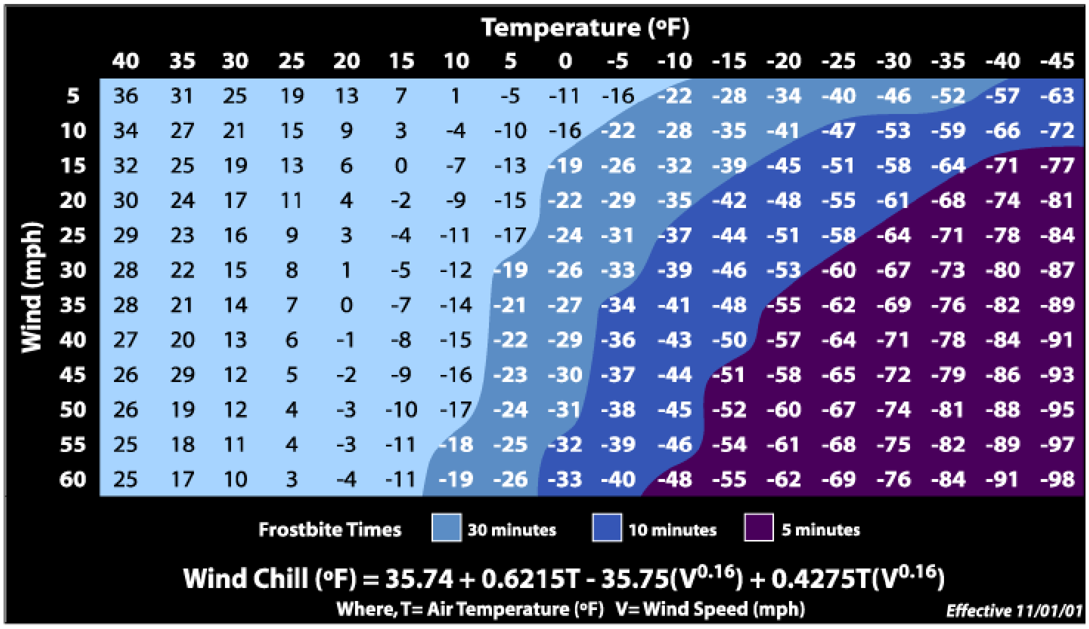
- Provide adequate insulating clothing to maintain core temperature at 98.6° F if work is to be performed in air temperatures below 40° F. Wind chill cooling rates and the cooling power of air are critical factors. The higher the wind speed and the lower the air temperature in the work area, the greater the insulation value of the protective clothing should be.
- If the air temperature is 32° F or less, hands should be protected by mittens/gloves.
- If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of clothing should be impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outer layer should be changed as it becomes wet. The outer garments should include provisions for easy ventilation in order to prevent wetting of the inner layer by sweat.
- If available clothing does not give adequate protection to prevent cold injury, work should be modified or suspended until adequate clothing is available, or until weather conditions improve.
- For prolonged work, heated shelters should be available. Workers should be encouraged to use these at regular intervals, with the frequency depending on the severity of the environmental exposure. When entering the shelter, the outer layer of clothing should be removed and the remainder of the clothing

loosened to permit heat evaporation, or a change of work clothing should be provided.

- Warm, sweet drinks, such as hot cocoa or soup, should be available at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of diuretic and circulatory effects.
- The weight and bulk of cold-weather gear should be included in estimating the required work performance and weights to be lifted in the field.

Workers should be instructed in safety and health procedures regarding cold work environments as part of the pre-work safety meeting. The training program should include instruction in preventing, recognizing, and treating cold stress conditions.

Wind Chill Chart



Temperature (°F)

Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	29	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times ▨ 30 minutes ▨ 10 minutes ■ 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

HEAT STRESS

There is a potential for heat stress from the use of protective clothing and climate conditions. One or more of the following procedures may be employed to alleviate potential heat stress problems in the event that site conditions warrant the use of personal protective equipment (PPE), or ambient temperatures exceed 85° F. Heat stress training must be emphasized during the daily safety meetings, and adequate supplies of potable water must be provided to workers each day.

General Precautions. Provide plenty of liquids. To replace body fluids (water and electrolytes) lost because of sweating, use a 0.1 percent saltwater solution, more heavily salted foods, or commercial drink mixes. The commercial mixes may be preferable for those employees on a low sodium diet. Employees on low sodium diets, or other special diets, are advised to contact their personal physician for recommendations regarding appropriate electrolyte replacement fluids/beverages.

In extremely hot weather, conduct operations in early morning or evening and rotate shifts of workers wearing impervious clothing. Install mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.

Ensure that adequate shelter is available for breaks to protect personnel against heat, which can decrease physical efficiency and increase the probability of accidents.

Acclimatization for workers not accustomed to working in elevated temperature environments will be considered and implemented as appropriate in accordance with American Conference of Governmental and Industrial Hygienists (ACGIH) Guidelines.

Heat Stress Monitoring.

For monitoring the body's recuperative ability toward excess heat, one or more of the following techniques should be used as a screening mechanism. Monitoring of personnel wearing impervious clothing should commence when the ambient temperature is 70° F or above. Frequency of monitoring should increase as the ambient temperature increases or as slow recovery rates are indicated. When temperatures exceed 80° F, regardless of the use of Personal Protective Equipment (PPE), workers will be monitored for heat stress after every work period.

Good hygienic standards must be maintained by the employee to aid in the prevention of heat stress illnesses. At a minimum, frequent changes of clothing and daily showering should occur with clothing being allowed to dry during rest periods. Persons who notice skin problems should immediately inform their supervisor.

Heart rate (HR) should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute. If the HR is higher, the next work period should be shortened by 25 percent. The HR is then measured again, once each minute for 2 minutes (a total of three measurements), after the initial rest period measurement. The HR should decrease by ten beats per minute between each measurement (a total reduction of 20 beats). If the HR does not decrease, the work period should be reduced by an additional 25 percent.

Body temperature can be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature (OT) at the beginning of the rest period should not exceed 99°F. If it is greater than 99°F, the next work period should be shortened by 25 percent. The OT should be measured again at the end of the rest period to make sure that it has dropped below 99° F.

Effects of Heat Street

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat loading, a number of physical reactions can occur. The severity of these reactions ranges from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to severe (fatal).

Heat-related illnesses include:

Heat rash (also known as prickly heat rash) is caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Heat rash decreases the ability to tolerate heat as well as being a nuisance. Signs are not limited to, but may include, a red prickly rash.

Appendix D
Job Safety Analysis (JSA)

Job Safety Analysis

COMPANY/ PROJECT NAME or ID/ LOCATION (City, State) **TRC**	DATE PREPARED FOR HASP: 6/20.2024	☐ NEW ☒ REVISED
JSA WORK ACTIVITY (Description): Groundwater Sampling and Gauging	List of Contractor(s) and key work activity: N/A	

SITE SPECIFIC JSA AUTHOR	**POSITION / TITLE**	**DEPT**	**SIGNATURE**
Emily Kessler	Deputy Project Manager	ECR	

TRC HEALTH AND SAFETY MANAGEMENT	**POSITION / TITLE**	**APPROVAL DATE**

PERSONAL PROTECTION EQUIPMENT (PPE) QUICK SUMMARY
Required PPE (indicate with "R") vs. Must Have Available On-site (indicate "A")

__R_REFLECTIVE VEST __R__HARD HAT __R_GLOVES: ANSI Cut Level ____ Kevlar __R_SAFETY GLASSES _____GOGGLES _____FACE SHIELD	____ HEARING PROTECTION _R_SAFETY SHOES: Protective Toe _____ 5pt.HARNESS / LANYARD PPE CLOTHING: _____Coveralls ____Tyvek Suit _____Nomex ____Other (specify):	RESPIRATORY PROTECTION: ☐ NA _____½ face Air Purifying Respirator (APR) ____Particulate Mask: ☐ PM100 ☐ PM95 _____Cartridge: ☐ P100-Multigas ☐ ______________ ______Full face ARP; specify cartridge type: _____ Air Supplied Respirator ____SCBA ____Air-line	Additional PPE: .

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

¹ JOB TASKS	² POTENTIAL HAZARDS	³ HAZARD CONTROLS (beyond wearing "Required" PPE)
1) Groundwater Measurements	a. Lack of concentration and unfamiliarity with site	a. Review all plans and logs in field notebook prior to starting a new task. a. Follow cell phone use procedures when working.
	b. Moving vehicles.	b. Always face traffic or moving equipment when working (establish eye contact with drivers). b. Follow work area exclusion Zone Procedures Use "buddy system" when unable to observe traffic of moving equipment (> 50 lbs).
	c. Pinched fingers or toes; and strained muscles.	c. Wear leather gloves when opening barrels & well lids, lifting sharp or heavy equipment. Use proper tools for opening and closing purge water storage barrels. c. Lift heavy objects utilizing leg muscles rather than depending entirely on your back. Get assistance when equipment exceeds 50-lbs.
	d. Lost equipment and damage to well from foreign objects.	d. Fasten equipment raising and lowering ropes or cables to object larger than well diameter. Carry no loose pens or tools in pockets, place well lid fasteners away from well opening.
	e. Fire/Explosions	e. No Smoking or Open Flames while on site. Request anyone smoking to please extinguish cigarettes. Identify location(s) of all emergency shut-off devices.
	f. Electrocution	f. Perform all necessary equipment and safety checks prior to event startup (per operating manual). Check sounding and measurement equipment for shorts, frayed wires, or loose connections.
	g. Contamination	g. Wear nitrile or latex gloves with handling water or soil. Wear Safety glasses with splash guards when handling groundwater. g. Always cap open wells and replace surface covers when finished. Don't leave any open well unattended.
	h. Slip/trips and falls	h. Maintain good house keeping - place unused equipment out walkways and work areas. Clean-up all spills. h. Use portable steps to mount and dismount sampling vehicle. Place equipment and tools down on truck bed before mounting and dismounting sampling vehicle.
	i. Noise	i. Use hearing protection when working with operating equipment (>75db).
	j. Visitors/spectators	

j. Control entry in work area using exclusions zones and check-in log in field notebook.

