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REMEDIAL DESIGN WORK PLAN

CLOVE AND MAPLE AVENUES FORMER MGP SITE
OPERABLE UNIT 1
HAVERSTRAW, ROCKLAND COUNTY, NEW YORK

NYSDECSITE #: 3-444-049

Project No. 2254

Prepared For:

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CERTIFICATION

I, Christopher A. Robb, certify that I am currently a NYS registered professional engineer and that this Remedial Design 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).

STATE OF NEW YORK
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5-28-2015

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Date

1 INTRODUCTION

On behalf of Orange and Rockland Utilities, Natural Resource Technology (NRT) has prepared this Remedial Design Work Plan (RDWP) for the remediation of impacted soils and groundwater within Operable Unit # 1 (OU-1), at the Orange and Rockland (O&R) Haverstraw Clove and Maple Avenues Former Manufactured Gas Plant (MGP) Site (Site) located in the Village of Haverstraw, Rockland County, New York (Figure 1). The Site is identified by the New York State Department of Environmental Conservation (NYSDEC) as site number 3-44-049. Figure 2 shows the layout of the Site. This RDWP provides the guidelines to implement the remedy selected by the NYSDEC in accordance with the Record of Decision (ROD, NYSDEC, 2011) and the Administrative Order on Consent, Index No. D3-0001-98-03 between NYSDEC and Orange and Rockland Utilities (NYSDEC, 1998). This work plan has been prepared in accordance with NYSDEC's Technical Guidance for Site Investigation and Remediation (DER-10).

O&R has performed a series of environmental studies focusing on the Site and nearby properties. An Initial Hazard Assessment was completed in 1996, followed by a Preliminary Site Assessment in 1997 and a Surface Soil and Risk Assessment in 1997. A Remedial Investigation (RI) was started in 1998; this was composed of multiple phases of field work, analysis, and review. The RI produced several reports, and resulted in a NYSDEC-approved Remedial Investigation Report (RIR) in May 2009 (CMX, 2009). Following the acceptance of the RIR, a Feasibility Study (FS) was prepared on September 2010 (GEI, 2010). During this process the Site was broken into three Operable Units (OUs), consisting of:

- **OU-1** - The MGP parcel, owned by O&R, and the drainage swale located between the O&R property and 104 Maple Avenue. OU-1 is approximately 1 acre in size.
- **OU-2** - Off-site properties including several private residences, an apartment complex and a portion of Maple Avenue that is assumed to be impacted. OU-2 is approximately 3 acres in size. Details regarding these properties are as follows:
    - The Apartment Complex property includes four apartment buildings on Maple Avenue and one apartment building on West Street
    - A row house on Maple Avenue with four single-family residential properties, consisting of the adjacent properties at 111, 113, 115, and 117 Maple Avenue
    - Single-family residential properties on West Street, consisting of six properties at 96, 100, 102, 104, 108, and 116 West Street
    - A portion of the alleyway between Maple Avenue and West Street
    - A section of Maple Avenue between 103 Maple Avenue and 131 Maple Avenue
- **OU-3** - Sediments in the nearby Hudson River embayment

The triangular parcel at the intersection of Maple Avenue and West Street, owned by the Village of Haverstraw, and the parcel at 146 Maple Avenue, which houses the Head Start facility, were included in the RIR study area but were deemed to be substantially un-impacted by the MGP, and so were not included in the areas requiring remedial action. After a public meeting and responsiveness survey, NYSDEC issued a ROD (NYSDEC, 2011) for the Site in March 2011. The ROD addressed environmental impacts in OU-1. Impacts in OU-2 and OU-3 will be addressed separately.

1.1 DER-10 Requirements

A copy of the ROD has been included as Appendix A of this document to satisfy the following RDWP requirements of DER-10:

- Summary of the Remedial Investigation Report, provided in Section 6.1 of the ROD
- Summary of sampling results collected up to the date of the publication of the ROD
- Figures identifying all areas where the remedial action will be conducted
- Figures showing the vertical and horizontal extent of the area to be remediated

1.2 Nature and Extent of Contamination

As specified in DER-10, if the Remedial Investigation and Feasibility Study have been approved by NYSDEC and a ROD has been issued, no summary of nature and extent of contamination is required in the RDWP. A copy of the ROD is included in Appendix A.

1.3 Selected Remedy

A full description of the selected remedy is documented in the ROD, a copy of which is included in Appendix A.

1.4 Standards, Criteria, and Guidance

Standards, Criteria, and Guidance (SCGs) are promulgated requirements and non-promulgated guidance, which guide site activities during investigation and remediation. SCGs include chemical specific, action-specific, and location-specific SCGs. SCGs that are considered potentially applicable to remediation activities at the Clove and Maple Avenue Former MGP Site are summarized below.

Chemical-Specific SCGs

Chemical-specific SCGs that are applicable to the Clove and Maple Avenue Former MGP Site include:

- NYS Soil Cleanup Objectives (6 NYCRR Part 375-1, 6 NYCRR Part 375-2, and 6 NYCRR Part 375-6)

- CP-51/Soil Cleanup Guidance - NYSDEC Policy (October 21, 2010)
- DER-10/Technical Guidance for Site Investigation and Remediation - NYSDEC Policy (May 3, 2010)
- 6 NYCRR Parts 700 - 706 Water Quality Regulations
- TAGM 4030 - Selection of Remedial Actions at Inactive Hazardous Waste Sites
- Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP) Limits (40 CFR 261 and 6 NYCRR Part 371)

The 2009 RIR, the 2011 FS and the 2012 ROD included a comparison of analytical data for various Site media (including soil and groundwater) to the applicable chemical-specific SCGs. In accordance with the ROD, no MGP-related impacts within OU-1 have resulted in exceedances of chemical-specific SCGs in the Hudson River and thus no remediation activities are required for these media.

Action-Specific SCGs

Action-specific SCGs that are considered potentially applicable to the proposed remedial actions at the Clove and Maple Avenue Former MGP Site include:

- General health and safety requirements, including Occupational Safety and Health Administration (OSHA) regulations (29 USC §553 and 42 USC§126; 29 CFR §1910.120; 40 U.S.C. §333; 29 U.S.C. §§653, 655, 657; 29 CFR Part 1926; 29 U.S.C. §§657, 658, 660, 669, 673; and, 29 CFR Part 1904).
- NYSDOH Generic Community Air Monitoring Plan (CAMP), which identifies air monitoring requirements for in work areas when certain activities are in progress at contaminated sites.
- Resource Conservation Recovery Act (RCRA) Land Disposal Restrictions (LDRs), which govern the land disposal of hazardous wastes (6 NYCRR Part 376).
- RCRA and United States and New York State Department of Transportation (USDOT and NYSDOT) regulations for the transportation and management of hazardous materials (42 U.S.C.§§ 6906, 6912, 6922-6925, 6937, and 6938; 40 CFR Part 263; 49 CFR Parts 107 and 171.1-172.558; Article 27, Titles 3, 9, and 15; 6 NYCRR Part 364; ECL, Article 27; 6 NYCRR Part 372; and, 6 NYCRR Part 372.3 a-d; ECL).
- NYSDEC Department of Environmental Remediation document entitled “Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment” (DER-4/ Program ID: TAGM 4061(2002)).

Location-Specific SCGs

Location-specific SCGs that are considered potentially applicable to the Clove and Maple Avenue Former MGP Site include:

- Local permits from Rockland County and the Village of Haverstraw

2 DESIGN INVESTIGATIONS

During preparation of the FS and the RDWP, additional information was identified as necessary to complete the remedial design. A pre-design investigation (PDI) will be performed to gather the required information.

2.1 PDI Objectives

The purpose of the PDI is to gather the additional information required to design the selected remedy for the Site as specified in the ROD. Details of the pre-design investigation are presented in the Pre-Design Investigation Work Plan included in Appendix B. The objectives of this PDI are:

- Obtain a topographic, property boundary and utility survey to serve as the design base map. This survey will meet the DER-33 requirements so that it can be used for any environmental easements or deed restrictions that may be required following the completion of remedial construction.
- Further delineate the vertical and horizontal limits of MGP-related impacts that require subsurface soil excavation via field classification of soils and select analytical testing.
- Further delineate source material along the northern boundary of excavation to determine where deeper excavation is required to remove source material.
- Collect geotechnical data, including blow counts, on the soils within and along the perimeter of the excavation areas for analysis and design of the excavation support system(s).
- Further investigate the Site hydrology and hydrogeology to include seasonal and storm event fluctuations, characterize reported artesian pressures in underlying soil units, and define soil permeability and horizontal hydraulic conductivity.
- Assess Site construction water discharge options based on required sampling and available/allowable discharge capacities at local POTW.
- Collect data on stormwater flows in the drainage swale to prepare for temporary bypass options during excavation in the swale.
- Record subsurface structures that may present obstructions during excavation, including utilities which will require demolition and/or relocation. Observe the construction and condition of the foundations of adjacent offsite structures via exterior inspections for the purpose of evaluating potential impacts to nearby structures during construction activities.
- Limited pre-characterization of soil will be included to evaluate disposal options/ requirements of off-site waste management facilities as part of the proposed work. The majority of waste characterization required to implement the remedial action will be performed at a later date.

2.2 Pre-Design Investigation Scope and Rationales

The PDI will consist of the following activities:

- Topographic, property boundary, and utility surveys will be completed to provide a Site map for remedial design and to meet requirements for utility protection.
- Geotechnical drilling will include hollow stem auger (HSA) methods and cased drive and wash rotary methods, if required. Standard penetration testing (SPT) will be used to collect soil samples for geotechnical analysis and delineation of excavation limits.
- Physical soil testing will be performed to evaluate geotechnical properties.
- Direct-push drilling will be used to collect soil samples for chemical analysis to facilitate delineation of excavation limits.
- Aquifer testing will be performed to define aquifer parameters and allow evaluation of excavation dewatering alternatives.
- Stormwater flow modeling will be performed.
- Perform exterior inspections of adjacent structures, including photographic documentation, from the Site and rights of way (i.e., no access agreements will be required).
- Prepare and submit Pre-Design Investigation Summary Report.

3 DESIGN SCOPE

3.1 Design Activities

The ROD requires implementation of a remedial design program to allow construction, operation, maintenance, and monitoring of the remedial action. This section provides a conceptual design of construction activities. Discussion of operation, maintenance, and monitoring is described in Section 6.

Consistent with the requirements of DER-10, the remedial design will include the following elements:

- This Remedial Design Work Plan including a Pre-Design Investigation Work Plan
- A pre-design investigation
- Sixty-five percent design documents
- Draft one hundred percent design documents and bid package
- One hundred percent design documents and bid package
- Project plans

Sixty-five percent design submittals will include drafts of the Remedial Design specifications, drawings, and project plans. Draft 100 percent design submittals will include revised drawings, specifications, and project plans incorporating NYSDEC's 65 percent design comments. One hundred percent design submittals will include final biddable quality specifications, drawings, and project plans and a package.

Planning elements that will be incorporated in to the project drawings and specifications include the following:

- Traffic Control and Truck Routing
- Water Management
- Soil Management and Pre-characterization

In addition and as necessary, project plans will be prepared to provide more detail of important aspects of construction activities. Specific plans that will be provided include the following:

- Community Air Monitoring Plan (CAMP)

3.2 Remedial Action Summary

The selected remedy for the Site described in the ROD includes the following construction activities:

- Excavation and off-site disposal of MGP-impacted soil to depths ranging from approximately 15 feet to 22 feet below ground surface (bgs).
- Excavation and off-site disposal of existing former MGP structures, debris, piping, and major obstructions.
- Excavation and off-site disposal of impacted soil in the drainage swale area located along the northern boundary of the site.
- Soil excavation will be performed within a temporary structure to control odor, vapor, and dust.
- Groundwater extraction during construction and off-site treatment and disposal, or onsite treatment and discharge in compliance with applicable discharge standards.
- Excavation of surface soils to a depth of two feet bgs and placement of site cover to allow for restricted residential use of the site.

In addition to these activities, the ROD includes a requirement that institutional and engineering controls and a Site Management Plan (SMP) be implemented. These are discussed in Section 6. Additionally, in-situ treatment of remaining groundwater to enhance natural attenuation may be implemented if required. Preparation of the SMP and design of an in-situ groundwater treatment system are not included in the design for OU-1.

Further description of the remedial construction activities required to implement this remedy is provided below.

3.3 Remedial Action Description

The following section describes the elements of the design basis that apply to the remedial design. Figure 3 presents the proposed remedial action.

3.3.1 Site Preparation

The Site will be prepared for the required remedial actions and restoration work. The Site preparation activities include: mobilization; installation of additional security fencing (if necessary); installation of erosion and sedimentation controls; installation of temporary site facilities; surveying to establish baseline conditions and grades; utility location, protection, and relocation (if necessary); protection of existing structures (if necessary), and implementation of traffic controls.

Engineering controls to control dust, odors, erosion, and stormwater will be mobilized, setup and installed prior to the start of intrusive activities.

3.3.2 Excavation of Impacted Soils

The estimated horizontal limits of excavation established by the FS and ROD are shown on Figure 3. The final required limits of excavation will be established based on soil cleanup objectives (SCOs) discussed in Section 3.4 in comparison with soil analytical data from the RI and PDI. The excavation includes removal of approximately 1,300 cubic yards of shallow soil to a depth of two feet. Subsurface soil excavation includes removal to a maximum depth of 15 feet in accordance with the Restricted Residential SCOs except in locations where source material is present. Source material is defined as soil containing substantial DNAPL contamination in layers thicker than 0.2 feet. According to the ROD, the maximum expected depth of excavation is 22 feet.

In the northeastern portion of the site, along Maple Avenue, shoring will be used to provide excavation support, protect structures and utilities, and provide groundwater cutoff. To the extent practical, deep excavation will be conducted inside a temporary fabric structures using conventional earth moving equipment. A temporary fabric structure will not be used for the 2-foot shallow soil excavation.

Geotechnical data generated by the pre-design investigation will allow for the preparation of specifications for shoring design and performance requirements of shoring systems at the Site. Shoring will be implemented in areas where needed to provide support for utilities and structures.

If the bottom of excavation is 15 feet bgs or if source material present is excavated to a practicable depth greater than 15 feet bgs, documentation samples will be collected to provide information on soil remaining on-site after remediation. In those locations, backfill may proceed immediately after samples have been collected.

3.3.3 On-Site Waste Management

To the extent possible, all excavated soil will be loaded directly into trucks for off-site transportation to a permitted treatment or disposal facility. Large boulders or concrete footings may be encountered during excavation; they may require decontamination to meet disposal facility acceptance requirements. Decontamination will take place using brushes, steam cleaners, and/or pressure washers. Residues from decontamination operations will be collected and managed with impacted soils. Excavation debris may potentially be decontaminated and sent to an off-site facility for disposal. Any stockpiles of impacted material will be located within the temporary structure. Excavated soil showing no signs of MGP impacts may be stockpiled outside of the temporary structure for potential reuse as backfill below a depth of 15 feet. Any soil stockpiled outside of the temporary structure will be covered. Decontamination water, as well as residuals from dewatering activities will be temporarily stored in appropriate tanks prior to treatment and management in the temporary water treatment system or transported to an appropriate off-site disposal facility as required.