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.		
[1] JOB TASKS	**[2] POTENTIAL HAZARDS**	**[3] HAZARD CONTROLS (beyond wearing "Required" PPE)**
2) Sample Storage and Well Closure	a. Damage to Samples b. Well Damage	a. Use procedures outlined in TRC's Groundwater Monitoring and Sampling Procedures. b. Cap and lock sampled well, then securely fasten drive-over cover before moving onto next well to be sampled.
3)		

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3)		
[1] JOB TASKS	**[2] POTENTIAL HAZARDS**	**[3] HAZARD CONTROLS (beyond wearing “Required” PPE)**
4)		
	LOCATION(S) WHERE HAZARD IS TO BE EXPECTED	**[3] HAZARD CONTROLS (beyond wearing “Required” PPE)**
1.	a.	a.
2.	a.	a.
3.	a.	a.

Field Notes:

____

____

LIMITATION: As part of TRC’s HSMS, a JSA is provided by TRC for its employees. The purpose of a JSA is NOT to identify all hazards associated with a task, but to identify key potential hazards to get TRC and other onsite personnel thinking about other potential safety hazards and mitigating actions for unsafe conditions and behavior during various works. TRC recognizes that JSA’s may not cover every conceivable step or hazard that emerges during a job, so we’ve provided a “Field Change” section below to amend a JSA if required. The JSA does not supersede or replace any local, state or federal permit, regulation, statute or other entities policies and procedures but is simply a tool for enhancing the execution of safe work at a jobsite under TRC’s supervision. Similarly, all subcontractors are required to provide their own JSA(s) for their specialty prior to performing any work for TRC or its customers in accordance with TRC’s HSMS; however, any unsafe condition or hazard not covered in any JSA is ultimately the direct responsibility of the person or entity performing the work.

Soil Sampling/Well Installation Job Safety Analysis

COMPANY/ PROJECT NAME or ID/ LOCATION (City, State) **TRC**	DATE PREPARED FOR HASP: 6/20/2024	☐ NEW ☒ REVISED
JSA WORK ACTIVITY (Description): **Soil Borings/Well Installation**	List of Contractor(s) and key work activity: **Land, Air, Water Environmental Services (LAWES)**	

SITE SPECIFIC JSA AUTHOR	POSITION / TITLE	DEPT	SIGNATURE
Elise He	**Deputy Project Manager**	**ECR**	

TRC HEALTH AND SAFETY MANAGEMENT	POSITION / TITLE	APPROVAL DATE

PERSONAL PROTECTION EQUIPMENT (PPE) QUICK SUMMARY

Required PPE (indicate with "R") vs. Must Have Available On-site (indicate "A")

__R__ REFLECTIVE VEST __R__HARD HAT __R__GLOVES: **ANSI Cut Level 4 & 5 Kevlar** __R__SAFETY GLASSES _____GOGGLES _____FACE SHIELD	__R__ HEARING PROTECTION __R__SAFETY SHOES: Protective Toe _____ 5pt.HARNESS / LANYARD PPE CLOTHING: ____Coveralls ____Tyvek Suit ____Nomex ____Other (specify):	RESPIRATORY PROTECTION: ☒ NA ____½ face Air Purifying Respirator (APR) ___ Cartridge: ☐ P100 ☐ Multigas_ _____Full face ARP; specify cartridge type: _____ Air Supplied Respirator ____SCBA _____Air-line	Additional PPE/Notes: As per defined in the job/site specific Health and Safety Plan (HASP) wear PPE at all times when performing site work.

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

[1] JOB TASKS	[2] POTENTIAL HAZARDS	[3] HAZARD CONTROLS (beyond wearing "Required" PPE)
1) Set-up	a. Lack of concentration or focus.	a1. Review all plans (HASP, Work, Utility, Site Plans, etc.), logs, and field notes prior to starting a new task. Identify daily tasks and required personnel actions. a2. Conduct safety tailgate meeting with subcontractor personnel prior to beginning work activities. Explain the site safety hazards and work precautions outlined in the HASP and obtain signatures indicating the HASP was discussed.
	b. Fire and explosion.	b1. No smoking or open flame. Periodically monitor ambient air concentrations with PID/LEL Meters. Shut down job and move personnel and equipment upwind if hydrocarbon concentrations are HASP defined action levels. b2. Deploy 2-20lb ABC Fire extinguishers in accordance site safety officer's direction.
	c. Electric shock/ electrocution.	c1. Have a qualified electrician cut all power connections to the site and remove main breaker from power panel. c2. De-energize all circuits/power sources and follow TRC's Lock-Out, Tag-Out (LOTO) procedures for circuits within 3-feet of boring location or 10-feet' of overhead utilities.

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

[1] JOB TASKS	[2] POTENTIAL HAZARDS	[3] HAZARD CONTROLS (beyond wearing "Required" PPE)
1) Cont'd	d. Malfunctioning heavy equipment safety devices.	d1. Inspect drill rig to determine if in good condition. Perform all equipment and safety checks prior to event startup (per operating manual).
	e. Being struck by moving vehicles or equipment onsite.	e1. Always wear safety vest, establish eye contact with operators utilizing flag men wear appropriate. e2. Vehicles shall use reverse beepers or flagmen. e3. Create an exclusion zone at least 10-feet beyond the limits of the boring to limit access to staging/work area using snow fencing, barricades, delineators, cones and/or caution tape. e4. Face the direction of oncoming traffic during work activities when possible.
	f. Bad organization creating confusion and hazard.	f1. Identify staging area with good lateral and vertical access for loading and unloading of trucks.
	g. Unauthorized personnel in exclusion zone.	g1. Use visitor check-in log and allow no-one in exclusion area without proper PPE (as defined on this JSA) and training documentation (e.g., HAZWOPER, other as defined in the HASP).
2) Drilling	a. Contact with subsurface water, gas, electrical, and/or fiber optic lines in the vicinity of drilling locations.	a1. If unknown lines or obstructions are encountered, stop drilling and notify PM. Do not undermine any utilities.
	b. Broken rod.	b1. Do not stand in close proximity of the rods being pushed into the ground. Stand off to the side and wear required PPE.
	c. Distracted driller.	c1. Always communicate with the driller before approaching the operating drill stem.
	d. Slips, trips, and falls.	d1. Spread absorbent to soak up any pools of water that accumulate during drilling. d2. Maintain a clean, unobstructed work area by good housekeeping and placing unused equipment away from work area.
	e. Soil cross contamination.	e1. Ensure downhole sampling equipment is cleaned between samples. e2. Create a clean sample collection area with removable poly sheeting/aluminum foil or other method ensure a clean work surface that is refreshed between each sample.
	f. Cut/pinched fingers or toes; and strained muscles.	f1. See PPE Quick Summary. f2. Use proper lifting techniques and 2-man rule as outlined in TRC's Employee IIPP Handbook and "Back Safety: A User's Guide" training module" handbook, when moving heavy objects (>50 lbs).

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

[1] JOB TASKS	[2] POTENTIAL HAZARDS	[3] HAZARD CONTROLS (beyond wearing "Required" PPE)
2) Cont'd	g. Noise.	g1. All personnel will use hearing protection within work area while heavy machinery is operating at >85 dB.
	h. Flying particles, dust and hazardous substances from clearance activities.	h1. See PPE Quick Summary.
	i. Exposure to impacted soil or groundwater.	i1. Wear latex or nitrile gloves during handling of soil or ground water.
	j. Toxic or explosive atmosphere.	j1. Periodically monitor ambient atmosphere with PID or LEL meter. Shut down job and move personnel and equipment upwind if concentrations are detected above HASP defined action levels.
	k. Opening/handling core sleeves.	k1. Do not attempt to open retrieved core sleeves. Request the driller to open the plastic sleeves using ANSI cut level 5 Kevlar gloves. TRC personnel must have ANSI cut level 4 Kevlar gloves when handling/transporting open core sleeves.
	l. Inclement weather/ lightning.	l1. Monitor forecasted weather prior to and during drilling activities. Hault drilling activities if lightning is observed or anticipated and wait in personal/company vehicle until weather passes or until directed otherwise by the project manager.
	m. Heat illness.	m1. Refer to Activity Performed in Hot Illness Prevention JSA.
	n. Cold illness.	n1. Refer to Activity Performed in Cold Illness Prevention JSA.
3) Boring Completion	a. Bad organization causing cross-contamination of soil, groundwater, or personnel.	a1. Waste management—Identify and delineate soil stockpile area or storage area if soil cuttings/purge water are to be drummed. a2. Blot up puddles of standing water and the work area will be swept.
	b. Moving heavy objects (>50-lbs) and mixing grout/concrete.	b1. Get assistance for moving heavy objects and mixing grout/concrete. Use mechanical aids to move objects or mix grout/concrete.
	c. Opening/closing/ moving drums.	c1. Wear must wear ANSI cut rated 4 or 5 Kevlar gloves during the opening and closing of drums to protect fingers. c2. Use only drum dolly to move drums with soil, hydrated bentonite grout, or concrete or other heavy contents. c3. Empty metal drums could also cause strain or injury if not moved properly. Use caution and appropriate tools (e.g., dolly).

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

[1] JOB TASKS	[2] POTENTIAL HAZARDS	[3] HAZARD CONTROLS (beyond wearing "Required" PPE)
	d. Slips, trips, falls and physical injury during auger removal.	d1. Place all removed rods to side, so as not to become a trip hazard.

Always perform a Safety Assessment (Hazard Hunt): 1) prior to starting work; 2) when changing tasks; and 3) throughout the day. Focus on each new task, procedures, and skill sets to be used.

[1] JOB TASKS	[2] POTENTIAL HAZARDS	[3] HAZARD CONTROLS (beyond wearing "Required" PPE)
3) Cont'd	e. Overspray and cross-contamination during rod decontamination.	e1. See PPE Quick Summary. e2. Do not overspray while cleaning rods. Create a "clean zone" with plastic liner for placement of decontaminated rods.
	LOCATION(S) WHERE HAZARD IS TO BE EXPECTED	**[3] HAZARD CONTROLS (beyond wearing "Required" PPE)**
1.	a.	a.
2.	a.	a.
3.	a.	a.