The composition of the excavated soils are assumed to meet the requirements of “Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment” [(DER-4), NYSDEC, 2002], and can be managed as solid wastes at permitted off-site treatment or disposal facilities. Excavation below the water table will be necessary. Therefore, the design will address soil dewatering requirements including use of a staging area with a gravity sump to collect fluids, or local dewatering to draw groundwater levels below the excavation limit, with appropriate water management. If required, the soils will be amended with a drying agent such as cement kiln dust or absorbent polymer to facilitate transport to the off-site disposal facility. Quick lime or lime kiln dust greater than 50% available CaO and MgO are no longer acceptable to the NYSDEC for this purpose. All soil amendment activities will take place within the temporary fabric structure.

3.3.4 Waste Characterization

Soil that has been impacted by MGP residues will be classified as non-hazardous industrial waste unless it is determined to exhibit the characteristics of ignitability, corrosivity, reactivity, or benzene toxicity (by the toxicity characteristics leaching procedure [TCLP]), as determined by laboratory testing. Soils that exhibit one or more of these characteristics will be classified as hazardous wastes. The exception to this will be soils that exhibit only the benzene toxicity characteristic, which will be sent for thermal treatment – such soils will be designated as Conditionally Exempt MGP Remediation Waste per “Management of Coal Tar Waste and Coal tar Contaminated Soils and Sediment From Former Manufactured Gas Plants” (DER-4; NYSDEC, 2002).

Soils will be characterized for waste disposal prior to excavation. Soil samples will be collected and analyzed for parameters required by specific permitted treatment and disposal facilities at the required frequency to allow direct loading and shipment of excavated material.

Removal of gas piping associated with the former gas regulator station and the former MGP is anticipated. The NRT Team will coordinate with O&R utility personnel as necessary regarding removal and disposal of former regulator station piping. Samples of these materials will be collected and analyzed during the pre-design investigation to characterize these materials for waste disposal. Additional sample collection and analysis may be required prior to and during remedial activities to meet requirements of specific permitted treatment and disposal facilities.

3.3.5 Off-site Transportation

Excavated materials will be transported off site in dump trucks to a treatment or disposal facility permitted to accept such material. Transportation of impacted materials from the Site will be performed in accordance with all regulatory requirements and in accordance with the transportation planning elements prepared as part of remedial design documents.

All haul trucks will have poly bed liners that fully line the bed of the truck and can be overlapped to cover the top of the load to manage odors during transportation. All loads must also be covered with solid fabric covers, no mesh covers will be allowed. Depending on loading practices, full decontamination of trucks may be required prior to leaving the Site. However, the design will specify that the vehicles will be loaded in such a way as to avoid contamination of their exteriors including tires. Decontamination requirements will be detailed in the specifications.

Waste shipments will be documented using the required waste manifests. Other materials that have no specific documentation requirements will be documented using waste tracking forms, bills of lading, and receipts. All shipments of waste from the Site will be documented describing the type and amount of material and the receiving facility.

3.3.6 Excavation Dewatering and Water Management

Dewatering and construction water treatment systems will be required to maintain dry conditions during excavation and backfill. Groundwater elevation and flow data and groundwater chemistry data from the pre-design investigation will allow for the design of the dewatering and treatment systems. Artesian conditions have been reported at some locations on the Site and where necessary, dewatering specifications will include requirements for depressurizing the artesian aquifer so as to minimize risk of uncontrolled upward flow into excavations. Dewatering specifications will also include requirements for monitoring artesian pressures during construction to demonstrate that bottom of excavation will be stable and safe. Inflow rates will be estimated to allow proper sizing of water treatment systems.

Any construction water that is generated during the remedial action, including decontamination water and stormwater that comes in contact with open excavations, will be collected, treated on-site, and discharged to storm sewer/surface water or the local publically owned treatment works (POTW) in accordance with requirements of a State Pollution Discharge Elimination System (SPDES) Permit and/or local sewer department requirements. Discharge to the POTW is the preferred method and will be considered first.

3.3.7 Site Restoration

Following all remedial activities, excavated areas will be backfilled to finish grade with clean imported fill or reusable on-site materials, in accordance with DER-10 provisions for importing backfill and soil reuse.

Excavated soil showing no signs of MGP impacts may be stockpiled for potential reuse as backfill below a depth of 15 feet. Stockpiling requirements were discussed in Section 3.3.3. Before potentially reusable soil is used as backfill, samples will be collected at the frequency required and analyzed for the constituents specified in DER-10, Chapter 5.4(e). These soils may be placed once analytical results are received and review indicates the soils are suitable for backfill by meeting the SCOs. If analytical results provide sufficient documentation of visual observations, a reduced frequency of soil sampling for reuse may be requested.

3.3.8 Odor, Vapor, and Dust Control

Odor, vapor, and dust control will be conducted for this project due to the sensitive location of the Site and immediate proximity to residential and commercial buildings.

A variety of engineering controls will be available to control odors, vapors, and dust. The primary method of control will be completing subsurface soil excavation in a temporary fabric structure to the extent practicable. The structure is not expected to extend over the drainage swale or two-foot shallow excavation areas. Additional controls may include, but will not necessarily be limited to, wetting soils with water to control dust, limiting the size of excavations, covering contaminated soils with plastic sheeting; use of odor suppressant foam; Biosolve®, Rusmar foam, or similar; and possible use of other odor suppressant systems.

3.3.9 Air Monitoring

Community and work zone air monitoring will be performed per the NYSDOH and the Occupational Safety and Health Administration (OSHA) requirements, and according to the site-specific HASP (to be generated by the selected contractor) and CAMP. A Community Air Monitoring Plan (CAMP) will be prepared to meet the requirements of DER-10 as prescribed in the generic CAMP. The contaminants of concern at the Site are VOCs and particulates.

Community air monitoring will be continuous during activities capable of generating dust or releasing odors or vapors, such as site clearing, soil erosion fencing installation, excavation and handling of impacted soils, and backfilling and grading. Details of the community air monitoring program will be provided in the Community Air Monitoring Plan (CAMP).

Summaries of all air monitoring data will be provided to NYSDEC and NYSDOH on a weekly basis to facilitate the transfer of information related to protection of the local community. In the event that air monitoring data exceeds levels established in the CAMP, the NYSDEC and NYSDOH will be notified within 24 hours.

3.3.10 Noise and Vibration Evaluation

The planned remediation activities have the potential to generate noise and vibrations. The potential for noise and vibration impacts associated with the remediation process will be evaluated as part of the design. If necessary, requirements to monitor and mitigate these impacts will be included in the design.

3.3.11 Erosion and Sediment Control

Remediation activities will disturb an area greater than one acre in size. For that reason, the SPDES General Construction Stormwater Permit GP-0-08-001 from Construction Activity (GP-02-01, April 2008) will be required. The permit, as well as local permitting rules, requires preparation of a stormwater pollution prevention plan (SWPPP). Erosion and sedimentation best management practices (BMP) will be planned and implemented in accordance with the New York State Stormwater Management Design Manual and New York Standards and Specifications for Erosion and Sediment Control.

Erosion will be prevented and sediment will be controlled during all land disturbing activities. Stormwater runoff will be controlled in a manner to prevent contact with impacted soils. Stormwater that does contact impacted soils will be collected and transported off-site to an approved water handling facility or to the on-site water treatment plant. Hay bales, silt fence, diversions, and other BMPs described in the SWPPP will be used as necessary to prevent erosion of exposed soils.

Additional erosion control materials will be kept on site to immediately repair any deficiencies that are discovered during the inspections.

On-site decontamination pads will be used to remove mud from truck tires and prevent tracking of mud and impacted soil onto the streets. Detailed plans and specifications for erosion and sediment control will be provided with the design submittal.

3.3.12 Decontamination

During and upon completion of remediation activities, decontamination of equipment will be performed in order to prevent contaminated material from being spread off-site during waste hauling activities, and to prevent the spreading of impacted material to un-impacted areas of the Site. Trucks used for off-site transport of excavated material will be loaded in a manner that limits contact with impacted materials. Before they leave the site, trucks will be inspected and the extent of decontamination needed will be determined on a case by case basis.

An engineered equipment decontamination pad will be constructed to contain decontamination residues. When possible, trucks will be decontaminated using dry decontamination methods (i.e., removal of loose material with a broom or brush). If inspection determines that additional decontamination is required, wet decontamination using hoses or pressure washers will be performed.

Construction equipment will be decontaminated before it leaves areas of contamination in order to prevent tracking to unimpacted portions of the site. The method of equipment decontamination will consist of pressure washing to remove any impacted soil. Decontamination water generated during cleaning of tools and equipment will be collected on-site and disposed of at an approved water handling facility or treated on-site. Water generated from decontaminating personnel will be minimal due to the availability of disposable personal protective equipment (PPE) such as Tyvek coveralls, booties, and nitrile gloves. The volume of decontamination water generated from personnel decontamination is assumed to be negligible compared to equipment decontamination water, stormwater removal, and dewatering activities in the disturbed areas of the Site.

3.4 Design Requirements

3.4.1 Remedial Action Objectives

The remedial goals for the Site have been established through the remedy selection process stated in 6 NYCRR Part 375-1.10. As stated in the ROD, "The selected remedy is protective of human health and the environment, complies with State and Federal requirements that are legally applicable or relevant and appropriate to the remedial action to the extent practicable, and is cost effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies, to the maximum extent practicable, and satisfies the preference for remedies that reduce toxicity, mobility, or volume as a principal element".

In accordance with the ROD, the Remedial Action Objectives for Operable Unit 1 are as follows:

- Groundwater
  - Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.
  - Prevent contact with, or inhalation of, volatiles from contaminated groundwater.
  - Restore the groundwater aquifer to meet ambient groundwater quality criteria to the extent practicable.
  - Remove the source of groundwater contamination.
- Soil
  - Prevent ingestion/direct contact with soil exceeding applicable SCOs.
  - Prevent inhalation of contaminants, including dust, from the soil.
  - Prevent migration of contaminants that would result in groundwater or surface water contamination.
- Soil Vapor
  - Prevent inhalation of soil vapor contaminants due to soil vapor intrusion into future buildings.

3.4.2 Soil Cleanup Objectives

The ROD has established soil cleanup objectives used to determine the required limits of excavation including the SCOs for restricted residential land use established in 6 NYCRR 375-6.8(b).

Achievement of these standards will allow restricted residential use of the Site. Restricted residential use standards are applied to soil at depths less than 15 feet below the ground surface. Removal or treatment of soil at depths greater than 15 feet is not required in order to allow residential use. In order to meet the RAO for removal of source material described in Section 3.4.1, the FS established the definition of source material as soil containing substantial DNAPL contamination in layers thicker than 0.2 feet. Soil with staining, sheens, or MGP odors will not be considered source material.

3.4.3 Property Access

OU-1 is comprised of property owned by O&R and access agreements for remedial activities are not expected to be required; however, O&R will coordinate with the property owner of the adjacent 104 Maple Avenue property since excavation is expected to extend to the property line.

3.4.4 Utilities

The selected remedial contractor will coordinate with Dig Safely New York to identify and verify the location of subsurface utilities within the work limits. During the excavation work active utilities (if present) may need to be relocated or protected to allow access of excavation equipment. Utility relocation and protection will be addressed within the remedial design. Abandoned utilities within the excavation area will be removed and disposed as discussed in Section 3.3.4 above.

3.4.5 Environmental Monitoring Controls

Environmental controls will ensure that the work activities do not spread MGP-impacted materials outside the impacted areas and maintain the protection of human health and the environment throughout the remedial operations. These items will be covered in more detail in the Transportation Plan, CAMP, and HASP for the Site. These items will be submitted as part of the design.

3.4.6 Green Remediation

NYSDEC DER-31: Green Remediation (DER-31; NYSDEC, 2010b) requires that sustainable practices be considered during remedial design and construction. Specific practices identified in the ROD include the following:

- Considering the environmental impacts of treatment technologies in the long term
- Reducing direct and indirect greenhouse gas and other emissions

- Increasing energy efficiency and minimizing use of non-renewable energy
- Conserving and efficiently managing resources and materials
- Reducing waste, increasing recycling and increasing reuse of materials
- Maximizing habitat value and creating habitat when possible
- Fostering green and healthy communities and working landscapes which balance ecological, economic and social goals
- Integrating the remedy with the end use where possible

Detailed plans and specifications for the entire remedy will be prepared in accordance with DER-31 as part of the design activities. DER-31 compliant practices and requirements will be clearly identified and provided to NYSDEC as part of the 65 percent design submittal.

4 PERMITTING AND OTHER AUTHORIZATIONS

In addition to performance requirements established to ensure that the design of the remedial action meets the remedial action objectives set in the ROD (NYSDEC, 2011), the design will also be prepared to meet permitting and other regulatory requirements of local, state, and federal laws and regulations. As specified in Appendix 7B of the DER-10 Technical Guidance for Site Investigation and Remediation (NYSDEC, May 2010), the NYSDEC may grant exemption from most state permits required for completion of this remedial action, provided the substantive requirements of the permit programs are followed.

4.1 Construction Stormwater Permit

Remediation activities will disturb an area of approximately one acre and will require the SPDES General Construction Stormwater Permit GP-0-09-001 from Construction Activity (GP-02-01, April 2008). A notice of intent (NOI) will be filed with NYSDEC and a storm water pollution prevention plan (SWPPP) will be prepared and implemented. Copies of the NOI and SWPPP will be submitted to the village as part of the local permitting process.

4.2 Discharge Permit

Approval for discharge of treated groundwater collected during excavation dewatering will also be required. The water would be discharged to the locally owned public treatment works (POTW) or discharged to the local storm sewer system under a State Pollutions Discharge Elimination System (SPDES) permit equivalent through the Division of Environmental Remediation.

4.3 Local Permits Approvals

At an early stage in the design process, O&R will meet with local representatives to discuss permits and approvals for implementation of the work. Permits which may be required include the following:

- Land disturbing activity permit for clearing, filling, and grading
- Building, electrical, and plumbing permits for temporary facilities and controls
- Approvals for pipe hookups to storm drains or sanitary sewers for treatment system discharges
- Coordination with the Village of Haverstraw to establish truck routes for soil disposal hauling

A review of information from the Federal Emergency Management Agency indicates that the Site is not located in a regulated flood plain area. Reviews of the NYSDEC Environmental Resource Mapper and the National Wetland Inventory indicate that federal and state freshwater wetlands are not located within Site boundaries.

5 SCHEDULE

The schedule for remedial design activities is included in Appendix C.

6 POST CONSTRUCTION PLANS

In addition to the remedial construction activities described in Section 3, meeting ROD requirements may also require implementation of institutional and engineering controls once remedial construction is complete. These post-construction activities are not included in the remedial design.

6.1 Site Management Plan

As specified in DER-10, a Site Management Plan (SMP) is required whenever site restrictions are required as part of a remedial action. The SMP will include the following elements:

- An Institutional and Engineering Control Plan that insures institutional and/or engineering controls remain in place and effective
- An Operations and Maintenance (O&M) Plan describing procedures for maintaining engineering controls
- Provisions for the management and inspection of the identified engineering controls and groundwater controls
- Groundwater monitoring plan to assess performance and effectiveness of the remedy
- A schedule of monitoring and frequency of submittals to NYSDEC

6.2 Institutional and Engineering Controls

Institutional controls will be implemented in the form of environmental easements for the controlled properties that:

- Require the remedial party or site owners to complete and submit to the NYSDEC a periodic certification of institutional controls
- Restricts the use of groundwater as a source of potable or process water
- Prohibits the production of animal products for human consumption
- Requires compliance with the Department approved Site Management Plan
- Restricts the use of any vegetable gardens on site
- Prohibits single family housing

Elements of the remedial action which require ongoing operation, maintenance, or monitoring are considered engineering controls. As discussed previously, the two-foot soil cover in the shallow soil excavation area identified in the ROD would be an engineering control. The ROD specifies that the need for an in situ groundwater treatment system in OU-1 will be evaluated. If it is determined that implementation of in-situ groundwater treatment is required, that treatment system will be an engineering control.