PID—photoionization detector; LEL—lower explosive limit; PPE—Personal Protective Equipment; ANSI—American National Standards Institute

Field Notes:

____

____

LIMITATION: As part of TRC's EHS Policy, a JSA is provided by TRC for its employees. The purpose of a JSA is NOT to identify all hazards associated with a task, but to identify key potential hazards to get TRC and other onsite personnel thinking about other potential safety hazards and mitigating actions for unsafe conditions and behavior during various works. TRC recognizes that JSA's may not cover every conceivable step or hazard that emerges during a job, so we've provided a "Field Change" section below to amend a JSA if required. The JSA does not supersede or replace any local, state or federal permit, regulation, statute or other entities policies and procedures but is simply a tool for enhancing the execution of safe work at a jobsite under TRC's supervision. Similarly, all subcontractors are required to provide their own JSA(s) for their specialty prior to performing any work for TRC or its customers in accordance with TRC's EHS Policy; however, any unsafe condition or hazard not covered in any JSA is ultimately the direct responsibility of the person or entity performing the work.

Appendix E
Tailgate Meeting/Checklist

TRC

Daily Pre-Job Safety Briefing

Project Name: Mariners Marsh Park Phase I Site Characterization
Project Number: 554398.0000.0000
Work Location: Staten Island, New York
Date:
Tasks Performed: Groundwater sampling, soil sampling, sediment sampling
Time: AM PM
Client Name: Department of Parks & Recreation
Submitted By:

Health and Safety Plan Available Onsite: Yes ☒ No ☐
Health and Safety Plan Location:
Emergency Facility(s):
Number(s):
Physical Address:
First Aid/CPR Persons:

For Emergencies Dial 911/For Non-Emergencies Dial WorkCare (888) 449-7787

Personal Protective Equipment Required

	Yes	No	Type
Fall Protection	☐	☒	
body harness, lifelines, barricades, other (specify)			
Eye/Face	☒	☐	
goggles, face shield, hood, other (specify)			
Respirator	☐	☒	
SCBA, supplied air, HEPA, dust, other (specify)			
Foot Protection	☒	☐	
safety toe, EH rated, rubber boots, other (specify)			
Hand Protection	☒	☐	
leather, cut resistant, chemical, EH, other (specify)			
Head Protection	☒	☐	
hard hat, helmet, electrical hazard, other (specify)			
Clothing	☒	☐	
coveralls, welding, sleeves, rain, FR, reflective vest, chemical, other (specify)			
Hearing Protection	☒	☐	

Procedures/Programs Required	Yes	No
Hot Work	☐	☐
LOTO/Energy Control	☐	☐
Trenching/Excavation	☐	☐
Signs/Barricades	☐	☐
Confined Space	☐	☐
Cranes/Critical Lifts	☐	☐
Line Breaking/Hot Tap	☐	☐
Scaffolds/Aerial Lifts	☐	☐
System Testing/ Grounding	☐	☐
Employee Certification/Training Required		
Crane Operator	☐	☐
Forklift Operator	☐	☐
Mobile Equipment Operator	☐	☐
Competent Person	☐	☐
OSHA 10/30	☐	☐
HAZWOPER	☒	☐
Clearance/Tagging Authority	☐	☐

Additional Considerations

Work Procedures: ☐ Isolation of equipment
☐ Check for potential ☐ Adequate grounding
☐ Vehicle grounds ☐ Working clearances
☒ Dig Safe/CBYD ☒ E-911 Protocol
People: ☐ Worker fatigue ☐ Other work groups
☒ Public safety ☐ Pedestrian control ☐ Experience
☐ Traffic control ☐ Other utilities ☐ Spec. Training
Tools/Equipment: ☐ Adequate cover-up
☐ Live line tools ☐ Portable Grounds
☒ Inspection of tools/equipment
☐ Specialized tools/equipment
☒ Correct tool/equipment for the job
Special Precautions: ☐ Adjacent structures
☐ Condition of structures ☒ Weather conditions
☐ Lighting conditions ☐ Terrain ☐ Water bodies
☒ Spills and leaks ☒ Environmental ☐ Cultural
Other:

If Conditions CHANGE…Stop Work, Review and Revise the Plan!!

Daily Pre-Job Safety Briefing

Hazards Associated with the Job (focus on the GEMS)

Gravity	Electrical	Mechanical	Kinetic	Other/Environmental
☐ Falling from a height	☐ Electrical contact	☒ Equipment failure	☐ Traffic	☐ Asbestos/Lead
☒ Falling objects	☐ Induced voltage	☐ Conductor tension	☐ Driving conditions	☒ Animals/Insects
☐ Falling structures	☐ Back-feed	☐ Cable tension	☐ Moving/Shifting loads	☐ Confined space
☐ Climbing obstructions	☐ Flash potential	☐ Loaded springs	☒ Rotating machinery	☐ Excavations
☐ Dangerous trees	☐ Step/Touch potential	☒ Moving parts	☐ Vehicle stability	☒ Heat/Cold
☐ Aerial device operation	☐ Static charge	☐ Crane/Rigging	☒ Heavy equip. operation	☒ Pressurized fluids/gases

List all hazards associated with this task

Barriers to eliminate/control above hazards?

Supervisor Signature

Signature of Crew Members Present

Post Task Safety Analysis

Did any injuries or incidents occur today? If yes, explain.

☐ Yes ☐ No

Was the injury or incident reported the safety department?

☐ Yes ☐ No ☐ N/A

What problems did you have with today’s work assignment?

What can we do tomorrow to improve performance?

Appendix F
WorkCare Program Information

Appendix G
Incident Reporting

TRC Incident Reporting Guidelines

Incident Response:

1. For life threatening injuries and medical emergencies call 911 or go to the closest emergency room.
2. An injured worker must report an injury to their supervisor immediately.
3. Supervisor is required to complete The TRC Incident Report Form within 24 hours of the reported accident and forward to Bill Russell at Sargent & Associates with a copy to Mike Glenn.

   Bill Russell – Sargent &Associates
   Office: (978) 256-7459; Fax: (978) 256-4941
   bill@sargentandassociates.com

   Mike Glenn, National Safety Director
   Office: (949) 727-7347; Mobile: (949) 697-7418
   mglenn@trcsolutions.com

4. WorkCare can provide assistance in providing first aid advice and directing an injured worker to non-emergency medical care. WorkCare is a service that provides 24/7 access to an Occupational Healthcare physician or clinician.

   WorkCare Incident Intervention
   (888) 449-7787

Return to Work:

1. The injured worker is responsible for providing the Supervisor with a copy of the doctor’s note detailing the injury and “return to work” status within 24 hours of the doctor’s visit. The supervisor must email or fax the completed TRC Incident Report and Doctor’s notes to Sargent & Associates.
2. Sargent & Associates will contact the injured worker and the Supervisor to confirm the facts surrounding the injury.
3. Sargent & Associates will report the injury to the workers’ compensation insurance carrier, Zurich.

4. Zurich may contact the injured worker and supervisor to conduct an accident investigation.
5. Sargent & Associates will maintain communication with all parties in order to monitor the medical treatment, and the injured worker's return to work status. They will act as liaison between the injured worker, TRC, and Zurich.
6. Sargent & Associates will work with TRC's Health & Safety, Human Resources, and/or Supervisors to determine if modified duty work is an option, until the injured worker is able to return to full duty work activities.

Incident Investigation:

1. All incidents that result in injuries that require reporting for OSHA recordkeeping purposes and all high potential first aid and near miss events require an incident investigation.
2. The Supervisor with assistance from the National Safety Director and/or Safety Coordinator, must complete the incident investigation report/contributing cause analysis within 7 days of the incident and must develop a corrective action plan within 14 days of the incident.

TRC Incident Report Form

(To be completed immediately after an Injury, Illness, Incident, Accident or Significant Near Miss by Employee's Supervisor and Employee involved)

Incident Category

☐ Employee Injury/Illness ☐ Near Miss/Loss ☐ Property Damage ☐ Vehicle Accident ☐ Fire ☐ Other: Specify

1	Incident Location:	
2	Site Identification/Project No.:	
3	Site Address:	
4	Date Incident Occurred:	
5	Time Incident Occurred:	
6	Date Incident Reported to Supervisor:	
7	Date Report Completed:	
8	Was WorkCare Contacted? ☐ Yes ☐ No	
9	Client:	

TRC Employee Information

10	Name:		
11	Address:		
12	Employee Phone:		
13	Title or Occupation:		
14	Sector/Practice:		
15	Supervisor Name/Phone:		

TRC Employee Information (to be completed by Worker's Compensation Claims Administrator)

16	Employee Date of Birth:		
17	Employee Social Security Number:		
18	Employee Marital Status:	☐ Married	☐ Single
19	Number of Dependant under the age of 18:		
20	Date of Hire:		
21	Rate of Pay:		Hours per week:

Type of Employee Injury or Illness (To be determined by Safety Director)

22	☐ First Aid Only	20	☐ Extended Time Away From Work (3 days or more)
23	☐ Medical Treatment Only	21	☐ Fatality
24	☐ Restricted Work-case	22	☐ Other (specify):
25	☐ Lost Workday		
26	Estimated Number of Days on Restricted Work:		
27	Estimated Number of Days Away from Work:		

Employee Injury or Illness Description

28	Describe the Injury or Illness:
29	First Aid/Medical Treatment Administered:
30	Name of Doctor's Office, Clinic, or Hospital: Concentra
31	Address and Phone Number:

Incident Description

32	Equipment Involved:
33	Site Description:
34	What task was being performed at time of incident?
35	Describe Incident in Detail :
36	Conditions at time of Incident: (weather, lighting, etc.):
37	Motor Vehicle Accident:
38	TRC Vehicle ID:

39	Year/Make/Model:	

☐ DOT Regulated Vehicle ☐ Towed From Scene ☐ Airbag Deployed ☐ Seatbelt in Use ☐ TRC Fleet ☐ Rental ☐ Personal Vehicle

40	Other Vehicle License Plate	
41	Other Vehicle Year/Make/Model	
42	Other Vehicle Driver Name	
43	Other Vehicle Year/Make/Model	
44	Other Injured Parties ☐ Yes ☐ No	
43	Description of other injuries:	

Subcontractor Involvement / Description of Incident

44	Subcontractor Involved: ☐ Yes ☐ No
45	Name of Company:
46	Address:
47	Contact Name and Phone Number:
48	Subcontractor Description of Incident:

Witness Involvement / Description of Incident

49	Witnesses to Incident: ☐ Yes ☐ No
50	Name(s) and Address(s):
51	Phone Number(s):
52	Witness Description of Incident:

Personal Protective Equipment (PPE)

53	List PPE required to complete the task: (glasses, gloves, shoes, hard hat, respirator, hearing protection, etc.)
54	Was the employee using the proper PPE at the time of the Incident?