7 REFERENCES

AECOM, 2013. Remedial Design Work Plan, Clove and Maple Ave. Former MGP Site, Haverstraw, Rockland County, NY. NYSDEC Site Number 3-44-049. July 18, 2013.

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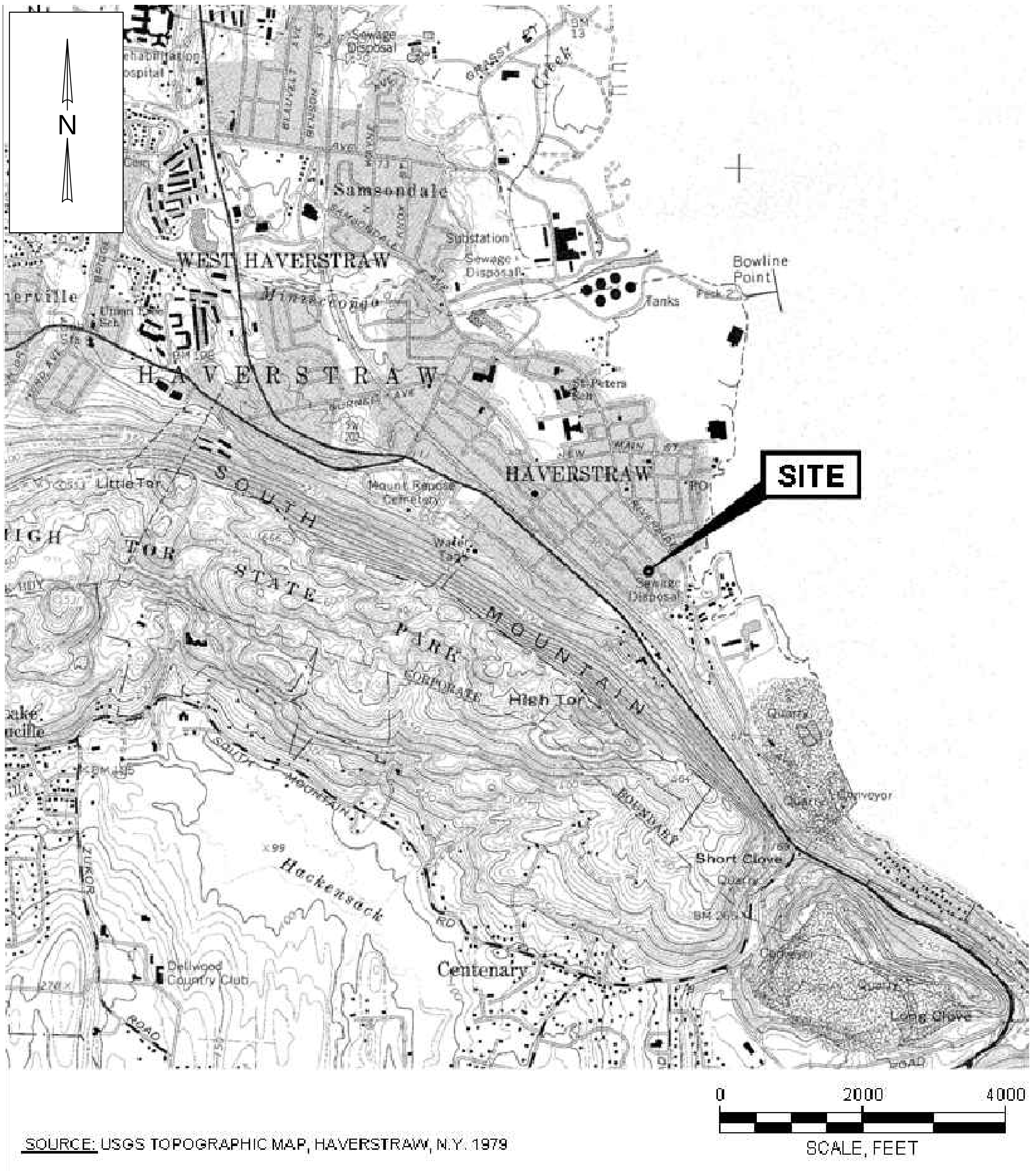
RETEC, 2005. Clove and Maple Avenue Former MGP Sites, Haverstraw, NY. Soil Gas, Indoor and Ambient Air Sampling of February 2005. Preliminary Evaluation of Results. Prepared by The RETEC Group, Inc. March 23, 2005.

FIGURES



SITE LOCATION MAP

NATURAL RESOURCE TECHNOLOGY

REMEDIAL DESIGN WORK PLAN
ORANGE AND ROCKLAND UTILITIES, INC.
CLOVE AND MAPLE FORMER MGP SITE
HAVERSTRAW, NEW YORK

DRAWN: DMD DATE: 02/12/15 CHK'D: JRR DATE: 03/06/15 APP'D: JFM DATE: 03/06/15

PROJECT NO. 2254/2.0

DRAWING NO. 2254-2-A01

FIGURE NO. 1

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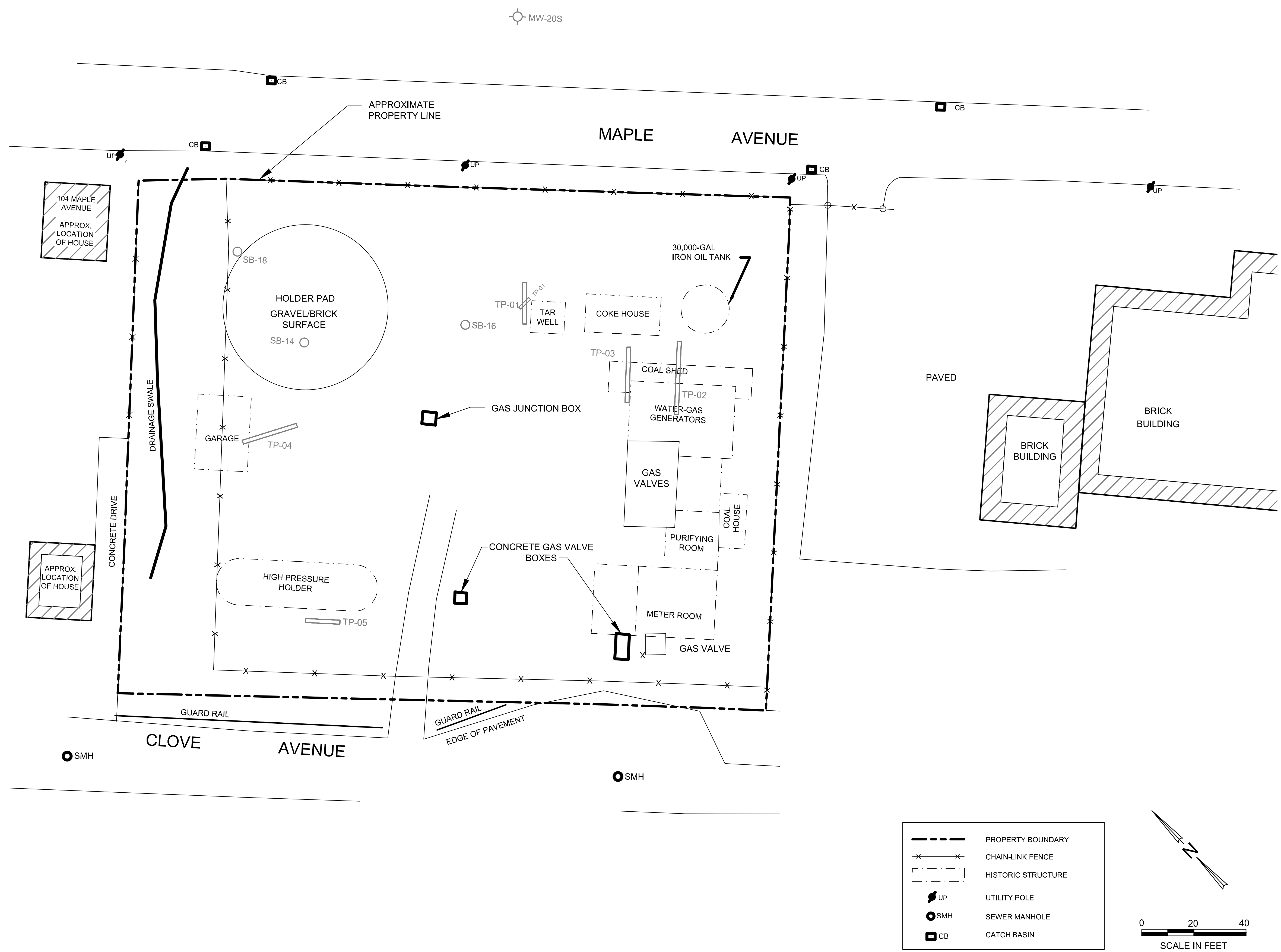

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APPROVED BY: JFM	DATE: 03/06/15
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SITE LAYOUT

REMEDIAL DESIGN WORK PLAN
ORANGE AND ROCKLAND UTILITIES, INC.
CLOVE AND MAPLE FORMER MGP SITE
HAVERSTRAW, NEW YORK

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2254/2.0

FIGURE NO.
2

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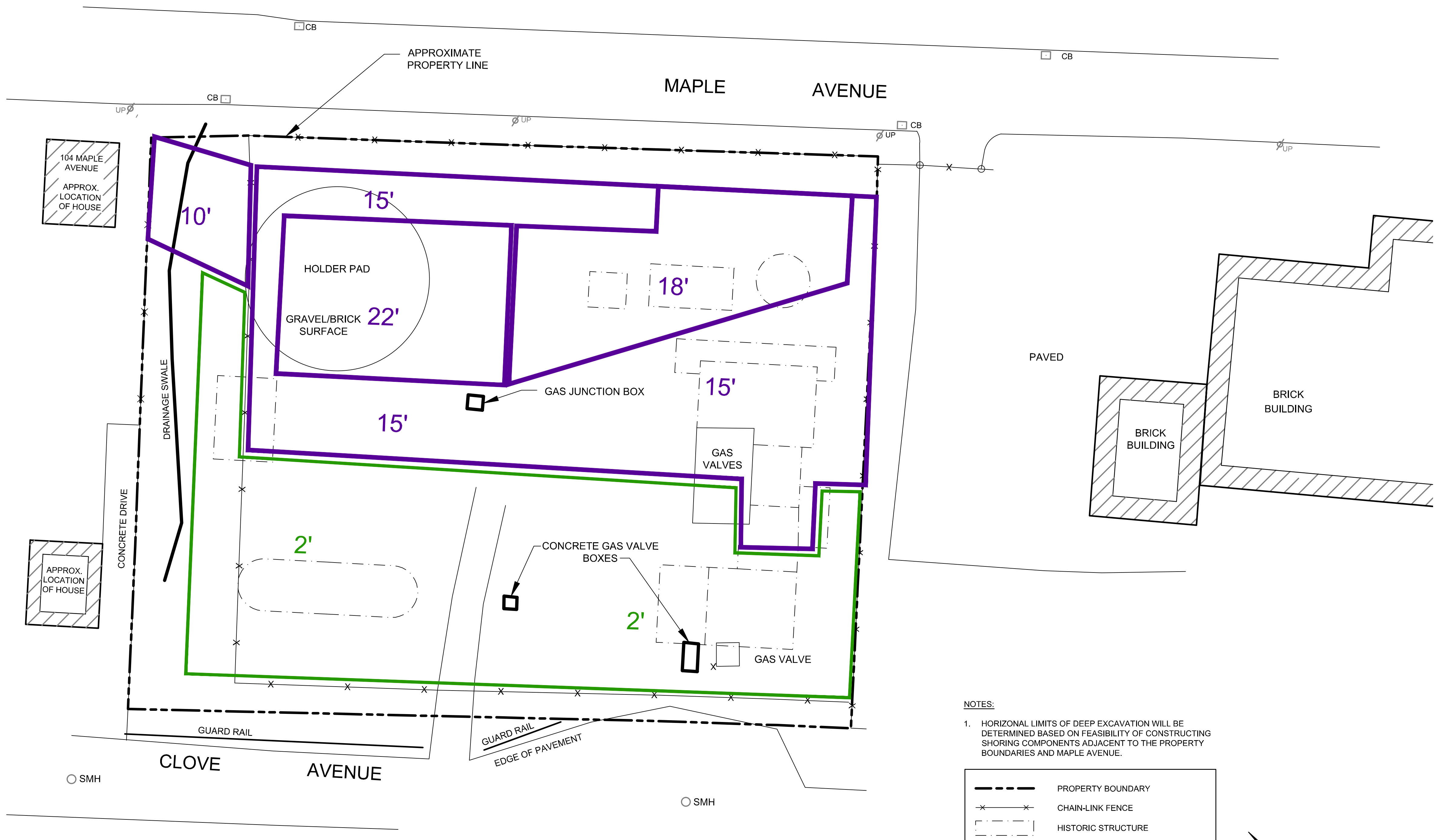

NOTES:

1. HORIZONAL LIMITS OF DEEP EXCAVATION WILL BE DETERMINED BASED ON FEASIBILITY OF CONSTRUCTING SHORING COMPONENTS ADJACENT TO THE PROPERTY BOUNDARIES AND MAPLE AVENUE.

	PROPERTY BOUNDARY
	CHAIN-LINK FENCE
	HISTORIC STRUCTURE
UP	UTILITY POLE
SMH	SEWER MANHOLE
CB	CATCH BASIN
	APPROXIMATE LIMITS OF SHALLOW TWO-FOOT EXCAVATION ESTABLISHED IN ROD
	APPROXIMATE LIMITS OF DEEP EXCAVATION ESTABLISHED IN ROD

N

0 20 40

SCALE IN FEET

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APPROVED BY:	JFM	DATE:	03/06/15
DRAWING NO:	2254-2-B03		
REFERENCE: .			

PROPOSED REMEDIAL ACTION

REMEDIAL DESIGN WORK PLAN
ORANGE AND ROCKLAND UTILITIES, INC.
CLOVE AND MAPLE FORMER MGP SITE
HAVERSTRAW, NEW YORK

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2254/2.0

FIGURE NO.
3

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APPENDIX A

RECORD OF DECISION

RECORD OF DECISION

OR - Haverstraw Clove & Maple Former MGP
Operable Unit Number: 01
Haverstraw, Rockland County
Site No. 344049
March 2011

Prepared by
Division of Environmental Remediation
New York State Department of Environmental Conservation

DECLARATION STATEMENT - RECORD OF DECISION

OR - Haverstraw Clove & Maple Former MGP
Operable Unit Number: 01
Haverstraw, Rockland County
Site No. 344049
March 2011

Statement of Purpose and Basis

This document presents the remedy for Operable Unit Number: 01 of the OR - Haverstraw Clove & Maple Former MGP site. The remedial program was chosen in accordance with the New York State Environmental Conservation Law and Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (6 NYCRR) Part 375, and is not inconsistent with the National Oil and Hazardous Substances Pollution Contingency Plan of March 8, 1990 (40CFR300), as amended.

This decision is based on the Administrative Record of the New York State Department of Environmental Conservation (the Department) for Operable Unit Number: 01 of the OR - Haverstraw Clove & Maple Former MGP site and the public's input to the proposed remedy presented by the Department. A listing of the documents included as a part of the Administrative Record is included in Appendix B of the ROD.

Description of Selected Remedy

The elements of the selected remedy are as follows:

1. A remedial design program will be implemented to provide the details necessary for the construction, operation, maintenance, and monitoring of the remedial program. Green remediation principals and techniques will be implemented to the extent feasible in the design, implementation, and site management of the remedy as per DER-31. The major green remediation components are as follows:

    - Considering the environmental impacts of treatment technologies and remedy stewardship over the long term;
    - Reducing direct and indirect greenhouse gas and other emissions;
    - Increasing energy efficiency and minimizing use of non-renewable energy;
    - Conserving and efficiently managing resources and materials;
    - Reducing waste, increasing recycling and increasing reuse of materials which would otherwise be considered a waste;
    - Maximizing habitat value and creating habitat when possible;
    - Fostering green and healthy communities and working landscapes which balance ecological, economic and social goals; and

- Integrating the remedy with the end use where possible and encouraging green and sustainable re-development

2. Excavation and off-site disposal of source material and contaminated soil to depths ranging from approximately 15 feet to 22 feet below ground surface (bgs). The limits of excavation are depicted in Figure 3.

3. Excavation and off-site disposal of existing former MGP structures, debris, piping, and major obstructions. The structures and associated piping will be removed to the extent practical.

4. Excavation and off-site disposal of impacted soil in the drainage swale area located along the northern boundary of the site. The soil will be removed to a depth of approximately 12 feet bgs.

5. Soil excavation will be performed within a temporary structure to control odor, vapor, and dust.

6. Groundwater extracted during construction will be sent off-site for treatment and disposal or treated on-site and discharged in compliance with applicable discharge standards.

7. A site cover will be required to allow for restricted residential use of the site. The cover will consist either of the structures such as buildings, pavement, sidewalks comprising the site development or a soil cover in areas where the upper two feet of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs). Where the soil cover is required it will be a minimum of two feet of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for restricted residential use. The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer.

8. Imposition of an institutional control in the form of an environmental easement for the controlled property that will:

   a) require the remedial party or site owner to complete and submit to the Department a periodic certification of institutional and engineering controls in accordance with Part 375-1.8 (h)(3);

   b) allow the use and development of the controlled property for restricted-residential, commercial and industrial uses as defined by Part 375-1.8(g), although land use is subject to local zoning laws;

   c) restrict the use of groundwater and/or surface water as a source of potable or process water, without necessary water quality treatment as determined by the Department, NYSDOH or County DOH;

   d) prohibit agriculture or vegetable gardens on the controlled property;

e) require compliance with the Department approved Site Management Plan.

9. A Site Management Plan is required, which will include the following:

   a) An Institutional and Engineering Control Plan that identifies all use restrictions and engineering controls for the site and details the steps and media-specific requirements necessary to ensure the following institutional and/or engineering controls remain in place and effective:

   Institutional Controls: The Environmental Easement discussed in paragraph 8 above.

   Engineering Controls: The site cover identified in paragraph 7 above.

   This plan includes, but may not be limited to:

      i. Excavation Plan which details the provisions for management of future excavation in areas of remaining contamination;

      ii. descriptions of the provisions of the environmental easement including any land use, and/or groundwater use restrictions;

      iii. provision for evaluation of the potential for soil vapor intrusion for any buildings developed on the site, including provision for implementing actions recommended to address exposures related to soil vapor intrusion;

      iv. provisions for the management and inspection of the identified engineering controls;

      v. the steps necessary for the periodic reviews and certification of the institutional and/or engineering controls; and

   b) a Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but may not be limited to:

      i. monitoring of groundwater to assess the performance and effectiveness of the remedy;

      ii. a schedule of monitoring and frequency of submittals to the Department;

      iii. monitoring for vapor intrusion for any buildings developed on the site, including provision to take actions to address any potential exposures to soil vapor intrusion.

<u>New York State Department of Health Acceptance</u>

The New York State Department of Health (NYSDOH) concurs that the remedy for this site is protective of human health.

Declaration

The selected remedy is protective of human health and the environment, complies with State and Federal requirements that are legally applicable or relevant and appropriate to the remedial action to the extent practicable, and is cost effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies, to the maximum extent practicable, and satisfies the preference for remedies that reduce toxicity, mobility, or volume as a principal element..

MAR 31 2011

Date

Dale A. Desnoyers, Director
Division of Environmental Remediation

RECORD OF DECISION

OR - Haverstraw Clove & Maple Former MGP
Operable Unit Number: 01
Haverstraw, Rockland County
Site No. 344049
March 2011

SECTION 1: SUMMARY AND PURPOSE

The New York State Department of Environmental Conservation (the Department), in consultation with the New York State Department of Health (NYSDOH), has selected a remedy for the above referenced site. The disposal of hazardous wastes at the site has resulted in threats to public health and the environment that would be addressed by the remedy. The disposal or release of hazardous wastes at this site, as more fully described in this document, has contaminated various environmental media. The remedy is intended to attain the remedial action objectives identified for this site for the protection of public health and the environment. This Record of Decision (ROD) identifies the selected remedy, summarizes the other alternatives considered, and discusses the reasons for selecting the remedy.

The Department has issued this document in accordance with the requirements of New York State Environmental Conservation Law and 6 NYCRR Part 375. This document is a summary of the information that can be found in the site-related reports and documents.

SECTION 2: SITE DESCRIPTION AND HISTORY

Location: The Orange and Rockland Utilities (O&R) Clove and Maple site is a former manufactured gas plant (MGP) and is located at 120 Maple Avenue in a residential and commercial portion of Haverstraw, Rockland County, New York. The site is approximately 1 acre in size and was operated from 1887 through 1935. The site ceased operation in 1935 after the introduction of natural gas in the area. The site is bounded by two residential properties to the northwest, a residential apartment complex and a former pond area to the northeast, Clove Avenue to the southwest and Maple Avenue to the southeast.

Site Features: The site is currently owned by O&R and was utilized as a natural gas regulator station until 2007 at which time the station was decommissioned. The site is currently vacant and only the piping associated with the former regulator station remains at the site.

Current Zoning/Uses: The site is currently zoned for light industrial uses. The majority of the surrounding area is residential.

Historical Uses: The O&R Clove and Maple site was the location of a former gas manufacturing plant which operated from 1887 through 1935. The plant structures were demolished in the 1960s and the property was subsequently used as a natural gas regulator station. Prior to the MGP operations at the Clove and Maple site, a gas plant was in operation at 93B Maple Avenue. The 93B site (Site No. 344044) is located northwest of the Clove and Maple site on the opposite side of Maple Avenue. The 93B MGP Site and nearby properties were previously investigated and remediated in 2003 and 2005.

Site Geology and Hydrogeology: The site is located at the base of High Tor Mountain and is characterized by moderate relief with the ground surface sloping approximately 25 feet to the north. Site geology consists of four geologic units and they are from top to bottom: 1) fill, with thickness ranging from 5 feet to approximately 15 feet and consist of cobbles, gravel, cinders and coal; 2) alluvium (7 feet to 25 feet thick) consisting of silt, clay including coarse-grained sand and gravel; 3) glacial lacustrine clay, with thickness ranging from 2 feet to about 18 feet and; 4) clay consisting of dense silty clay with thickness ranging from 17 feet to about 36 feet. The on-site and off-site groundwater flows northeasterly towards a former pond area and the Hudson River. The former pond area is located under the apartment complex and its parking lot. This pond area was also part of a former stream channel that emptied into the Hudson River. The depth of groundwater varies throughout the site with typical depths of 5 feet to 8 feet below ground surface.

Operable Units: The site was divided into three operable units. An operable unit represents a portion of a remedial program for a site that for technical or administrative reasons can be addressed separately to investigate, eliminate or mitigate a release, threat of release or exposure pathway resulting from the site contamination. Operable unit 1 (OU1) is the on-site former MGP area (the O&R property) and drainage swale. OU2 consists of off-site properties including single family residential properties, an apartment complex, a portion of an alleyway, and a portion of Maple Avenue. OU3 consists of sediments in the Hudson River embayment located close to the site.

Operable Unit (OU) Number 01 is the subject of this document.

A Record of Decision has yet to be issued for OU 02 and 03.

A site location map is attached as Figure 1.

SECTION 3: LAND USE AND PHYSICAL SETTING

The Department may consider the current, intended, and reasonably anticipated future land use of the site and its surroundings when evaluating a remedy for soil remediation. For this site, alternatives (or an alternative) that restrict(s) the use of the site to restricted-residential use (which allows for commercial use and industrial use) as described in Part 375-1.8(g) is/are being evaluated in addition to an alternative which would allow for unrestricted use of the site.

A comparison of the results of the investigation to the appropriate standards, criteria and guidance values (SCGs) for the identified land use and the unrestricted use SCGs for the site contaminants is included in the Tables for the media being evaluated in Exhibit A.

SECTION 4: <u>ENFORCEMENT STATUS</u>

Potentially Responsible Parties (PRPs) are those who may be legally liable for contamination at a site. This may include past or present owners and operators, waste generators, and haulers.

The PRPs for the site, documented to date, include:

Orange and Rockland Utilities, Inc.

This MGP Site is part of the Orange and Rockland Utilities (O&R) multi-site Consent Order. The Department and O&R entered into Consent Orders in January 8, 1996 (D3-0002-94-12) and September 29, 1998(D3-0001-98-03). These orders were superseded by and Order dated March 11, 1999(D3-0001-99-01). The Orders obligate O&R to implement a full remedial program.

SECTION 5: <u>SITE CONTAMINATION</u>

5.1: <u>Summary of the Remedial Investigation</u>

A Remedial Investigation (RI) has been conducted. The purpose of the RI was to define the nature and extent of any contamination resulting from previous activities at the site. The field activities and findings of the investigation are described in the RI Report.

The following general activities are conducted during an RI:

- Research of historical information,
- Geophysical survey to determine the lateral extent of wastes,
- Test pits, soil borings, and monitoring well installations,
- Sampling of waste, surface and subsurface soils, groundwater, and soil vapor,
- Sampling of surface water and sediment,
- Ecological and Human Health Exposure Assessments.

5.1.1: <u>Standards, Criteria, and Guidance (SCGs)</u>

The remedy must conform to promulgated standards and criteria that are directly applicable or that are relevant and appropriate. The selection of a remedy must also take into consideration guidance, as appropriate. Standards, Criteria and Guidance are hereafter called SCGs.

To determine whether the contaminants identified in various media are present at levels of concern, the data from the RI were compared to media-specific SCGs. The Department has developed SCGs for groundwater, surface water, sediments, and soil. The NYSDOH has developed SCGs for drinking water and soil vapor intrusion. The tables found in Exhibit A list the applicable SCGs in the footnotes. For a full listing of all SCGs see: http://www.dec.ny.gov/regulations/61794.html

5.1.2: RI Information

The analytical data collected on this site includes data for:

- air
- groundwater
- soil
- soil vapor

The data have identified contaminants of concern. A "contaminant of concern" is a hazardous waste that is sufficiently present in frequency and concentration in the environment to require evaluation for remedial action. Not all contaminants identified on the property are contaminants of concern. The nature and extent of contamination and environmental media requiring action are summarized in Exhibit A. Additionally, the RI Report contains a full discussion of the data. The contaminant(s) of concern identified for this Operable Unit at this site is/are:

benzene	fluorene
ethylbenzene	naphthalene
toluene	indeno(1,2,3-cd)pyrene
xylene (mixed)	benzo(a)pyrene
acenaphthene	benzo(g,h,i)perylene
anthracene	dibenzo[a,h]anthracene
benzo[k]fluoranthene	phenanthrene
chrysene	pyrene
fluoranthene	lead

As illustrated in Exhibit A, the contaminant(s) of concern exceed the applicable SCGs for:

- groundwater
- soil

5.2: Interim Remedial Measures

An interim remedial measure (IRM) is conducted at a site when a source of contamination or exposure pathway can be effectively addressed before issuance of the Record of Decision.

The following IRM(s) has/have been completed at this site based on conditions observed during the RI.

On-site soil cover and fence IRM

As a result of the Preliminary Site Assessment investigations in 1997, a small area of surface soil was found to be impacted by coal tar and PAH compounds. Based on this information, several inches of gravel were placed over this location as well as other areas where foot traffic was observed. Also, a fence was installed around the entire site to restrict access; and no trespassing signs were posted.

5.3: Summary of Human Exposure Pathways

This human exposure assessment identifies ways in which people may be exposed to site-related contaminants. Chemicals can enter the body through three major pathways (breathing, touching or swallowing). This is referred to as *exposure.*

Operable Unit 1 (OU-1) - The site is completely fenced, which restricts public access. However, persons who enter the site could contact contaminants if they were to dig or otherwise disturb the soil located beneath the gravel cover material. People are not drinking the contaminated groundwater because the area is served by a public water supply that is not affected by this contamination. Volatile organic compounds in the groundwater may move into the soil vapor (air spaces within the soil), which in turn may move into overlying buildings and affect the indoor air quality. This process, which is similar to the movement of radon gas from the subsurface into the indoor air of buildings, is referred to as soil vapor intrusion. Because there is no on-site building, inhalation of site contaminants in indoor air due to soil vapor intrusion does not represent a concern for the site in its current condition. The potential exists for the inhalation of site contaminants due to soil vapor intrusion for any future on-site development and occupancy.

Operable Unit 2 (OU-2) - Contact with contaminated soil or groundwater is unlikely unless people dig below the ground surface. People are not drinking the contaminated groundwater because the area is served by a public water supply that is not affected by this contamination. Sampling indicates soil vapor intrusion is not a concern for buildings in OU-2.

Operable Unit 3 (OU-3) - The potential exists for people to come in contact with contaminants in the shallow river sediments while entering or exiting the river during recreational activities.

5.4: Summary of Environmental Assessment

This section summarizes the assessment of existing and potential future environmental impacts presented by the site. Environmental impacts may include existing and potential future exposure pathways to fish and wildlife receptors, wetlands, groundwater resources, and surface water.

The Fish and Wildlife Resources Impact Analysis (FWRIA) for OU 01, which is included in the RI report, presents a detailed discussion of the existing and potential impacts from the site to fish and wildlife receptors.

The primary contaminants of concern are coal tar that was produced and stored at the MGP. Sampling and analysis of the groundwater revealed contamination with volatile and semi-volatile compounds in both the dissolved and in pure product states which exceed groundwater standards. Concentrations of contaminants found on-site exceed soil cleanup objectives. Test pits and soil borings revealed that coal tar and non-aqueous phase liquid (NAPL) coated soils are found at various depths ranging from 6 to 22 feet below ground surface (bgs). NAPLs are organic substances that are relatively insoluble in water and have a different density than water.

Hudson River sediments near a storm water outfall, which is part of OU3, need further investigation to determine the extent of MGP contamination. Some sediments near this storm water outfall have shown MGP impacts.

SECTION 6: SUMMARY OF THE EVALUATION OF ALTERNATIVES

To be selected the remedy must be protective of human health and the environment, be cost-effective, comply with other statutory requirements, and utilize permanent solutions, alternative technologies or resource recovery technologies to the maximum extent practicable. The remedy must also attain the remedial action objectives identified for the site, which are presented in Exhibit B. Potential remedial alternatives for the Site were identified, screened and evaluated in the feasibility study (FS) report.