Immediate Corrective Actions

55	Describe the immediate corrective actions taken:		
56	Immediate Supervisor:	Signature:	Date:
57	Employee:	Signature:	Date:

Supervisor's Post-Incident Review and Recommendations

Safety Violation ☐ Yes ☐ No

58 State the company safety rule, OSHA regulation, or specific training that was violated:

59 Describe the training the employee received to prevent this violation:

#	Root Cause Factors (RCF)
1	Lack of skill or knowledge
2	In the past, did not follow procedures or acceptable practices and no incident occurred (injury, product quality incident, equipment damage, regulatory assessment or production delay)
3	Doing the job according to procedures or acceptable practices takes more time/effort
4	Short-cutting procedures or acceptable practices are positively reinforced or tolerated
5	Lack of or inadequate operational procedures
6	Inadequate communication of expectations regarding procedures or acceptable practices
7	Inadequate tools or equipment (available, operable and safely maintained, proper task and workplace design)
8	External factors

60	Root Cause(s)	Identified Root Cause(s):							
		#1	#2	#3	#4	#5	#6	#7	#8
A		☐	☐	☐	☐	☐	☐	☐	☐
B		☐	☐	☐	☐	☐	☐	☐	☐
C		☐	☐	☐	☐	☐	☐	☐	☐
D		☐	☐	☐	☐	☐	☐	☐	☐
E		☐	☐	☐	☐	☐	☐	☐	☐
F		☐	☐	☐	☐	☐	☐	☐	☐
G		☐	☐	☐	☐	☐	☐	☐	☐
H		☐	☐	☐	☐	☐	☐	☐	☐

61 **Conclusion: Why did the Incident Occur?**

62	Item No.	RCF No.	Recommended Corrective Action(s) How to Prevent Incident from Reoccurring	Responsible Person	Due Date	Completed (date)	Verified/ Validated (date)

Supervisor: ____________________________ Signature: _______________________________ Date: __________

TRC Safety Director: ________________________ Signature: _______________________________ Date:__________

Results you can rely on

AUTO INCIDENT REPORT

TRC DRIVER INFORMATION:

Driver's Name: Driver's Phone: ( )

Company Name: Company Location:

Supervisor's Name: Supervisors Phone: ( )

Project Name: Client Name:

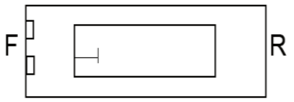
Driver's Date of Birth (MM/DD/YY): Driver's License #: State:

TRC VEHICLE INFORMATION (V-1):

Year/Make/Model of Vehicle:

License Plate #: Vehicle ID # (VIN):

Circle Point of Contact:



Was Vehicle Drivable? ☐ Yes ☐ No
Personal: ☐ Yes Rental: ☐ Yes Fleet: ☐ Yes
Rental Company

INCIDENT INFORMATION:

Date of Incident: Time of Incident: A.M. P.M. Photos Taken: ☐ Yes ☐ No

Location of Incident: City:

Were The Authorities Contacted? Police: ☐ Yes ☐ No Ambulance: ☐ Yes ☐ No Fire: ☐ Yes ☐ No

Name of Police Dept: Case #: Officer Name:

Were Citations Issued? ☐ Yes ☐ No If Yes, To Whom?

Citation Number:

Were There Any Witnesses? ☐ Yes ☐ No If Yes, Please Provide Name, Address and Phone Below:

Witness Name: Witness Phone: ( )

Witness Address:

Traffic Conditions (i.e., heavy, light): Weather Conditions (i.e., dry, wet, ice, fog):

Was the TRC Driver Injured? ☐ Yes ☐ No Was Medical Treatment Received? ☐ Yes ☐ No

Describe Injuries:

Describe Damage to Property Other Than Motor Vehicles (i.e., guardrails, mailboxes, etc.):

AUTO INCIDENT REPORT

OTHER DRIVER & VEHICLE INFORMATION (V-2):

Driver's Name: ______________________ Driver's Phone: (   ) ______________

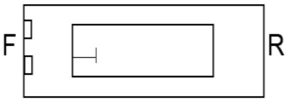
Driver's Address: ____

Owner's Name (If different than driver): ______________ Owner's Phone: (   ) ______________

Owner's Address: ____

Year/Make/Model of Vehicle: ______________ License Plate #: __________ State: ______

Circle Point of Contact:



Was Vehicle Drivable? ☐ Yes ☐ No

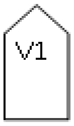
Insurance Company Name: ______________________ Policy Number: ______________________

Insurance Company Phone: (   ) ______________ Number of Passengers in Vehicle: __________

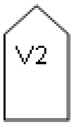
List Persons Injured: ____

Were Any Other Vehicles Involved in Incident? ☐ Yes ☐ No If yes, provide details below:

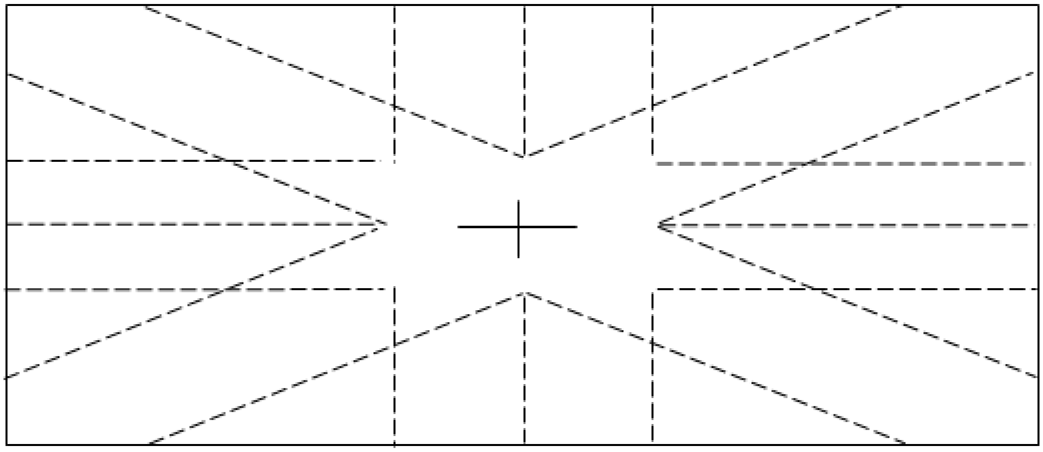
PLEASE DESCRIBE THE INCIDENT AND COMPLETE THE DIAGRAM BELOW. Be sure to indicate as many details as possible (i.e., How many lanes in each direction; Were there any turn lanes; What kind of traffic controls were there – light, stop sign, yield sign, Positions of vehicles on impact).

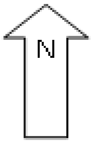


V-1 TRC Vehicle



V-2 Other Vehicle





Completed By: ______________________ Signature: ______________________

Appendix H
Safe Catch Report

TRC

“Safe Catch” Report

A “Safe Catch” is a potential hazard or incident that has not resulted in any personal injury. Unsafe working conditions, unsafe employee behaviors, 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 incidents immediately. Please complete this form as a means to report these “Good Catch” situations and submit to your local OSC Representative and Mike Glenn, National Safety Director.

Employee Name:		Date:	
Incident Location:		Office:	
Project:		Practice:	

Conditions

Please check all appropriate conditions:

☐ Unsafe Act ☐ Unsafe Condition ☐ Unsafe Equipment ☐ Unsafe Use of Equipment

Description of Incident or Potential Hazard:

Task Performed at Time of Incident:

Causes (Primary and Contributing):

Corrective Action(s) Taken (remove the hazard, replace, repair, or retrain):

Employee Signature:		Date Completed:	

Our Mission: To reduce the frequency of incidents by applying local lessons learned globally.

If you have any questions about this report or would like additional information, please reference Compliance Program CP019—TRC Incident Response and Lessons Learned Program, located on TRCNET or contact Mike Glenn, National Safety Director at mglenn@trcsolutions.com.

Appendix I
Acknowledgement

PERSONAL ACKNOWLEDGEMENT

A component of the Health and Safety Plan (HASP), designed to provide personnel safety during this subsurface investigation requires that you receive training as described in the HASP prior to working at this site. Additionally, you are required to read and understand the HASP. When you have fulfilled these requirements, please sign and date this personal acknowledgement:

Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date
Name (Printed)	Signature	Date

APPENDIX E

Key Personnel Qualifications

Lindsay A. O’Hara, CHMM
Office Practice Leader

Areas of Expertise:

- *Project Management*
- *Environmental Site Assessments, Investigations and Audits*
- *Soil and Groundwater Investigation and Remediation*
- *Indoor Air Quality Assessments*
- *Feasibility Studies*
- *Ambient and Community Air Monitoring*
- *Remedial Activity Oversight and Management*
- *Hazardous Materials Building Inspections*
- *Regulatory Compliance*
- *Quality Assurance/Quality Control*

Lindsay A. O’Hara, CHMM possesses 17 years of environmental consulting experience, primarily in connection with projects in New York City. Ms. O’Hara’s experience includes project management, comprehensive due diligence investigations and assessments (Phase I and Phase II ESAs), soil investigations and remediation, hazardous materials building assessments, remediation oversight, light non-aqueous phase liquid (LNAPL) remediation systems installation oversight, groundwater monitoring well sampling, product gauging and LNAPL extraction, monitoring well installation oversight, preparation of feasibility studies, implementation of community air monitoring plans (CAMP), and fuel release investigations. Additionally, Ms. O’Hara is experienced in the use of EarthSoft EQuIS^{TM} Data Gathering Engine (EDGE) software for field data collection purposes for various types of assignments, including waste characterization sampling, site Investigations; remedial investigations; and implementation of remedial action work plans.