A summary of the remedial alternatives that were considered for this site is presented in Exhibit C. Cost information is presented in the form of present worth, which represents the amount of money invested in the current year that would be sufficient to cover all present and future costs associated with the alternative. This enables the costs of remedial alternatives to be compared on a common basis. As a convention, a time frame of 30 years is used to evaluate present worth costs for alternatives with an indefinite duration. This does not imply that operation, maintenance, or monitoring would cease after 30 years if remediation goals are not achieved. A summary of the Remedial Alternatives Costs is included as Exhibit D.

6.1: Evaluation of Remedial Alternatives

The criteria to which potential remedial alternatives are compared are defined in 6 NYCRR Part 375. A detailed discussion of the evaluation criteria and comparative analysis is included in the FS report.

The first two evaluation criteria are termed "threshold criteria" and must be satisfied in order for an alternative to be considered for selection.

1. Protection of Human Health and the Environment. This criterion is an overall evaluation of each alternative's ability to protect public health and the environment.

2. Compliance with New York State Standards, Criteria, and Guidance (SCGs). Compliance with SCGs addresses whether a remedy will meet environmental laws, regulations, and other standards and criteria. In addition, this criterion includes the consideration of guidance which the Department has determined to be applicable on a case-specific basis.

The next six "primary balancing criteria" are used to compare the positive and negative aspects of each of the remedial strategies.

3. Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of the remedial alternatives after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the engineering and/or institutional controls intended to limit the risk, and 3) the reliability of these controls.

4. Reduction of Toxicity, Mobility or Volume. Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

5. Short-term Impacts and Effectiveness. The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and/or implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared against the other alternatives.

6. Implementability. The technical and administrative feasibility of implementing each alternative are evaluated. Technical feasibility includes the difficulties associated with the construction of the remedy and the ability to monitor its effectiveness. For administrative feasibility, the availability of the necessary personnel and materials is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, institutional controls, and so forth.

7. Cost-Effectiveness. Capital costs and annual operation, maintenance, and monitoring costs are estimated for each alternative and compared on a present worth basis. Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision.

8. Land Use. When cleanup to pre-disposal conditions is determined to be infeasible, the Department may consider the current, intended, and reasonable anticipated future land use of the site and its surroundings in the selection of the soil remedy.

The final criterion, Community Acceptance, is considered a "modifying criterion" and is taken into account after evaluating those above. It is evaluated after public comments on the Proposed Remedial Action Plan have been received.

9. Community Acceptance. Concerns of the community regarding the investigation, the evaluation of alternatives, and the PRAP are evaluated. A responsiveness summary will be prepared that describes public comments received and the manner in which the Department will address the concerns raised. If the selected remedy differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes.

6.2: Elements of the Remedy

The basis for the Department's remedy is set forth at Exhibit E.

The estimated present worth cost to implement the remedy is $8,000,000. The cost to construct the remedy is estimated to be $5,900,000 and the estimated average annual cost is $60,000.

The elements of the selected remedy are as follows:

1. A remedial design program will be implemented to provide the details necessary for the construction, operation, maintenance, and monitoring of the remedial program. Green remediation principals and techniques will be implemented to the extent feasible in the design, implementation, and site management of the remedy as per DER-31. The major green remediation components are as follows:

   - Considering the environmental impacts of treatment technologies and remedy stewardship over the long term;
   - Reducing direct and indirect greenhouse gas and other emissions;
   - Increasing energy efficiency and minimizing use of non-renewable energy;
   - Conserving and efficiently managing resources and materials;
   - Reducing waste, increasing recycling and increasing reuse of materials which would otherwise be considered a waste;
   - Maximizing habitat value and creating habitat when possible;
   - Fostering green and healthy communities and working landscapes which balance ecological, economic and social goals; and
   - Integrating the remedy with the end use where possible and encouraging green and sustainable re-development.

2. Excavation and off-site disposal of source material and contaminated soil to depths ranging from approximately 15 feet to 22 feet below ground surface (bgs). The limits of excavation are depicted in Figure 3.

3. Excavation and off-site disposal of existing former MGP structures, debris, piping, and major obstructions. The structures and associated piping will be removed to the extent practical.

4. Excavation and off-site disposal of impacted soil in the drainage swale area located along the northern boundary of the site. The soil will be removed to a depth of approximately 12 feet bgs.

5. Soil excavation will be performed within a temporary structure to control odor, vapor, and dust.

6. Groundwater extracted during construction will be sent off-site for treatment and disposal or treated on-site and discharged in compliance with applicable discharge standards.

7. A site cover will be required to allow for restricted residential use of the site. The cover will consist either of the structures such as buildings, pavement, sidewalks comprising the site development or a soil cover in areas where the upper two feet of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs). Where the soil cover is required it will be a minimum of two feet of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for restricted residential use. The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer.

8. Imposition of an institutional control in the form of an environmental easement for the controlled property that will:

    a) require the remedial party or site owner to complete and submit to the Department a periodic certification of institutional and engineering controls in accordance with Part 375-1.8 (h)(3);

    b) allow the use and development of the controlled property for restricted-residential, commercial and industrial uses as defined by Part 375-1.8(g), although land use is subject to local zoning laws;

    c) restrict the use of groundwater and/or surface water as a source of potable or process water, without necessary water quality treatment as determined by the Department, NYSDOH or County DOH;

    d) prohibit agriculture or vegetable gardens on the controlled property;

    e) require compliance with the Department approved Site Management Plan.

9. A Site Management Plan is required, which will include the following:

    a) an Institutional and Engineering Control Plan that identifies all use restrictions and engineering controls for the site and details the steps and media-specific requirements necessary to ensure the following institutional and/or engineering controls remain in place and effective:

    Institutional Controls: The Environmental Easement discussed in paragraph 8 above.

    Engineering Controls: The site cover identified in paragraph 7 above.

    This plan includes, but may not be limited to:

    i. Excavation Plan which details the provisions for management of future excavation in areas of remaining contamination;
    ii. descriptions of the provisions of the environmental easement including any land use, and/or groundwater use restrictions;

iii. provision for evaluation of the potential for soil vapor intrusion for any buildings developed on the site, including provision for implementing actions recommended to address exposures related to soil vapor intrusion;
iv. provisions for the management and inspection of the identified engineering controls;
v. the steps necessary for the periodic reviews and certification of the institutional and/or engineering controls; and

b) a Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but may not be limited to:

i. monitoring of groundwater to assess the performance and effectiveness of the remedy;

ii. a schedule of monitoring and frequency of submittals to the Department;

iii. monitoring for vapor intrusion for any buildings developed on the site, including provision to take actions to address any potential exposures to soil vapor intrusion.

Exhibit A

Nature and Extent of Contamination

This section describes the findings of the Remedial Investigation (RI) for all environmental media that were evaluated. As described in Section 5.1.2, samples were collected from various environmental media to characterize the nature and extent of contamination.

For each medium, a table summarizes the findings of the investigation for OU 1. The tables present the range of contamination found at the site in the media and compares the data with the applicable SCGs for the site. The contaminants are arranged into categories; volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and inorganics (metals and cyanide). For comparison purposes, the SCGs are provided for each medium that allows for unrestricted use. For soil, if applicable, the restricted-residential use SCGs identified in Section 5.1.1 are also presented.

Waste/Source Areas

As described in the RI report, waste/source materials were identified at the OU1 portion of the site which are impacting groundwater and soil.

Wastes are defined in 6 NYCRR Part 375-1.2 (aw) and include solid, industrial and/or hazardous wastes. Source Areas are defined in 6 NYCRR Part 375 (au). Source areas are areas of concern at a site where substantial quantities of contaminants are found which can migrate and release significant levels of contaminants to another environmental medium. Wastes and source areas were identified at the site, as described below.

Manufactured gas was cooled and purified prior to distribution. Two principal waste materials were produced in this process: coal tar and purifier waste. Coal tar is a reddish brown to black oily liquid by-product which formed as a condensate as the gas cooled. Purifier waste is a mixture of iron filings and wood chips which was used to filter and remove cyanide and sulfur gases from the mix prior to distribution.

Coal tar does not readily dissolve in water. Materials such as this are commonly referred to as non-aqueous phase liquid, or NAPL. The term NAPL and coal tar are used interchangeably in this document. Although most coal tars are slightly denser than water, the difference in density is slight. Consequently, they can either float or sink when in contact with water.

Specific volatile organic compounds (VOCs) of concern are benzene, toluene, ethylbenzene and xylenes. These are referred to collectively as BTEX in this document. Specific semivolatile organic compounds of concern are the polycyclic aromatic hydrocarbons (PAHs):

acenaphthene	*benzo(a)pyrene*	*chrysene*
acenaphthylene	*benzo(b)fluoranthene*	*dibenzo(a,h)anthracene*
anthracene	benzo(g,h,i)perylene	fluoranthene
benzo(a)anthracene	*benzo(k)fluoranthene*	fluorene

indeno(1,2,3-cd)pyrene	naphthalene	pyrene
2-methylnaphthalene	phenanthrene	

Total PAH concentrations as referred to in this plan are the sum of the individual PAHs listed above. The italicized PAHs are probable human carcinogens.

Unlike NAPL, purifier waste is a solid waste of oatmeal consistency. Purifier waste has the potential to leach cyanide and create acidic conditions in nearby surface water and/or groundwater. It contains high concentrations of sulfur and cyanide and has a characteristic blue color from complexed ferrocyanides.

Source areas were identified at the site as noted on Figure 2. The coal tar was found at depths ranging from 5 to 22 feet below the ground surface. These areas were found primarily near the locations of the former MGP structures.

The waste/source areas identified in OU1 will be addressed in the remedy selection process.

Groundwater

Groundwater samples were collected from monitoring wells and analyzed for volatile, semivolatile, and metals compounds to assess conditions at OU1. The results indicate that groundwater contamination exceeds the SCGs for volatile and semivolatile compounds. The contamination is found in a similar zone as the subsurface soils above the till layer. The underlying compacted till provides a confining layer which appears to limit the potential vertical migration of contaminants at the site. The surrounding area is served by public water.

Table 1 - Groundwater

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
Benzene	ND - 1600	1	31/94
Ethylbenzene	ND – 1300	5	30/94
Toluene	ND – 2800	5	17/94
Xylenes	ND - 3400	5	30/94
SVOCs			
Acenaphthene	ND – 120	20	18/94
Anthracene	ND - 920	50	2/94
Benzo(a)anthracene	ND – 430	0.002	5/94
Benzo(b)fluoranthene	ND - 240	0.002	4/94
Benzo(k)fluoranthene	ND – 24	0.002	2/94
Chrysene	ND – 380	0.002	6/94

Table 1 - Groundwater			
Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
Fluoranthene	ND -1100	50	12/94
Fluorene	ND - 1100	50	12/94
Naphthalene	ND – 10000	10	31/94
Indeno(1,2,3-cd) pyrene	ND- 29	0.002	2/94

a - ppb: parts per billion, which is equivalent to micrograms per liter, ug/L, in water.
b- SCG: Standard Criteria or Guidance - Ambient Water Quality Standards and Guidance Values (TOGs 1.1.1), 6 NYCRR Part 703, Surface water and Groundwater Quality Standards, and Part 5 of the New York State Sanitary Code (10 NYCRR Part 5).

Based on the findings of the RI, the groundwater contaminants associated with the operation of the former MGP are volatile organic compounds (VOC) and semi-volatile organic compounds (SVOCs). The site contaminants that are considered to be the primary contaminants of concern which will drive the remediation of groundwater to be addressed by the remedy selection process are: benzene, toluene, ethylbenzene and xylene (collectively referred to as BTEX); and naphthalene, acenapthene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, and indeno(1,2,3-cd) pyrene which are a subgroup of compounds generally referred to as polycyclic aromatic hydrocarbons (PAHs). Metals were not determined to be contaminants of concern in groundwater. As noted on Figure 2, groundwater contamination is generally located near the former MGP structures located on the OU 1.

Soil

Surface and subsurface soil samples were collected and analyzed for volatile, semivolatile, and metals compounds at the OU1 area during the RI. Shallow soil samples were collected from a depth of 0-6 inches s. Subsurface soil samples were collected to depths up to 32 feet below ground surface (bgs) to assess soil contamination impacts. The results indicate that soils at the site exceed the unrestricted SCG for volatile and semi-volatile organics and metals ranging from 8 to 22 feet bgs for OU1.

Table 2 - Soil					
Detected Constituents	Concentration Range Detected (ppm)[a]	Unrestricted SCG[b] (ppm)	Frequency Exceeding Unrestricted SCG	Restricted-Residential SCG[c] or Protection of Groundwater SCG[d] (ppm)	Frequency Exceeding Restricted-Residential SCG
VOCs					
Benzene	ND-62	0.06	19/73	0.06 [d]	19/73
Toluene	ND-140	0.7	12/73	0.7	12/73
Ethylbenzene	ND- 65	1.0	17/73	1.0 [d]	17/73
Xylene (mixed)	ND-360	0.26	22/73	1.6 [d]	22/73
SVOCs					
Acenaphthene	ND-100	20	5/74	98 [d]	5/74

Table 2 - Soil					
Detected Constituents	Concentration Range Detected (ppm)[a]	Unrestricted SCG[b] (ppm)	Frequency Exceeding Unrestricted SCG	Restricted-Residential SCG[c] or Protection of Groundwater SCG[d] (ppm)	Frequency Exceeding Restricted-Residential SCG
Benzo(a)anthracene	ND-45	1	20/73	1	20/73
Benzo(a)pyrene	ND-30	1	19/73	1	19/73
Benzo(b)fluoranthene	ND-22	1	14/73	1	14/73
Benzo(k)fluoranthene	ND-23	0.8	18/73	3.9	17/73
Chrysene	ND-42	1	19/73	3.9	19/73
Dibenz(a,h)anthracene	ND-43	0.33	12/73	0.33	12/73
Fluoranthene	ND-120	100	1/73	100	1/73
Fluorene	ND-140	30	6/73	100	1/73
Indeno(1,2,3-cd)pyrene	ND-14	0.5	18/73	0.5	18/73
Naphthalene	ND-670	12	17/73	12 [d]	17/73
Phenanthrene	ND-440	100	6/73	100	6/73
Pyrene	ND-170	100	3/73	100	3/73
Metals					
Lead	15.9-726	63	47/71	400	3/71

a - ppm: parts per million, which is equivalent to milligrams per kilogram, mg/kg, in soil.
b - SCG: Part 375-6.8(a), Unrestricted Soil Cleanup Objectives.
c - SCG: Part 375-6.8(b), Restricted Use Soil Cleanup Objectives for the Protection of Public Health for Restricted-Residential Use, unless otherwise noted.
d - SCG: Part 375-6.8(b), Restricted Use Soil Cleanup Objectives for the Protection of Groundwater

The primary soil contaminants are PAHs and lead associated with paint residues on former gas holders from the operation of the former MGP. The area of soil contamination associated with the former MGP site is shown on Figure 2.

PAHs and metals concentrations in surface soil samples exceeded soil cleanup objectives (SCOs) in multiple locations of OU1. Background soil concentrations for metals were found to also exceed SCOs. Surface soil contamination detected during the RI will be addressed in the selected remedy to be consistent with the next intended use of the site.

Based on the findings of the Remedial Investigation, the past disposal of hazardous waste has resulted in the contamination of surface and subsurface soil. The site contaminants identified in soil which are considered to be the primary contaminants of concern, to be addressed by the remedy selection process, are BTEX, PAHs and lead.