CREDENTIALS

Education:

- B.A., Environmental Studies (Environmental Science Track), Union College, 2007

Professional Certifications/Training:

- Certified Hazardous Materials Manager, February 2015
- OSHA 40-Hour HAZWOPER Training and 8-hour Refresher
- OSHA 10-Hour Construction Safety Training
- First Aid/CPR

REPRESENTATIVE EXPERIENCE

The City of New York Department of Parks and Recreation – New York City
Ms. O’Hara serves as a Senior Project/Program Manager providing consulting services in connection with the construction and reconstruction of park facilities in New York City. Specifically, Ms. O’Hara serves as Project Manager for the Former Bayside Fuel Oil Depot Site in Williamsburg, Brooklyn, New York, which will be developed as part of Bushwick Inlet Park. Responsibilities include consulting services related to closure of the Major Oil Storage Facility (MOSF) license including preparation of a Site Investigation Plan, consulting services in support of closure of the State Pollution Discharge Elimination System (SPDES) permit, closure of the oil/water separator system on-Site and management for review of contract drawings and specifications for demolition activities. Responsibilities include all aspects of scope of work and cost estimate preparation, client consultation, staff supervision, subcontractor supervision and work plan preparation and report writing including development of conclusions and recommendations.

The Port Authority of New York and New Jersey - Howland Hook Marine Terminal – Port Ivory Facility – Staten Island, New York
Ms. O’Hara serves as Program Manager for environmental tasks associated with three former Voluntary Cleanup Program (VCP) Sites at the Howland Hook Marine Terminal (HHMT) – Port Ivory Facility (VCP Site No. V00615-2 (Site 1), VCP Site No. V00674-2 (Site 2) and VCP Site No. V00675-2 (Site 3). Ms. O’Hara assumed responsibilities in connection with budget and schedule management and preparation of several reports for this project, including the final Site Management Plans for Sites 1 and 2, the Final Engineering Reports for Sites 1 and 2, the Periodic Review Reports for Sites 1 and 2, Landfill Monitoring Summary Reports, and monthly progress reports. Additionally, in support of termination of the VCP for Site 3, Ms. O’Hara provided a presentation to the NYSDEC at the Region 2 offices which included a summary of the site history and proposed future actions. Ms. O’Hara managed the performance of an Engineering Evaluation at Site 3, which included a geotechnical investigation and overall evaluation to determine if the proposed post-closure use would negatively affect the integrity of the landfill.

New York City School Construction Authority (NYCSCA)
TRC served a critical role supporting NYCSCA's efforts to evaluate water quality in approximately 1,600 New York City public schools. In 2016, over 100 schools were successfully sampled by TRC during a five-week period, and over 8,000 samples were collected by TRC. Throughout this project, Ms. O'Hara served as the Quality Assurance/Quality Control Manager and reviewed laboratory analytical data reports, tabulated results and summary emails prior to submission to the NYCSCA. Ms. O'Hara worked directly with the Project Manager and Field Team Manager to ensure summary reports were prepared immediately following receipt of laboratory data to ensure all reporting deadlines were met and high-quality deliverables were provided to NYCSCA. During this program TRC sampled over approximately 12,000 potable water fixtures in nearly 200 schools located throughout the five (5) NYC boroughs.

Additionally, Ms. O'Hara serves as a Program Manager for environmental due diligence assignments in support of new construction and renovations of New York City public schools. Responsibilities include Phase I Environmental Site Assessments, Phase II Environmental Site Investigations, Indoor Air Quality Investigations, and Outdoor Air Assessments. Ms. O'Hara's responsibilities have included all aspects of preparation of reports and all elements of management of field investigations and subcontractor supervision associated with completion of due diligence assessments. Additionally, Ms. O'Hara served as the TRC lead for the Universal Pre-Kindergarten due diligence investigations in the Borough of Queens and the Universal 3K due diligence investigations in Brooklyn.

Ms. O'Hara serves as Project Manager for tasks relating to investigation and remediation of a Brownfield Cleanup Program (BCP) site in Brooklyn, New York. Prior to preparation of the BCP Application, Ms. O'Hara managed the implementation of an Interim Remedial Measure consisting of excavation of over 350 tons of contaminated soil for off-Site disposal, post-excavation soil sampling and backfilling of the excavation with clean fill material. Ms. O'Hara attended the pre-application meeting at the NYSDEC Region 2 office, prepared the BCP Application and RI Work Plan for the site for submission to the NYSDEC.

Following acceptance of the Site into the BCP, Ms. O'Hara prepared the Citizen Participation Plan and managed the implementation of the Remedial Investigation (RI) which consisted of advancement of soil borings, installation and development of monitoring wells, installation of soil vapor points and collection and laboratory analysis of soil, groundwater and soil vapor samples, performance of a Site survey and preparation of an RI Report. Following NYSDEC approval of the RI Report, Ms. O'Hara provided a presentation to the NYSDEC of the Site history, results of the RI and proposed remedial actions for the Site. The Remedial Action Work Plan was prepared following the meeting and was approved by NYSDEC. Ground-intrusive remedial actions are expected to start in 2020.

Port Authority - Red Hook Container Terminal, Building 111 – NYSDEC Spill Case No. 0612595 – Brooklyn, NY
Ms. O'Hara serves as Project Manager for environmental tasks for the closure and removal of four 4,000-gallon underground storage tanks (USTs) at the property and the implementation of remedial measures in support of spill case closure. Ms. O'Hara's project management responsibilities included communication with the Port Authority project managers, contractors, and regulators; review of analytical data generated; supervision of field staff performing on-site monitoring; and preparation of all work products, including daily reports, the UST Closure Report, the Remedial Action Work Plan (RAWP), and Progress Reports. As part of the remedial action, Ms. O'Hara managed the implementation of sulfate injections, gauging, and product removal activities, and post-injection groundwater monitoring events. Finally, Ms. O'Hara managed the implementation of a hydrogeologic investigation to confirm groundwater flow direction at the site. Remedial actions are ongoing and consist of monthly gauging events and implementation of sulfate injections.

Wes D. Lindemuth, CHMM, CSP

Wes D. Lindemuth, CHMM, CSP
Senior Project Manager

Location: New York, NY

wlindemuth@trccompanies.com

c: (347) 738-1452

d: (917) 794-3107

Areas of Expertise:

- *Environmental Health and Safety*
- *Remedial Construction Inspection and Management*
- *Project Management*
- *Environmental Assessment and Audit*
- *Remedial Investigation*
- *Underground Storage Tank Investigation and Management*
- *Hazardous Materials Building Inspections*
- *Indoor Air Quality Investigations*
- *Vapor Intrusion Assessments*

Wes D. Lindemuth, CHMM, CSP serves as a Senior Project Manager based in TRC's Engineering, Construction and Remediation (ECR) Practice in midtown Manhattan and has over 18 years of environmental consulting experience. His experience includes project scoping, budgeting, management, implementation of site assessments and investigations, reporting, health and safety management and close out of large-scale environmental projects as well as supervising and directing project staff. Mr. Lindemuth has performed, reviewed and managed staff in connection with over 500 Phase I Environmental Site Assessments (ESAs) and 40 Phase II Environmental Site Investigations (ESIs) for residential, commercial, industrial, manufacturing and other properties throughout his career.

CREDENTIALS

Education:

- B.S., Environmental Science, Kutztown University, 2004

Professional Certifications:

- IHMM – Certified Hazardous Materials Manager – CHMM (#15661), 2010
- BCSP – Certified Safety Professional – CSP, (#CSP-30429), 2015

Professional Training:

- 8-Hour OSHA HAZWOPER Supervisor, August 2015
- 8-Hour OSHA HAZWOPER Refresher, May 2020
- 10-Hour OSHA Construction Safety Training, August 2015
- 30-Hour OSHA Construction Safety Training, September 2010
- 40-Hour OSHA HAZWOPER, August 2004

REPRESENTATIVE EXPERIENCE

The City of New York Department of Parks and Recreation – New York City, NY
Mr. Lindemuth serves as a Senior Project Manager providing consulting services in connection with the construction and reconstruction of park buildings and facilities in New York City. His responsibilities include investigation, remediation and reconstruction of several ballfields under the direction of the USEPA located within the 57-acre Red Hook Recreation Area. His responsibilities also include all aspects of scope of work and cost estimate preparation, client consultation, staff supervision, subcontractor supervision and work plan preparation and implementation, preparation of contract drawings and specifications, preparation of engineers estimates, and report writing including development of conclusions and recommendations.

NYC Economic Development Corporation – New York City, NY
Mr. Lindemuth served as an Assistant Project Manager in connection with seven Phase I ESAs, four Phase II ESIs, one hazardous material building inspection, an UST closure and two in-situ soil characterizations. His responsibilities included all aspects of preparation of Phase I ESA reports, all elements of Phase II ESI field investigations, confined space entry associated with the inspection of an underground storage tank vault, and preparation of two winning proposals for in-situ soil characterization. Additionally, he was responsible for the field inspection services in connection with the initial preparation of the Bush Terminal Landfill for development into a park. Mr. Lindemuth responsibilities included inspection of dynamic compaction activities on the landfill, storm water management, soil gas sampling, and installation of groundwater monitoring well network.

MTA Long Island Rail Road – New York
Mr. Lindemuth serves as a Senior Project Manager providing safety review and compliance audit services in connection with the review and audit of the Metropolitan Transportation Authority (MTA) Long Island Rail Road (LIRR) System Safety Program Plan (SSPP). The SSPP encompasses all elements required by the Federal Railroad Administration (FRA) for a safe transit system. The project includes third party review of the SSPP and auditing performance, noting the successes and highlighting any gaps over the three-year contract. His responsibilities include auditing, client consultation, staff supervision, subcontractor supervision, and report writing including development of conclusions and recommendations.

NYC School Construction Authority – New York, NY
Mr. Lindemuth serves as a Senior Project Manager (Contract Title: Project Manager) and provides consulting services in connection with proposed new construction, alteration, and leased sites to assess the suitability of the sites for use as public school facilities. Between 2016 and 2017 Mr. Lindemuth conducted potable drinking water sampling in support of the City-Wide sampling of potable water fixtures in over 200 public schools. His responsibilities include management of 25 Phase I ESAs, 15 Phase II ESIs, five Vapor Intrusion and Indoor Air Quality Investigations, four PCB remediation projects, three underground storage tank (UST) closures, four petroleum spill investigations, four Product Safety reviews, review of two excavated material disposal plans (EMDPs), preparation of state pollutant discharge elimination system (SPDES) permit applications, Long Island well permit applications, a chemical bulk storage tank closure plan, and assisted with obtaining New York City (NYC) Department of Environmental Protection (DEP) sewer use permits. Mr. Lindemuth responsibilities also include all aspects of scope of work and cost estimate preparation, client consultation, staff supervision, subcontractor supervision and work plan implementation, emergency response, and report writing including development of conclusions and recommendations.

Strategic Capital – Hudson Park North Project, Yonkers, NY
Served as a Senior Project Manager responsible for the management of revision of several site-specific plans, design of engineering controls, and oversight and reporting in connection with the redevelopment of the NYSDEC Brownfield Cleanup Program Site No. C360071 located in Yonkers, New York. The Site consists of an 10,000 square foot lot which has been redeveloped into a residential high-rise structure. Responsibilities included oversight a subsurface investigation, revision of several site-specific plans including the Remedial Action Work Plan (RAWP), Health and Safety Plan (HASP), Community Air Monitoring Program (CAMP), Site Management Plan (SMP), and Excavation Work Plan. Management of the design of a vapor barrier and sub-slab depressurization system (SSDS), and in-place closure of two (2) 3,000-gallon No. 2 fuel oil USTs, ad closure by removal of one 500-gallon No. 2 fuel oil UST.

Queens West Development Corporation – Queens, NY
Mr. Lindemuth served as the Site Construction Manager in connection with the remediation of a nine acre designated Brownfield (NYSDEC BCP Site Nos. C241095 and C241096) site in Long Island City, Queens, NY. Supervised a team of four environmental professionals during the excavation of approximately 100,000 tons of soil under negative pressure enclosures (tents), removal of Light Non Aqueous Phase Liquid (LNAPL) via high vacuum extraction and implementation of an in-situ chemical oxidation pilot test using direct injection methods and a five foot diameter soil mixing/injection tool, post-excavation (end point) soil sampling, post-remediation groundwater well construction and sampling and soil vapor sampling. Supervised supplemental remediation activities including excavation of approximately 10,000 cubic yards of “grossly contaminated” soil below a lower permeability “peat” layer and the water table. Responsibilities included staff supervision and management of daily reporting to NYSDEC Region 2, oversight of excavation, dewatering, management of separate phase product, off-site transportation and disposal of excavated material, post-excavation sampling, procurement of clean soil backfill, backfilling of excavations and implementation of the site SWPPP, community air monitoring program, and health and safety oversight. A certificate of completion was issued by NYSDEC in December 2010.

ProSource Technologies LLC, NYS Smart Home Buyout Program – NY
Mr. Lindemuth served as a Project Manager providing consulting services in connection with pre-acquisition due diligence for Hurricane Sandy-impacted residential and commercial properties located throughout New York. His responsibilities included the management of the completion of nearly 400 Phase I ESAs, 1,045 Tier II Forms, 12 Phase II ESIs and implementation of Stormwater Pollution Prevention Plan (SWPPP) inspections. Mr. Lindemuth responsibilities also included all aspects of scope of work and cost estimate preparation, attending client meetings, staff supervision, subcontractor supervision, work plan implementation, and report preparation.

AIMCO, West Harlem Portfolio – Manhattan, NY
Mr. Lindemuth served as a Senior Project Scientist responsible for performing pre-acquisition due diligence surveys for 95 apartment buildings located throughout the Harlem neighborhood in Manhattan, New York for AIMCO, a real estate investment trust company. Responsibilities included preparation of Phase I ESA reports for each property as well as radon sampling and implementing several Phase II ESIs. Performed construction oversight for remediation projects including oversight of the removal of an underground storage tank system and oversight of in-situ chemical oxidation for groundwater remediation for AIMCO.

SL Green Realty Corporation – Due Diligence - New York City
Mr. Lindemuth served as a Project Manager responsible for the performance of due diligence and environmental investigation services associated with acquisition, financial lending and redevelopment of over 25 properties located in NYC. Services provided include performance of property inspections, remediation cost estimates, Phase I ESAs, Phase II ESIs and one property enrolled in the New York State Brownfield Cleanup Program.

EMILY KESSLER, CHMM

EDUCATION

M.P.H., Environmental and Occupational Health Sciences, CUNY Graduate School of Public Health & Health Policy, 2021

B.S., Environmental Scientist, University of Vermont, 2013

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

Certified Hazardous Materials Manager

40-Hour HAZWOPER and current 8-Hour Refresher

OSHA 10-Hour Construction Safety Training

Transit Worker Identification Credential (TWIC) holder

Red Cross First Air/CPR/AED Certified

AREAS OF EXPERTISE

Ms. Emily Kessler, has project management and technical experience in the following general areas:

- Project Management
- Environmental Site Assessment and Investigation
- Environmental Regulatory Compliance
- Remedial Activity Oversight and Management
- Underground Storage Tank Closure
- Non-Hazardous and Hazardous Waste Management
- Soil, Groundwater, and Soil Vapor Remedial Investigations
- Soil Vapor Intrusion Investigation
- Remedial Action
- Ambient and Community Air Monitoring
- Indoor Air Quality Assessments

REPRESENTATIVE EXPERIENCE

New York City School Construction Authority (NYCSCA) – Multiple Sites – New York City

Ms. Kessler is a Project Manager responsible for performing site assessments, investigations, and oversight of remediation actions for new construction and renovation of New York City public schools. Responsibilities include Phase I ESAs, Phase II ESIs, indoor air quality (IAQ) investigations, outdoor air assessments, and SVI assessments. Ms. Kessler has successfully prepared over 90 Phase I Environmental Site Assessments for properties located in Queens, Brooklyn, Manhattan, and Bronx. Additionally, Ms. Kessler routinely provides recommendations and prepares Phase II Environmental Site Investigation Scopes of Work, which investigate all recognized environmental conditions identified during completion of the Phase I Environmental Site Assessment. Ms. Kessler's project management responsibilities include all aspects of Due Diligence program management, scope of work and cost estimate preparation and budget management, emergency response, and coordination and communication with NYCSCA project managers, TRC senior staff, contractors, and supervision of field staff.

Additionally, Ms. Kessler serves as a project manager for tasks relating to investigation and remediation of a Brownfield Cleanup Program (BCP) site in Brooklyn and for an E-designated site in Manhattan. Ms. Kessler has also served as project scientist for management of remedial activities and IRMs for public school sites that are in the BCP, including authoring IRM work plans, RI reports, Remedial Action Work Plans (RAWPs), and Construction Completion Reports (CCRs).

Ms. Kessler has also served as a project manager for PCB remedial actions at public schools. Ms. Kessler's responsibilities have included daily communication and project coordination with NYCSCA Project Managers and contractors, supervision of field staff, and review of work products (including summary reports, surface soil investigation reports and PCB soil remediation reports).

New York City Economic Development Corporation

Ms. Kessler serves as a project manager for tasks relating to environmental due diligence. Ms. Kessler has prepared Phase I ESA reports for submittal to the New York City Economic Development Corporation. In addition, Ms. Kessler has successfully managed the implementation of Indoor Air Quality Investigations for over 80 properties located in New York City in support of the Learning Bridges project. Ms. Kessler's project management responsibilities included communication with NYCEDC project managers and building operators; supervision of field staff performing on-site sampling; review of analytical data generated; and preparation and review of all work products including daily summary emails and Indoor Air Quality Survey Letter Reports. The Surveys were completed within an expedited turnaround time.

Ms. Kessler also served as a project manager for tasks related to the St. George Ferry Landing Upland Scope for the Ballpark at St. George Stadium in Staten Island, NY. Ms. Kessler's responsibilities included coordination with contractors and NYSDEC; review of submittals for soil reuse and import; and, preparation of daily summary reports.

MTA Long Island Rail Road – New York

Ms. Kessler serves as a Project Manager performing due diligence assessments and investigation for Metropolitan Transportation Authority (MTA) Long Island Rail Road (LIRR). Ms. Kessler's responsibilities have included management and review of two (2) Phase I ESAs prior to site investigation activities. Ms. Kessler has assisted in managing remedial investigation activities associated with a spill and review of the RI report, leading to spill closure by the NYSDEC in May 2021. In addition, Ms. Kessler manages quarterly groundwater monitoring for a Site that is being remediated under a NYSDEC Order on Consent.

New York City Department of Parks and Recreation – Multiple Sites – New York City

Ms. Kessler serves as project manager in connection with the construction and reconstruction of park facilities in New York City. Specifically, Ms. Kessler serves as Project Manager for the Environmental Engineering Services in connection with Plant 2 at Fresh Kills Park. Ms. Kessler's responsibilities include preparation of a Remedial Investigation Work Plan and implementation of a Geotechnical Investigation. In addition, Ms. Kessler serves as Project Manager for the Environmental Engineering Services in connection with Mariners Marsh Park. Ms. Kessler's responsibilities include review of existing background materials and preparation of a Records Search Report. Ms. Kessler also served as a project scientist providing consulting services in connection with the environmental design, construction and reconstruction of park buildings and facilities in New York City. Responsibilities included implementation and oversight during permeability testing and subsurface investigations and preparation of subsurface investigation reports.

New York State Department of Environmental Conservation (NYSDEC) Superfund Standby Contract

Under TRC's contract with the NYSDEC to provide environmental engineering services for investigation and remediation of State Superfund sites, Ms. Kessler has served as a project scientist in connection with Remedial Investigations at several project sites including Bridge Cleaners Site in Long Island City, NY and Gem Cleaners in Rockville Centre, NY. Her responsibilities have included implementation of soil vapor intrusion and groundwater sampling, quality assurance/quality control reviews of analytical data summary tables presenting soil and groundwater sampling results, and preparation of remedial investigation reports.

Cypress Creek Renewables – New York State

Ms. Kessler serves as a Project Manager performing due diligence assessments in support of development of solar facilities. Responsibilities included completion of Phase I ESAs, Phase I ESA updates, and Phase II ESIs for over 40 sites throughout New York State. Each site encompasses between approximately two and 150 acres and up to 6 Phase I ESAs were completed concurrently. Additionally, Ms. Kessler served as project manager for underground storage tank (UST) investigation, UST removal, and spill closure activities at a proposed solar facility.