Soil Vapor

The evaluation of the potential for soil vapor intrusion resulting from the presence of site related soil or groundwater contamination was evaluated by the sampling of soil vapor. At OU1, no buildings were present in impacted areas, structure vapor intrusion evaluation and sampling could not be conducted on-site; however soil vapor was evaluated at representative locations along the property line and around the perimeter of the Head Start building which is adjacent to the site. The soil vapor investigation confirmed that no MGP-related vapor impacts have been identified extending onto the

Head Start property. Soil vapor and indoor air sampling were performed on the properties comprising OU2 to determine whether actions are needed to address exposure related to soil vapor intrusion. It was concluded that there was no need for remedial actions at the Apartment Complex buildings or the nearby residences on Maple Avenue or West Street based on the sampling analysis.

Based on the concentration detected, and in comparison with the NYSDOH Soil Vapor Intrusion Guidance, no site-related soil vapor contamination of concern was identified during the RI. However, the remedy will address any future site development and the potential for on-site soil vapor intrusion.

Exhibit B

SUMMARY OF THE REMEDIATION OBJECTIVES

The objectives for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375. The goal for the remedial program is to restore the site to pre-disposal conditions to the extent feasible. At a minimum, the remedy shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at the site through the proper application of scientific and engineering principles.

The remedial objectives for the OU1 portion of the site are:

Groundwater

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.
- Restore ground water aquifer to meet ambient groundwater quality criteria, to the extent practicable.
- Remove the source of groundwater contamination.

Soil

- Prevent ingestion/direct contact with contaminated soil exceeding applicable SCOs.
- Prevent inhalation of or exposure from contaminants, including dust, from the soil
- Prevent migration of contaminants that would result in groundwater or surface water contamination.

Soil Vapor

- Prevent impacts to public health resulting from the potential for soil vapor intrusion into future buildings at a site.

Exhibit C

Description of Remedial Alternatives

The following alternatives were considered based on the remedial action objectives (see Exhibit B) to address the contaminated media identified at OU 1 for the site as described in Exhibit A:

Alternative 1: No Further Action

The No Further Action Alternative recognizes the remediation of a portion of the site completed by IRM(s) described in Section 5.2. This alternative leaves the site in its present condition and does not provide any additional protection to public health and the environment.

Alternative 2: Site Management

This alternative recognizes the remediation of a portion of the site completed by the IRM(s) described in Section 5.2. Institutional and engineering controls are necessary to continue the effectiveness of the IRM. This alternative maintains engineering controls (fence and gravel cover) which were part of the IRM and includes institutional controls, in the form of an environmental easement and site management plan (to restrict the use of site groundwater and land use restriction to present use, etc), necessary to protect public health and the environment from contamination remaining at the site.

Present Worth:.. *$530,000*
Capital Cost:.. *$70,000*
Annual Costs:.. *$30,000*

Alternative 3: Soil Removal to Commercial SCOs and Natural Attenuation of Groundwater

This alternative would include demolition and off-site disposal of the concrete holder pad; excavation and removal of approximately 11,800 cubic yards of MGP-impacted subsurface soils exceeding the commercial use soil cleanup objectives (SCOs) to a depth up to 15 feet bgs and MGP source material to a depth of approximately 22 feet bgs; removal of approximately 870 cubic yards of impacted shallow soil to a depth of one foot below ground surface; placement of a one foot soil cover with clean material from an off-site location. A demarcation layer will be placed at the bottom of excavation. Also this remedy will allow for post-remedial natural attenuation and, if determined necessary, in-situ groundwater treatment. An environmental easement and site management plan as defined in DER 10 will be established as part of the remedy. The groundwater will be monitored to determine if a downward trend is observed. The in-situ groundwater treatment will be a contingency action to address elevated groundwater contaminant concentrations if needed. In-situ oxygenation technology was used as a basis for the cost estimate.

Present Worth:.. *$6,700,000*
Capital Cost:.. *$4,900,000*
Annual Costs:.. *$60,000*

Alternative 4: Soil Removal to Restricted-Residential SCOs and Natural Attenuation of Groundwater

This alternative would include demolition and off-site disposal of the concrete holder pad; excavation and off-site disposal of approximately 15,000 cubic yards of MGP-impacted subsurface soils exceeding the restricted-residential SCOs to a depth up to 15 feet bgs and MGP source material to a depth of approximately 22 feet bgs as depicted in Figure 3; removal of approximately 1,300 cubic yards of shallow soil to a depth of two feet; placement of a two foot soil cover over a demarcation layer with clean material from an off-site location; post-remedial natural attenuation that will include in-situ groundwater treatment, if determined necessary; establishment of an environmental easement and site management plan as defined in DER 10. The groundwater will be monitored to determine if a downward trend is observed. The in-situ groundwater treatment is a contingency action to address elevated groundwater contaminant concentrations if needed. In-situ oxygenation technology was used as a basis for the cost estimate.

Present Worth:..$8,000,000
Capital Cost:..$5,900,000
Annual Costs:...$60,000

Alternative 5: Restoration to Unrestricted Conditions

This alternative achieves all of the SCGs discussed in Section 5.1.1 for ROD and Exhibit A and soil meets the unrestricted SCOs listed in Part 375-6.8 (a). This alternative would include: excavation and off-site disposal of all waste and soil contamination above the unrestricted SCOs. The remedy will not rely on engineering or institutional controls to prevent future exposure. There would be no Site Management, no restrictions, and no periodic review. This remedy will have no annual cost, only the capital cost.

Capital Cost:..$11,300,000

Exhibit D

Remedial Alternative Costs

Remedial Alternative	Capital Cost ($)	Annual Costs ($)	Total Present Worth ($)
No Action	0	0	0
Alternative 2	70,000	30,000	530,000
Alternative 3	4,900,000	60,000[1]	6,700,000
Alternative 4	5,900,000	60,000[1]	8,000,000
Alternative 5	11,300,000	0	11,300,000

1-The Annual Costs for Alternative 3 and 4 include groundwater treatment for 10 years.

Exhibit E

SUMMARY OF THE SELECTED REMEDY

The Department is proposing Alternative 4 for OU1, Soil Removal to Restricted-Residential SCOs and Natural Attenuation of Groundwater as the remedy for this site. The elements of this remedy are described in Section 6.2. The selected remedy is depicted in Figure 3.

Basis for Selection

The selected remedy for OU1 is based on the results of the RI and the evaluation of alternatives.

Alternative 4 is being selected for OU1 because, as described below, it satisfies the threshold criteria and provides the best balance of the balancing criterion described in Section 6.1. It would achieve the remediation goals for the site by removing the contaminated soils from surface and subsurface locations. This will achieve the Restricted-Residential, Restricted Use Soil Cleanup Objectives in 6 NYCRR375-6.8(b). Alternative 4 will address the contaminated soil from the former plant site, which is the most significant threat to public health and the environment, and will create the conditions necessary to restore groundwater quality to the extent practicable. This alternative also includes a contingency action to address groundwater contamination at OU1 if downward trends in the groundwater are not observed following the removal of contaminated soil. Alternative 4 is an effective restoration of the site which allows future use

Alternative 1 (No Further Action) does not provide protection to public health and the environment with the existing conditions and will not meet the SCGs nor satisfy the RAOs. Alternative 2 (Site Management through Institutional and Engineering Controls) will not meet the SCGs and will not satisfy RAOs. Alternatives 1 and 2 will not be evaluated further. Alternative 5, by removing all soil contaminated above the unrestricted soil cleanup objectives, would be the most protective of the alternatives. Alternatives 3 and 4 will comply with these criteria but to a lesser degree or with lower certainty. Because Alternatives 3, 4, and 5 satisfy the threshold criteria, the remaining criteria are particularly important in selecting a final remedy for the site.

Alternatives 3, 4 and 5 will all have short-term impacts to the community and workers which could be controlled. The time needed to achieve the remedial goals will be longest for Alternative 3 and shortest for Alternative 5 due to the increasing amount of contaminated soil removed. The greater the removal of contaminated soil, the more quickly the groundwater quality will improve. For Alternatives 3, 4, and 5, the short-term impacts increase with the greater potential for short-term impacts occurring with Alternative 5 because of the greater soil volume removal.

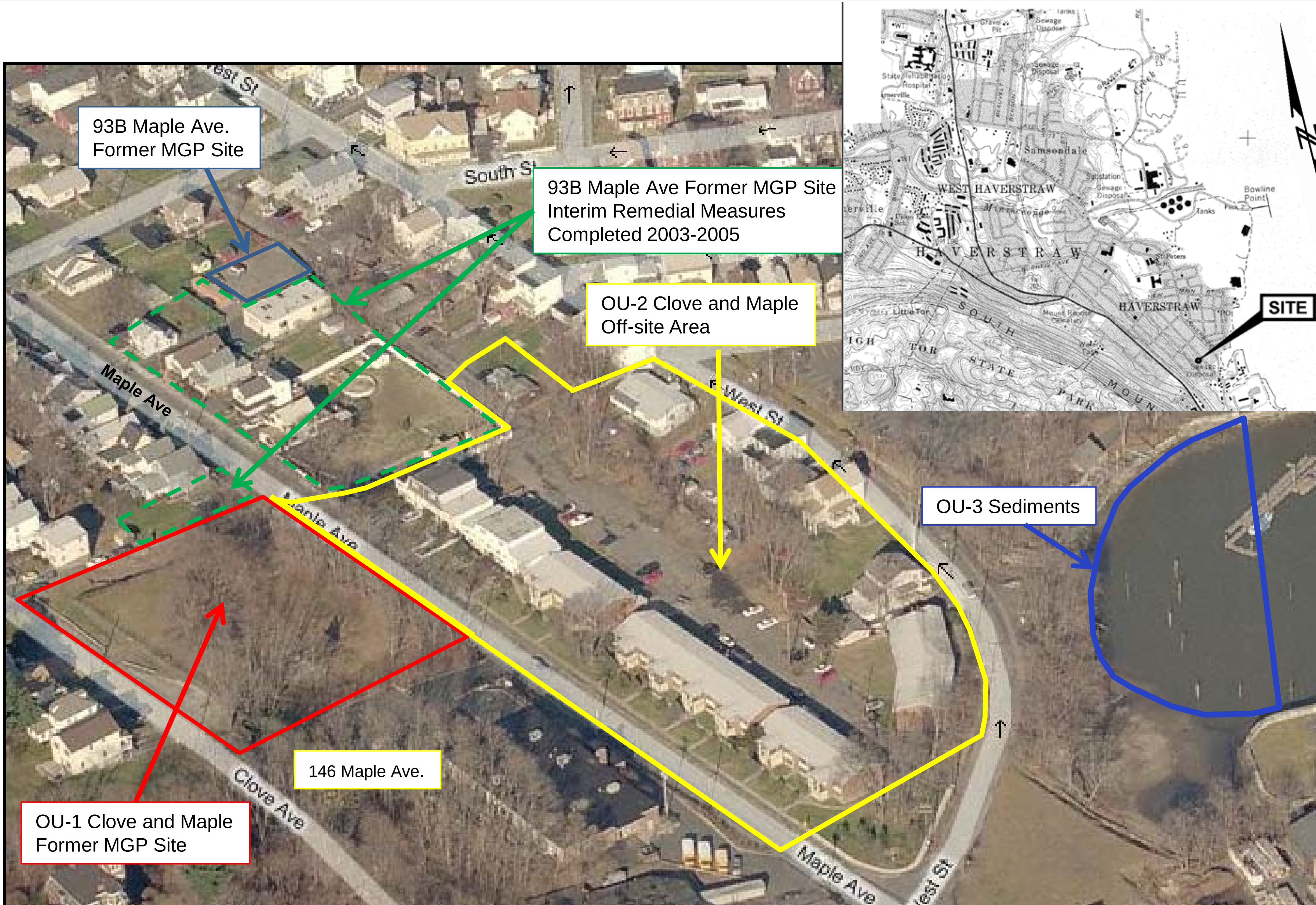
Long-term effectiveness is best accomplished by those alternatives involving excavation of the contaminated overburden soils (Alternatives 3, 4 and 5). Alternative 5 would achieve the greatest long-term effectiveness because it would remove the greatest amount of contaminated soil above SCGs. Alternative 4 would result in the removal of a greater amount of contaminated soil at the site compared to Alternative 3. However, both alternatives will still require an environmental easement and long-term monitoring since residual impacted materials will be left in place. Alternative 4 addresses the source of contamination to the groundwater to a greater extent than Alternative 3 because more impacted material will be removed under Alternative 4. By removing more impacted material, Alternative 4 will allow much quicker restoration of groundwater to ambient groundwater standard.

Alternatives 3, 4 and 5 each involves excavation and off-site disposal, reduces the toxicity, mobility and volume of on-site waste by transferring the material to an approved off-site location. Alternatives 3, 4, and 5 are favorable in that they are readily implementable. The implementability would become more difficult with increasing volumes of soil being removed for Alternatives 3, 4 and 5. Alternative 3 would be the most implementable soil removal alternatives, followed by Alternative 4 and then Alternative 5. Alternative 5 would involve a very large portion of the project area and would pose severe space limitations, obstructions, water management, and other logistical issues associated with the increased depth and amount of soil removal. Alternative 5 will result in increased level of noise and heavy truck traffic to the community. Although this alternative will result in greater excavation of a greater volume of MGP impacted soil, it will result in greater short-term adverse impacts on nearby residents during construction, without providing a substantial benefit for the protection of human health and the environment.

The costs of the alternatives vary significantly. With the large volumes of soil to be handled, Alternatives 3, 4, and 5 (excavation and off-site disposal) will have higher present worth costs. The present worth costs of Alternatives 3, 4 and 5 increase proportionally with the increase in volume of soils being excavated with the capital cost for Alternative 5 being the highest. The incremental cost of over $3 million and significantly increased community disruption associated with Alternative 5 over Alternative 4 are not justified by the marginal increase in protection. Alternative 4 will provide higher level of protection compared to Alternative 3 due to the increased level of removal. Alternative 4 is very favorable because it will achieve cost effective soil cleanup levels and will allow future re-use of the site.

Since the anticipated use of the site is restricted-residential or commercial, Alternative 3 will be less desirable because greater amount of contaminated soil will remain on the property compared to Alternative 4. Residual contamination that will be left behind under Alternative 4 will be controllable with implementation of an environmental easement to restrict the use and groundwater as a source of potable water and will include monitored natural attenuation of groundwater and in-situ groundwater treatment, if needed.

On the basis of the above evaluations, Alternative 4 offers the most balanced and cost effective remedy.