Civic Builders

Ms. Kessler serves as project manager for tasks relating to environmental due diligence and subsurface investigation services for Civic Builders, a developer of new charter schools in New York City. Ms. Kessler has been responsible for preparation of Phase I Environmental Site Assessment reports and Phase II Environmental Site Investigation reports. In addition, Ms. Kessler has prepared Remedial Investigation Work Plans and RI Reports for redevelopment projects enrolled in the New York City Office of Environmental Remediation (OER) Voluntary Cleanup Program.

Forefront Power – New York State

Ms. Kessler serves as a Project Manager performing due diligence assessments in support of development of solar facilities. Responsibilities included completion of Phase I Environmental Site Assessments (ESAs), for over 14 sites throughout New York State. She successfully managed the completion of 11 Phase I ESAs throughout New York State concurrently within 4 weeks.

Elise He
Environmental Scientist

Location: New York, NY

ehe@trccompanies.com

c: (917) 576-5867

Areas of Expertise:

- *Environmental Site Assessments*
- *Regulatory Compliance*
- *Environmental Project Management*
- *Report Preparation*
- *Geographical Information Systems*
- *Laboratory Data Analysis and Interpretation*
- *Field Instrument Calibration*
- *Community Air Monitoring*
- *Collection of Soil, Groundwater, and Soil Vapor Samples.*

Elise He serves as an Environmental Scientist based in TRC's Engineering, Construction and Remediation (ECR) Practice in midtown Manhattan and has over three (3) years of environmental consulting experience. Ms. He's experience includes preparation of Phase I Environmental Site Assessments (ESAs), performance of Phase II Environmental Site Investigations including implementation of geophysical survey, sub-surface drilling, soil screening and logging, and collection of soil and groundwater samples.

CREDENTIALS

Education:

- B.S., Environmental and Sustainability Sciences, Cornell University, May 2020

Professional Training:

- 40-Hour OSHA Hazardous Waste and Emergency Response (HAZWOPER)
- 30-Hour OSHA Construction Training
- 8-Hour OSHA Supervisor HAZWOPER
- 8-Hour OSHA HAZWOPER Annual Refresher

REPRESENTATIVE EXPERIENCE

The City of New York Department of Parks and Recreation – Mariners Marsh Park, Deputy Project Manager
Ms. He serves as Deputy Project Manager in support of remediation of Phase I of Mariners Marsh Park and to satisfy the requirements of the Order on Consent and Administrative Settlement between the Department of Parks and Recreation and the NYSDEC. Ms. He has performed a site visit, coordinated with drilling subcontractors, prepared a Records Search Report, and prepared a preliminary sampling approach. Additionally, Ms. He is preparing a Site Characterization Work Plan to be submitted for NYSDEC approval.

The City of New York Department of Parks and Recreation – FY 23 Sub-Surface Investigations for Capital Projects – Multiple Sites
Ms. He served as an Environmental Field Technician in connection with the implementation of sub-surface investigations in support of the reconstruction and new construction of park facilities throughout New York City. The scope of work for the investigations includes environmental (i.e., soil and groundwater) and structural investigations, permeability evaluations, asbestos and regulated materials surveys, and sewer line inspection on behalf of DPR under the FY 23 Sub-Surface Investigations for Capital Projects – Multiple Sites task order. Responsibilities include on-site implementation of the field work, collection of soil and groundwater samples for laboratory analysis, performance of permeability tests, monitoring of subcontractors providing geophysical mark-out, drilling, geotechnical engineering, drain line video inspection services.

New York City School Construction Authority, Multiple Sites, Environmental Scientist
Ms. He serves as an environmental scientist performing site assessments and investigation for new construction and renovation of New York City public schools. Responsibilities include preparation of Phase I Environmental Site Assessments (ESAs) and Phase II Environmental Site Investigations. Ms. He has also performed oversight during construction activities. Her responsibilities included implementation of a Community Air Monitoring Plan (CAMP) and preparation of daily summary reports.

Grace Industries, Storm Water Prevention Pollution Plan (SWPPP) Inspections – JFK International Airport, NY
Ms. He assists in performing SWPPP Inspections on construction projects to maintain compliance with the State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharge from Construction Activity. Her responsibilities include inspecting erosion and sediment control measures and preparing associated reports.

NYU Langone Health, 5423 First Avenue Phase II Environmental Site Investigation, Environmental Scientist
Ms. He served as an Environmental Scientist, monitoring geophysical and drilling subcontractors, and calibrating and utilizing field instrumentation including a photoionization detector, water quality meter (i.e., Horiba), interface probe, and helium detector, during Phase II Environmental Site Investigation field activities. Ms. He's responsibilities included documentation of soil characteristics and groundwater sampling parameters and collection of soil, groundwater, and soil vapor samples for laboratory analysis, chain-of-custody (COC) completion.

New York State Department of Transportation, Kosciuszko Bridge, Environmental Scientist
Ms. He performed quarterly groundwater sampling activities in support of remedial progress tracking. Ms. He's responsibilities included calibration of field instrumentation, site-wide gauging, collection of headspace volatile organic compound (VOC) readings with a PID, groundwater quality parameter monitoring, and sample collection.

New York State Energy Research and Development Authority, Build-Ready Program Critical Issues Analyses, Environmental Scientist
Ms. He assessed the presence of existing contamination, potential for exposure to unknown contaminants, and landfill operations of two landfills under the NYSERDA Build-Ready Program in support of proposed development of the sites into solar farms. Ms. He reviewed online public environmental databases, prior reports, proposed and as-built engineering plans, and other client-provided documents, and summarized the findings in Critical Issues Analysis (CIA) reports.

National Cooperative Bank, Various Locations, Project Manager
Ms. He served as a project manager performing Phase I ESAs and Property Condition Assessments of commercial real estate properties in New York State. Ms. He prepared approximately 85 Phase I ESAs and PCAs in accordance with applicable ASTM International (ASTM) standards, Fannie Mae, local regulations, and client-customized scopes of work. Other responsibilities included review of environmental and historical data and prior reports, collection of asbestos samples, and correspondence with clients and site representatives.

Confidential Client, Construction Progress Monitoring Inspections, Project Manager
Ms. He performed construction monitoring inspections of an apartment complex undergoing renovations in Philadelphia, Pennsylvania. Ms. He reviewed invoices, performed site visits to monitor progress of renovations and accuracy of reported budgets, inspected building systems, and coordinated with clients and site representatives.

Piedmont Natural Gas, Geospatial Data Digitization, Geographic Information Systems Technician
Ms. He served as a Geographic Information Systems Technician and created and updated map grids of energy projects for natural gas utility clients in southeastern United Sates. Ms. He accurately digitized and implemented geospatial data across service areas spanning several neighborhoods in North Carolina, interpreted service cards and as-built construction drawings, and performed routine quality assurance and quality control checks.

CRISTINA NICLAS

PROFESSIONAL TITLE: Environmental Scientist

EDUCATION

B.S., Environmental Science, Trinity College, 2019

B.S., Biology – Concentration in Biomedical Sciences, Trinity College, 2019

AREAS OF EXPERTISE

Ms. Niclas has experience in the following general areas:

- Environmental Site Assessment and Investigation
- Environmental Regulatory Compliance
- Underground Storage Tank Closure and Removal
- Non-Hazardous and Hazardous Waste Management
- Environmental Media Sampling (Soil, Groundwater, Drinking Water, Air)
- Field Work Oversight/Monitoring
- Calibration, Maintenance, Use, and Troubleshooting of Field Instruments
- Construction / Soil Disposal Oversight
- Soil Vapor Intrusion Investigation
- Indoor Air Quality Assessments
- Report Preparation
- Drilling Permit Obtention
- Groundwater Elevation Surveys
- Generalized and Site-Specific Health and Safety Procedures

Ms. Niclas possesses over four years of environmental consulting experience including preparing Phase I and Phase II Environmental Site Assessments and State-required regulatory reports, performing the investigation and sampling of sites with petroleum, chlorinated solvents, polychlorinated biphenyls (PCBs), and heavy metal contamination in environmental media; environmental remediation oversight; underground storage tank closure and removal oversight; environmental health and safety oversight; and assisting the management of a variety of environmental sampling programs including groundwater, drinking water, soil, sediment, and soil gas. Ms. Niclas serves as an Environmental Scientist based in TRC's New York City office.

SUMMARY OF EXPERIENCE

A summary of Ms. Niclas' employment history is presented below.

- Environmental Scientist, TRC Engineers, Inc., 11/2022–Present
- Project Scientist, EBI Consulting., 09/2019– 10/2022

REPRESENTATIVE EXPERIENCE

Rise Light and Power, Vibracore and Benthic Macroinvertebrate Sampling

Ms. Niclas completed the field work associated with the Queensboro Renewable Express project - proposed as a ±400 kV merchant transmission facility with the capacity to deliver approximately 2.62 GW of wind energy generated on the Outer Continental Shelf into the Ravenswood Generating Station in Queens, New York. The HVDC Submarine Cable Corridor will begin at offshore platform(s) on the OCS and traverse approximately 28 miles through both

New Jersey and New York state waters to reach Ravenswood. As one of the lead environmental consultants, Ms. Niclas managed cable routing, marine surveys, environmental characterizations, preparing the project's Article VII application, and is supporting ongoing state and federal permitting. A marine field program, spanning from 2020 into 2024, included multiple high-resolution geophysical surveys to evaluate the physical characteristics of the area, a sediment sampling program to assess sediment bulk physical, chemical, and thermal properties, a benthic macroinvertebrate community assessment, as well as additional vibracore sample collection and storage for marine archaeological assessments.

Confidential Client, Environmental Due Diligence
Ms. Niclas was responsible for preparation of Phase I ESAs and Phase II ESAs for telecom, retail, commercial, multi-family residential, and industrial properties. Ms. Niclas' responsibilities have included all elements of field investigations, subcontractor supervision, and report preparation associated with due diligence assessments. Specifically, Ms. Niclas has performed and overseen the installation of soil borings, test pits, monitoring wells, and soil vapor points to facilitate soil, soil vapor, drinking water, and groundwater sampling and analyses. Ms. Niclas' responsibilities included the assistance of scope of work and cost estimate preparation, coordination with client representatives and contractors, DIG SAFE mark outs, and performance of field sampling procedures.