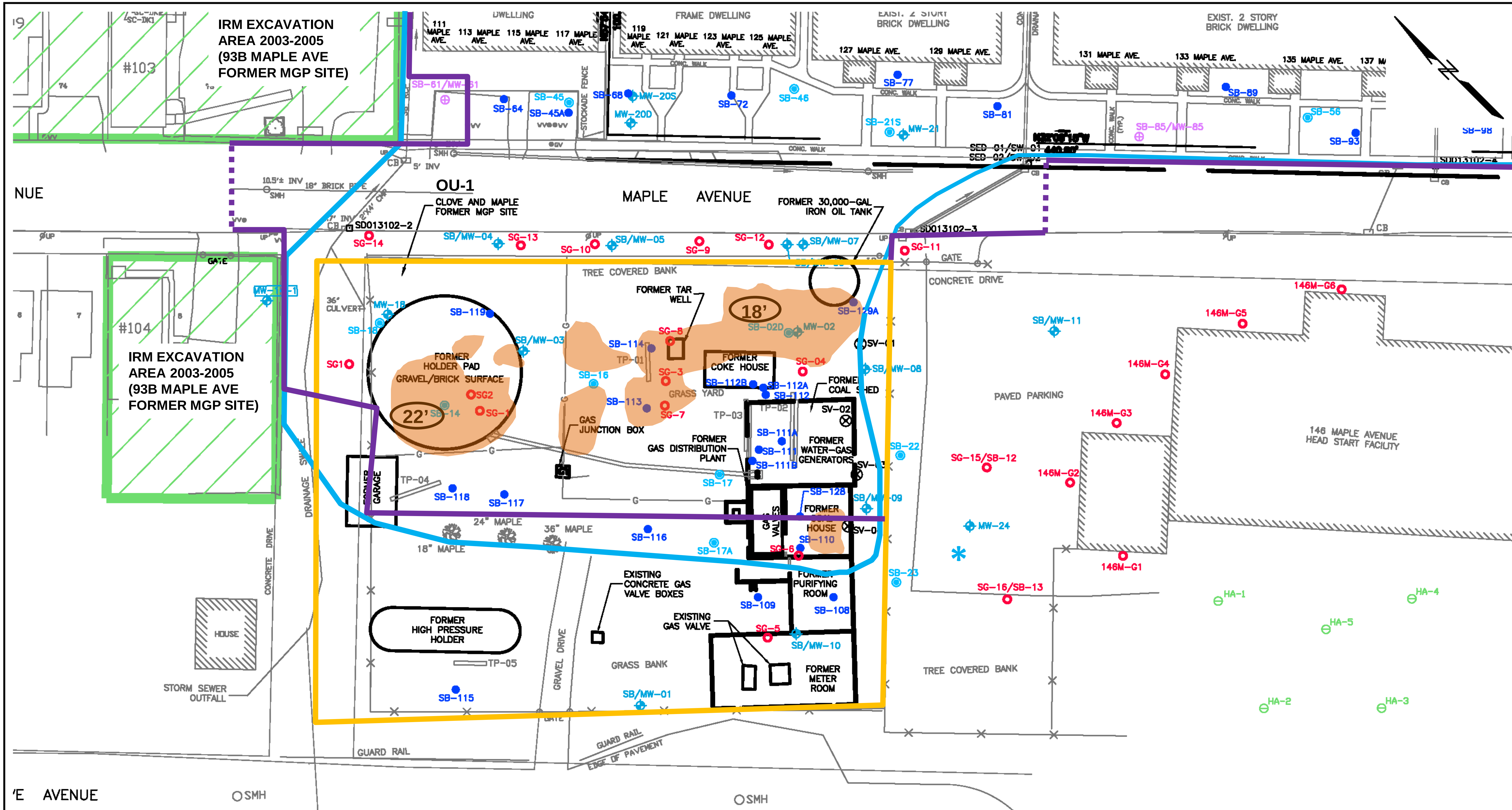


CLOVE AND MAPLE FORMER MGP SITE
HAVERSTRAW, NEW YORK

ORANGE AND ROCKLAND UTILITIES, INC.

OU-1 AND OU-2 LOCATION AERIAL PHOTOGRAPH

February 2011 **Figure 1**

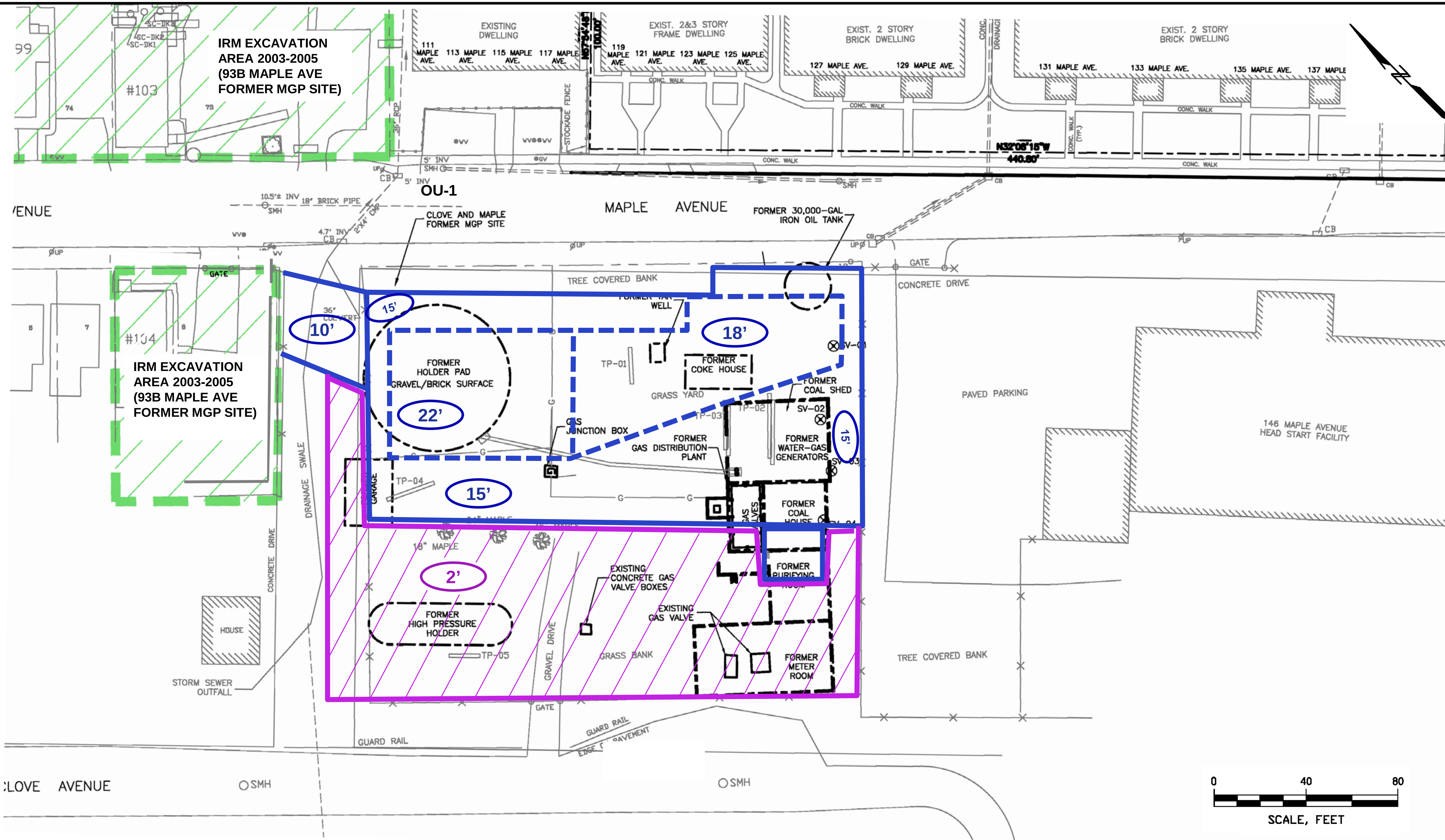


LEGEND:

- 22' APPROXIMATE MAXIMUM DEPTH OF SOURCE MATERIAL
- APPROXIMATE EXTENT OF SOURCE MATERIAL FROM EVS 3D MODEL
- APPROXIMATE EXTENT OF GROUNDWATER EXCEEDANCES OF NYSDEC AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES.
- * MW-24 HAD NO EXCEEDANCES EXCEPT ONE PAH, CHRYSENE, AT 0.5 mg/LJ (ESTIMATED VALUE).
- APPROXIMATE EXTENT OF SURFACE SOIL EXCEEDANCES OF NYSDEC PART 375 USCO.
- APPROXIMATE EXTENT OF SUBSURFACE SOIL EXCEEDANCES OF NYSDEC PART 375 USCO.
- EXTENT COULD NOT BE CONFIRMED DUE TO PROPERTY ACCESS RESTRICTIONS.
- APPROXIMATE LIMIT OF IRM ACTIONS COMPLETED 2003-2005.

CLOVE AND MAPLE FORMER MGP SITE HAVERSTRAW, NEW YORK	OU-1 – LOCATION OF SOURCE MATERIAL
ORANGE AND ROCKLAND UTILITIES, INC.	February 2011 — Figure 2

I:\GEI\ORANGE & ROCKLAND\HAVERSTRAW\RIR\ OU1 AND OU2 F-Plate 2-Site Layout 1-28-09.dwg \Oct 22, 2009



LEGEND:

15' APPROXIMATE DEPTH OF EXCAVATION

APPROXIMATE LIMITS OF EXCAVATION FOR PART 375 RESIDENTIAL CLEANUP (ALTERNATIVE 4) AND PLACEMENT OF CLEAN SOIL

APPROXIMATE LIMITS OF REMOVAL OF SURFACE SOIL AND PLACEMENT OF CLEAN SOIL: 2 FEET FOR ALTERNATIVE 4

CLOVE AND MAPLE FORMER MGP SITE HAVERSTRAW, NEW YORK	OU-1 ALTERNATIVE 4
ORANGE AND ROCKLAND UTILITIES, INC.	February 2011 Figure 3

APPENDIX A

Responsiveness Summary

RESPONSIVENESS SUMMARY

O&R Clove and Maple-Haverstraw Former MGP
Operable Unit No. 1
Haverstraw, Rockland County, New York
Site No. 344049

The Proposed Remedial Action Plan (PRAP) for the O&R Clove and Maple-Haverstraw Former MGP site, was prepared by the New York State Department of Environmental Conservation (the Department) in consultation with the New York State Department of Health (NYSDOH) and was issued to the document repositories on February 25, 2011. The PRAP outlined the remedial measure proposed for the contaminated soil and groundwater at the O&R Clove and Maple-Haverstraw Former MGP site.

The release of the PRAP was announced by sending a notice to the public contact list, informing the public of the opportunity to comment on the proposed remedy.

A public meeting was held on March 8, 2011, which included a presentation of the remedial investigation, feasibility study (RI/FS) for the O&R Clove and Maple-Haverstraw Former MGP as well as a discussion of the proposed remedy. The meeting provided an opportunity for citizens to discuss their concerns, ask questions and comment on the proposed remedy. These comments have become part of the Administrative Record for this site. The public comment period for the PRAP ended on March 28, 2011.

This responsiveness summary responds to all questions and comments raised during the public comment period. The following are the comments received, with the Department's responses:

COMMENT 1: Could you clarify the depth of soil contamination and how it relates to the clay layer you mentioned in the presentation?

RESPONSE 1: The depth of contamination varies across the site (OU 1) and it ranges from 8 to 22 feet below the ground surface (bgs). The majority of the contamination is present in a coarse-grained sand and gravel unit overlying a dense clay layer. The clay layer acts as a barrier and generally limits downward migration of MGP-related materials. The clay layer is located approximately 17 to 36 feet bgs. A pre-design investigation will further refine the limits of contamination that will be removed by excavation.

COMMENT 2: Is there any contamination under Maple Avenue? If so, how and when will that contamination be addressed?

RESPONSE 2: Investigations conducted at the site indicate site-related contamination has migrated off-site, under Maple Avenue. Maple Avenue and off-site areas will be addressed separately under Operable Unit No. 2 (OU 2). A Proposed Remedial Action Plan for OU 2 is anticipated later in the year.

COMMENT 3: I live on West Street. Will the remedial process for OU 2 be put on hold until such time as OU-1 is finished?

RESPONSE 3: No. The remedial process for OU 2 will continue in parallel with OU 1.

COMMENT 4: Realistically, how long do you expect it to take to implement the selected remedy for OU-1?

RESPONSE 4: The implementation for OU 1 is estimated to take one year to design, and approximately six months for the actual construction. Remedial design is scheduled to begin later this year.

COMMENT 5: Are these contaminants also north and south of the site?

RESPONSE 5: The extent of contamination was defined by the remedial investigation. The contamination extends to the drainage swale located north of the site. Site-related contamination does not extend past the property line in the southern direction.

COMMENT 6: I live adjacent to the site. Have there been any reported illnesses related to any of these sites in NY State?

RESPONSE 6: We are unaware of any illnesses directly related to exposure to contaminants at manufactured gas plant sites.

COMMENT 7: I live on West Street, is it safe for me or my neighbors to dig gardens, or have a vegetable garden and eat the produce?

RESPONSE 7: Coal tar, which is the primary contaminant at this manufactured gas plant site, is found well below the ground surface. Because this contamination is at a depth of approximately five feet or greater below the ground surface, it is not anticipated that plants growing in the top twelve to eighteen inches of soil would absorb any of the site related contaminants. However, due to the potential presence of urban fill material in the area, the NYSDOH often recommends the use of a raised bed gardening with clean soil to prevent contact with urban fill material (ash, coal, brick, concrete fragments, wood, etc.).

COMMENT 8: On the fact sheet, there is an arrow showing OU-2. Is that arrow pointing at where you will be digging?

RESPONSE 8: The arrow only shows the area which is identified as Operable Unit 2. The proposed remedy for OU-2 will be presented to the public later this year.

APPENDIX B

Administrative Record

Administrative Record

O&R Clove and Maple-Haverstraw Former MGP
Operable Unit No. 1
Haverstraw, Rockland County, New York
Site No. 344049

Proposed Remedial Action Plan for the O&R-Clove and Maple-Haverstraw Former MGP site, Operable Unit No.1, dated February 2011, prepared by the Department.

Orders on Consent: Index No. D3-0002-94-12, between the Department and O&R, executed on January 8, 1996; Index No. D3-0001-98-03 executed on September 29, 1998; and Index No. D3-0001-99-01 executed on March 11, 1999.

"Preliminary Site Assessment Report for Two Former Manufactured Gas Plant Sites, Haverstraw, New York", August 1997, Remediation Technologies, Inc.

"Remedial Investigation Report, Former Clove and Maple Manufactured Gas Plant Site", January 2009, CMX.

"Feasibility Study Report, Clove and Maple Avenues Former Manufactured Gas Plant", September 2010, GEI Consultants, Inc.

"Surface Soil Investigation and Risk Assessment Report for Former Manufactured Gas Plant Site at Clove and Maple in Haverstraw, New York", August 1997

APPENDIX B

PRE-DESIGN INVESTIGATION WORK PLAN

NATURAL RESOURCE TECHNOLOGY
ENVIRONMENTAL CONSULTANTS

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PRE-DESIGN INVESTIGATION WORK PLAN

CLOVE AND MAPLE AVENUES FORMER MGP SITE
OPERABLE UNIT 1
HAVERSTRAW, ROCKLAND COUNTY, NEW YORK

NYSDECSITE #: 3-444-049

Project No. 2254

Prepared For:

Orange & Rockland Utilities, Inc.
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Goshen, New York 10924

Prepared by the NRT Team:

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Silar Services, Inc.
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May 20, 2015

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NATURAL RESOURCE TECHNOLOGY

Sterling Environmental Engineering, P.C.