Confidential Client, Converter Station Geotechnical Investigation
Ms. Niclas led a multi-month-long geotechnical investigation in support of the construction of a converter station in New York City, acting as the lead field personnel and point of contact between clients and on-site field staff. Responsibilities included the management and oversight of a diverse set of sub-contractors, the completion of daily field reports, the coordination of field sampling schedules, and the conduction of daily health and safety meetings.

Regulatory Compliance and Report Preparation – Massachusetts Department of Environmental Protection (MassDEP) Massachusetts Contingency Plan (MCP)
Ms. Niclas successfully completed a graduate school course at the University of Massachusetts, Lowell, titled "Understanding the Massachusetts Contingency Plan." As such, Ms. Niclas is skilled in the understanding and completion of the MassDEP phased site compliance and closure program. Ms. Niclas' responsibilities have included all elements of field investigations, client meetings, and MCP report writing, including RNF submittals, DPS submittals, Phase I & Tier Classifications, PSS, Risk Assessments, and RAM plans/RAM Status Reports.

Block Island, Rhode Island Petroleum and Heavy Metal Investigation
Ms. Niclas conducted a Phase I ESA, Phase II ESA, Supplemental Phase II ESA, a groundwater elevation survey, and semi-annual groundwater and drinking water sampling and analyses to achieve regulatory compliance with Rhode Island Department of Environmental Management (RIDEM). Responsibilities included the assistance with designing and implementation of waste characterization investigations, monitoring well installations (utilizing a Geoprobe® drill rig), potable well sampling, and RIDEM regulatory report writing and submittals. As part of RIDEM regulatory requirements, Ms. Niclas also compiled field and lab results to produce groundwater surface elevation contour maps and predict contaminant plume movement.

Arsenic and Pesticide-Impacted Soil and Groundwater Investigation
Ms. Niclas conducted a series of Phase II ESAs in South Florida to evaluate concentrations of arsenic and pesticides in soil and groundwater on historic cattle ranches. The soil and groundwater sampling and analyses program included collection of soil samples at various

locations and depths of the site (via both handheld auger and Geoprobe® drill rig) and an evaluation of contaminant concentrations to Florida Department of Environmental Protection (FLDEP) regulatory standards.

New Mexico Environmental Media and Air Investigation
Ms. Niclas conducted Phase I and Phase II ESAs in New Mexico as part of a real estate due diligence evaluation. Environmental media sampled and analyzed included soil, groundwater, sub-slab soil vapor, external soil gas, and indoor air.

Verizon Wireless Telecommunications Investigations and APE-VE Surveys
Ms. Niclas conducted a variety of environmental telecommunications investigations on behalf of Verizon Wireless to evaluate concentrations of potential impacts to soil and groundwater, where proposed telecommunications towers and associated equipment would be placed. Ms. Niclas also completed a variety of APE-VE Surveys on behalf of Verizon, which including the visitation of telecommunication compounds to document general site conditions and surrounding neighborhoods to a 500-mi and 0.5 radius.

Underground Storage Tank Closure and Removal
Ms. Niclas conducted a variety of underground storage tank (UST) investigations and removals. Ms. Niclas was responsible for preliminary drilling and soil sampling investigations around the tanks to determine extents of impacts. Ms. Niclas contacted, scheduled, and supervised subcontractors' excavation and removal activities. Ms. Niclas was responsible for all hazardous waste sampling, proper storage/containment of impacted material, labeling of impacted materials, and coordinating removal of material for disposal. Ms. Niclas was also responsible for writing site closure reports associated with the UST removals, under MassDEP MCP regulatory guidance.

Soil Disposal Waste Characterization Sampling & Disposal Oversight
Ms. Niclas conducted a variety of waste characterization sampling for the disposal of soil on construction sites. Sampling procedures included composite, stock-pile sampling. Ms. Niclas also assisted with the writing of Soil Disposal Packages, in accordance with MassDEP's MCP. Ms. Niclas also handed out Material Safety Records (MSRs) day of stock-piled soil removal, in addition to scheduling and establishing soil removal trucking routes and schedules.

SPECIALIZED TRAINING

- 40-Hour OSHA Hazardous Waste and Emergency Response (HAZWOPER) Training
- OSHA HAZWOPER 8-Hour Refresher Training (multiple)
- 30-Hour OSHA Construction Training
- 8-Hour OSHA Site Supervisor Training
- NYSDEC Erosion and Sediment Control Training
- CPR/AED/First Aid Training
- New York City's Office Safety Coordinator (OSC) (On-boards new staff on TRC's Safety Policies & Procedures, manages NYC office's PPE, attends monthly safety meetings, and handles any safety-related incident/near miss/safe catch for the NYC office)

Nancy Weaver

Senior Chemist

EXPERIENCE OVERVIEW

Ms. Weaver has over thirty years combined laboratory, data validation and project management experience. She is the President and co-founder of EDS and is responsible for the technical data review and validation of laboratory data. Ms. Weaver has performed data validation on thousands of data validation projects. She has extensive knowledge in applying the various regional and project specific data validation guidelines and QAPPs. Her experience also includes writing Quality Assurance Project Plans (QAPPs), managing subcontracted analytical laboratories, performing laboratory audits, participating in field sampling activities and analyzing samples in a laboratory.

EDUCATION

Degree, University, Year

B.S., Chemistry, University of Colorado, Denver, Colorado

CERTIFICATIONS AND TRAINING

Certification, Year Received

State of New York Department of Environmental Conservation certified Asbestos Inspector
40-Hour OSHA Hazardous Waste Training
8-Hour Health and Safety Supervisor Training for Hazardous Waste Operations

PROJECT EXPERIENCE

Principal/Senior Chemist, Environmental Data Services, Inc., August 1994 - Present
As the Principal Chemist at Environmental Data Services, Inc., Ms. Weaver has provided Level IV, M3 and IM2 data review on more than 6000 Sample Delivery Groups (SDGs) generated through site investigations and/or remediations. These SDGs have included every analytical fraction possible including VOC, SVOC, pesticides, PCBs, herbicides, DRO, GRO, dioxin/furans, PCB congeners, metals, wet chemistry and radiological parameters. Sample matrices include water, soil, sediment, wipe, concrete and air. The SDGs have included CLP data packages produced under the CLP SOWs and CLP-like data packages with samples analyzed under SW-864 methodologies. Sample quantities validated may reach upwards of 120,000 per fraction over the past 20 years. Ms. Weaver has been using the Region III Modifications to the National Functional Guidelines since 1997 and has provided M2, M3, and IM-2 validation. Ms. Weaver has been using the National Functional Guidelines since 1993 and has provided both Level III and IV validation.

Chemist-Analyst Specialist, City & County of Denver, June 1992 - August 1994
As a Chemist-Analyst Specialist for the City and County of Denver, Ms. Weaver supervised performance and compliance sampling for O & M requirements at groundwater treatment facility. She provided assessment of analytical data for quarterly reports to local regulatory agencies. She also acted as liaison between the technical group and laboratory to coordinate sampling events and resolve problems with analyses. While in this capacity, she performed data validation for organic, inorganic and radiological analyses. Ms. Weaver reviewed over 2000 VOC, SVOC, pesticide, PCB, TPH, metals and wet chemistry samples. Ms. Weaver managed the database for groundwater and treatment plant sampling events and performed environmental site assessments for commercial and residential properties. She provided

technical review and recommendations of Phase I and Phase II site investigations performed by outside consultants. She also analyzed policy and interpreted city, state and federal environmental regulations.

Data Validation Specialist, C.C. Johnson & Malhotra, January 1990 to June 1992

While a Data Validation Specialist at C.C. Johnson & Malhorta, Ms. Weaver performed data validation and interpretation of organic analytical data generated from the EPA Contract Laboratory Program (CLP). Data analysis included VOC, SVOC, pesticides, PCBs, metals and wet chemistry. Ms. Weaver reviewed more than 600 SDGs and 9000 samples. She interpreted gas chromatograms, gas chromatography/mass spectral data and verified mathematical calculations.

Environmental Chemist, The Anschutz Corporation - SP Environmental Systems, Inc., July 1990 to January 1992

As an Environmental Chemist for The Anschutz Corporation - SP Environmental Systems, Inc., Ms. Weaver assisted in the management of site investigations and remediation for Southern Pacific Transportation Company properties. In this capacity, she performed environmental audits and site assessments and conducted site investigations at potential Superfund sites with state and federal agencies. She researched and prepared responses to regulatory agencies for non-compliant sites and defined the needs for hazardous waste disposal including the analysis required and disposal. Ms. Weaver also supervised the removal of underground storage tanks and remediation. She prepared closure reports for UST removals, as well as annual waste summary forms for TSD facilities throughout the state of Texas. She also constructed, developed, and sampled groundwater monitoring wells.

Environmental Specialist, Martin Marietta Astronautics Group, January 1988 to January 1990

While with Martin Marietta Astronautics Group as an Environmental Specialist, Ms. Weaver performed organic analysis and sampling of wastewater, groundwater, and drinking water in support of NPDES permit. She operated and maintained laboratory instrumentation including GC and GC/MS for volatile, semi-volatile, and pesticide/PCB analysis. Ms. Weaver also coordinated sample collection and preparation activities, developed and authored standard operating procedures for laboratory analysis, and followed EPA protocol for QA/QC requirements for analysis. She calculated and interpreted data and reported results.

Environmental Chemist, Camp, Dresser, & McKee, April 1986 to October 1987

As an Environmental Chemist with Camp, Dresser, & McKee, Ms. Weaver analyzed water/wastewater for organic compounds. She operated and maintained laboratory instrumentation including GC and infrared spectrophotometer for volatile, pesticide/PCB, and petroleum hydrocarbon analysis. She also calculated and interpreted data and reported results. Ms. Weaver analyzed more than 2000 samples.

EMPLOYMENT HISTORY

Environmental Data Services, Inc.	Principal/Senior Chemist	1994–Present
City & County of Denver	Chemist-Analyst Specialist	1992–1994
C.C. Johnson & Malhorta	Contractor/Data Validation Specialist	1990–1992
The Anschutz Corporation - SP Environmental Systems, Inc.	Environmental Chemist	1990–1992
Martin Marietta Astronautics Group	Environmental Specialist	1988–1990
Camp, Dresser, & McKee	Environmental Chemist	1986–1987