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1 INTRODUCTION

This Pre-Design Investigation (PDI) Work Plan (PDIWP) presents the sampling locations, rationale, field methods, and laboratory methods that will be employed to support the remedial design at the Clove and Maple Avenues, Haverstraw Former Manufactured Gas Plant (MGP) site (Site) Operable Unit 1 (OU-1). The site is listed as New York State Department of Environmental Conservation (NYSDEC) Site # 3-44-049 and is located in the Village of Haverstraw, Rockland County, New York. Figure 1 shows the Site location. The remedial design will be developed in accordance with the Administrative Order on Consent (AOC) Index No. D3-0001-98-03 between NYSDEC and Orange & Rockland Utilities, Inc. (O&R); the Record of Decision (ROD) issued for the O&R Clove and Maple MGP Operable Unit #1 issued March 2011; and Technical Guidance for Site Investigation and Remediation DER-10 May 2010. The selected remedy consists of:

- Excavation and off-site disposal of MGP-impacted soil to depths ranging from approximately 15 feet to 22 feet below ground surface (bgs).
- Excavation and off-site disposal of existing former MGP structures, debris, piping, and major obstructions.
- Excavation and off-site disposal of impacted soil in the drainage swale area located along the northern boundary of the site.
- Soil excavation will be performed within a temporary structure to control odor, vapor, and dust.
- Groundwater extraction during construction and off-site treatment and disposal, or onsite treatment and discharge in compliance with applicable discharge standards.
- Excavation of surface soils to a depth of two feet bgs and placement of site cover to allow for restricted residential use of the site.

O&R has performed a series of environmental studies focusing on the Site and nearby properties. An Initial Hazard Assessment was completed in 1996, followed by a Preliminary Site Assessment in 1997 and a Surface Soil and Risk Assessment in 1997. A Remedial Investigation (RI) started in 1998; consisted of multiple phases of field work, analysis, and review. The RI produced several reports, and resulted in a DEC-approved Remedial Investigation Report (RIR) in May 2009 (CMX, 2009). Following the acceptance of the RIR, a Feasibility Study (FS) was prepared on September 2010 (GEI, 2010). During this process the Site was divided into three Operable Units (OUs), consisting of:

- **OU-1** - The MGP parcel, owned by O&R, and the drainage swale located between the O&R property and 104 Maple Avenue. OU-1 is approximately 1 acre in size.

- **OU-2** - Off-site properties including several private residences, an apartment complex and a portion of Maple Avenue that is assumed to be impacted. OU-2 is approximately 3 acres in size. Details regarding these properties are as follows:
    - The Apartment Complex property includes four apartment buildings on Maple Avenue and one apartment building on West Street
    - A row house on Maple Avenue with four single-family residential properties, consisting of the adjacent properties at 111, 113, 115, and 117 Maple Avenue
    - Single-family residential properties on West Street, consisting of six properties at 96, 100, 102, 104, 108, and 116 West Street
    - A portion of the alleyway between Maple Avenue and West Street
    - A section of Maple Avenue between 103 Maple Avenue and 131 Maple Avenue
- **OU-3** - Sediments in the nearby Hudson River embayment

The triangular parcel at the intersection of Maple Avenue and West Street, owned by the Village of Haverstraw, and the parcel at 146 Maple Avenue, which houses the Head Start facility, were included in the RIR study area but were deemed to be substantially not impacted by the MGP, and so, were not included in the areas requiring remedial action. After a public meeting and Responsiveness Summary, NYSDEC issued a Record of Decision (ROD) (NYSDEC, 2011) for the Site in March 2011. The layout of the site is shown in Figure 2.

This PDIWP primarily addresses OU-1.

As outlined in Section 3.3 of DER 10, specific requirements for investigation work plans are provided in the following sections:

- Section 2 contains the Site description and history.
- Section 3 describes the PDIWP objectives, scope, and rationale.
- Section 4 provides a quality assurance project plan (QAPP).
- Section 5 describes health and safety protocols.
- Section 6 presents the PDI schedule.
- Section 7 provides references used to prepare the PDIWP.

2 SITE DESCRIPTION AND HISTORY

2.1 Site Description

The O&R Clove and Maple Avenues Former MGP site (Site) is located at 120 Maple Avenue in a residential and commercial portion of Haverstraw, Rockland County, New York. The Site is approximately 1 acre in size and is bounded by two residential properties to the northwest, Clove Avenue to the west and southwest, the Head Start Facility to the southeast, Maple Avenue to the east and northeast, and a residential apartment complex and a former pond area to the northeast. Clove Avenue borders the Site to the west and southwest beyond which are residential properties (Block 1, Lots 27 to 32). These residential properties are at a topographically higher elevation than the Site. The Site is currently zoned for light industrial uses while the majority of the surrounding area is zoned as single-family residential or multiple-family residential.

The vacant Site is owned by O&R and currently has a retired natural gas regulator station on the property. The gas regulator station was decommissioned by O&R in 2007 and the piping remains onsite in a small fenced enclosure. There are also several retired gas valve boxes and numerous abandoned gas pipelines located below grade on the Site. Additionally, the concrete and brick pad for the former gas holder is present in the northwest quadrant of the site. The Site is fenced with two locked gates located on the Clove Avenue portion of the Site.

The property is currently unoccupied and consists mostly of a mowed grassy area, three large deciduous trees, and a hedgerow of smaller trees along Maple Avenue. A landscape contractor maintains the grassed areas. The topography slopes down from Clove Avenue to the midpoint of the property, with a 75-foot wide, flat terrace over the northern half of the Site, closest to Maple Avenue. The hedgerow of trees is on a sloped bank down to Maple Avenue. A drainage swale is present beyond the western property boundary and intermittently directs stormwater runoff to a storm culvert beneath Maple Avenue.

The Site is located at the base of South Mountain and is characterized by moderate relief with the ground surface sloping approximately 25 feet to the north. Site geology consists of four geologic units and they are listed from top to bottom: 1) Fill, with thickness ranging from 5 feet to approximately 15 feet and consisting of cobbles, gravel, cinders and coal; 2) Alluvium (7 feet to 25 feet thick) consisting of several subunits including coarse-grained sand and gravel, clay and fine sand/silt mixtures, fine sand and/or silt and fine to coarse gravel; 3) Glaciolacustrine silt and clay, with thicknesses ranging from 2 feet to about 18 feet and; 4) Glacial Till primarily consisting of an unsorted diamict of dense silty clay to dense sandy clay with thicknesses ranging from 17 feet to about 36 feet. The onsite and off-site groundwater flows northeasterly towards OU-2, a former pond area and the Hudson River. The former pond area is located under the apartment complex and its parking lot. This pond area was also part of a former stream channel that emptied into the Hudson River. The depth to groundwater varies throughout the site with typical depths of 5 feet to 8 feet below ground surface.

2.2 Site History

According to historical records it appears that the Former MGP site operated for approximately 48 years, between 1887 and 1935. Circa 1935, natural gas was introduced into the area and the MGP operations ceased. The general configuration of the MGP did not substantially change over the operating period. The plant structures were demolished in the 1960s. The historical records indicate that MGP structures included an above-grade gas holder, an above-grade high pressure holder, an above-grade iron oil tank (30,000 gallons), a coke shed, a tar well, and gas generator and purifier rooms. A specific type of carbureted water gas process, known as the Boecklin process, was used at the Site which utilized both coal and crude oil as feedstock in the production of the gas. Additional details regarding the MGP history are provided in the RIR (CMX, 2009).

Prior to the MGP operations at the Site, a gas plant was in operation at 93B Maple Avenue, located to the northwest on the opposite side of Maple Avenue. The 93B MGP site and nearby properties were previously investigated and were remediated during a series of Interim Remedial Measures (IRMs) between 2003 and 2005. The remediation included excavations on properties immediately adjacent to the area now identified as OU-2 of the Clove and Maple Avenues MGP Site. An IRM excavation was also conducted in 2005 at 104 Maple Avenue, adjacent to OU-1 of the Clove and Maple Avenues MGP site. Additional detailed information regarding these IRMs is provided in the IRM Certification Report (GEI, 2006).

3 PRE-DESIGN INVESTIGATION OBJECTIVES, SCOPE, AND RATIONALE

3.1 Objectives

During preparation of the FS and the Remedial Design Work Plan (RDWP), additional information was identified as necessary to complete the remedial design. The purpose of this PDI is to gather the additional information required to design the selected remedy for the Site, as specified in the ROD. The objectives of this PDI are:

- Obtain a topographic, property boundary and utility survey to serve as the design base map. This survey will meet the DER-33 requirements so that it can be used for any environmental easements or deed restrictions that may be required following the completion of remedial construction.
- Further delineate the vertical and horizontal limits of MGP-related impacts that require subsurface soil excavation via field classification of soils and select analytical testing.
- Further delineate source material along the northern boundary of excavation to determine where deeper excavation is required to remove source material.
- Collect geotechnical data, including blow counts, on the soils within and along the perimeter of the excavation areas for analysis and design of the excavation support system(s).
- Further investigate the Site hydrology and hydrogeology to include seasonal and storm event fluctuations, characterize reported artesian pressures in underlying soil units, and define soil permeability and horizontal hydraulic conductivity.
- Assess Site construction water discharge options based on required sampling and available/allowable discharge capacities at local POTW.
- Collect data on stormwater flows in the drainage swale to prepare for temporary bypass options during excavation in the swale.
- Record subsurface structures that may present obstructions during excavation, including utilities which will require demolition and/or relocation.
- Observe the construction and condition of adjacent offsite structures via exterior inspection from the Site and/or adjacent rights of way for the purpose of evaluating potential impacts to nearby structures during construction activities.
- Limited pre-characterization of soil will be included to evaluate disposal options/ requirements of off-site waste management facilities as part of the proposed work. The majority of waste characterization required to implement the remedial action will be performed at a later date.

The general locations of these borings are shown in Figure 3 and the rationale/description for each proposed investigation activity is summarized in Table 1.

3.2 Pre-Design Investigation Scope and Rationales

The PDI will consist of the following activities:

- Topographic, property boundary, and utility surveys will be completed to provide a Site map for remedial design and to meet requirements for utility protection.
- Geotechnical drilling will include hollow stem auger (HSA) methods and cased drive and wash rotary methods, if required. Standard penetration testing (SPT) will be used to collect soil samples for geotechnical analysis and delineation of excavation limits.
- Physical soil testing will be performed to evaluate geotechnical properties.
- Direct-push drilling will be used to collect soil samples for chemical analysis to facilitate delineation of excavation limits.
- Aquifer testing will be performed to define aquifer parameters and allow evaluation of excavation dewatering alternatives.
- Stormwater flow modeling will be performed.
- Perform exterior inspections of adjacent structures, including photographic documentation from the Site or and/or adjacent rights of way (i.e. no access agreements will be required).
- Prepare and submit Pre-Design Investigation Summary Report.

All proposed boring and/or well locations are predicated on property owner approval to allow entry to the particular location. Actual locations will be determined during field implementation.

The description and rationale for these activities are summarized in Table 1 and described in more detail below.

3.2.1 Utility Clearance

Underground and overhead utilities, including electric lines, gas lines, storm and sanitary sewers, and communication lines will be identified prior to initiation of drilling and other subsurface work. This will be performed in conjunction with the Level B Utility Survey described in Section 3.2.2 below. Underground utility location will be accomplished as follows:

- All boring locations will be flagged or marked out with survey stakes and/or marking paint.
- Dig Safely New York ((800) 272-4480) will be contacted to initiate the locating activities. New York State law requires that Dig Safely New York be notified at least two working days, and not more than 10 working days, before subsurface work is conducted.
- Participating companies with subsurface utilities present will locate and markout all respective subsurface utility lines.

- Precautions regarding safe distance from the overhead electrical lines will be reviewed and equipment offset distances flagged and marked out in accordance with the O&R required clearances.
- Prior to advancement of boreholes, the locations will be pre-cleared to a depth of five feet using a combination of manual methods (i.e., hand clearing) or using vacuum extraction to either expose the subject utilities or confirm area is void of utilities.
- Once clear, drilling and excavation activities will proceed slowly and carefully for the top ten feet of each investigation location.
- Proposed sampling locations may be shifted to avoid subsurface and overhead utilities as appropriate.

3.2.2 Site Survey

In conjunction with the PDI, a field survey will be conducted to assist with the preparation of a base map suitable to support the project design work. This work would be completed concurrently with the subsurface investigations. The survey work will include field data collection and compilation of information from available mapping (Village of Haverstraw, O&R, CMX, and GEI), if available, to establish the mapping of and around the project limits:

- Property Boundary Survey - This effort would consist of establishing and recording property boundaries for each of the parcels (Site and drainage swale) in the affected area to be used for preparation of access agreements and designing the remediation work. As part of this work existing property surveys on record with the Village of Haverstraw and Rockland County will be obtained and reviewed. The boundary survey will include key site features and existing easements and any existing building plans and records will be reviewed and incorporated into the Site base mapping as appropriate. This survey will meet the DER-33 requirements so that it can be used for any environmental easements or deed restrictions that may be required following the completion of remedial construction.
- Level B Utility Survey - Evidence from previous site work indicates that no underground utilities are present other than O&R’s inactive gas lines; however, the NRT Team will perform a Level B utility survey to satisfy mapping requirements. This will be performed in conjunction with the utility clearance described in Section 3.2.1 above. and drilling mark-out. This level of utility survey involves the application of appropriate surface geophysical methods to determine the existence and horizontal position of virtually all utilities within the project limits. This activity is called "designating". The information obtained in this manner is surveyed to project control. It addresses problems caused by inaccurate utility records, abandoned or unrecorded facilities, and lost references. This information obtained will be added to the Site base map for design..
- Topographic Survey - A topographic survey is proposed to be completed for all of OU-1. Topography will be used to compute more accurate disposal and import soil volumes as well as provide for a basis of the restoration grading plan. The topographic survey would be completed concurrently with the subsurface investigations.

Following completion of the PDI, all sampling and investigation locations will be surveyed for elevation and location using a licensed New York surveyor. This information, as well as previous sample locations throughout the project area, will be incorporated on the site base map.

3.2.3 Delineation Borings

In order to fill data gaps, further identification of the vertical and horizontal limits of MGP impacts on the Site is required. These borings will be advanced using direct-push drilling methods. The general locations of the thirteen (13) delineation borings are shown in Figure 3 and include:

- All borings and wells that are drilled/ installed at the Site will require a permit from the Rockland County Department of Health (RCDOH). The NRT Team will obtain a permit to construct resource evaluation wells from the Rockland County Department of Health (RCDOH).The NRT Team will complete a permit application form and identify boring/well locations, drilling contractor, property owner, scope of work, and permit conditions.
- Perform subsurface soil sampling south of previous soil boring location SB-118 to define the southern limits of subsurface excavation in this area (Figures 2 and 3). Definition of this southern boundary of excavation in advance is necessary so the location of the excavation shoring can be established. Three (3) borings (GB-5, GB-6 and DB-13) are proposed in order to more fully delineate impacts in this area. Target depth of these borings will be approximately 25 to 30 feet bgs.
- Perform subsurface soil sampling in and adjacent to the drainage swale to define the limits of excavation in the swale. Subsurface soil impacts in the drainage swale have not been fully delineated. Impacts in the area, as reported in the RI, have been confined to the clay and fine sand/silt alluvium unit and upper portion of the glaciolacustrine layer in this area. Definition of this western boundary of excavation in advance is necessary so that the location of the excavation shoring can be established. Three (3) borings (GB-3, DB-1 and DB-6) are proposed in order to more fully delineate impacts in this area. Target depth of these borings will be approximately 20 to 22.5 feet bgs.

The borings will be continuously logged, recording the presence of fill material or subsurface obstructions, the nature of each geologic unit encountered, observations regarding moisture content, the PID readings, and visual and olfactory observations regarding the presence of hydrocarbon-like residuals. Samples will be collected from borings and selectively submitted for chemical laboratory analysis. If no source material is observed in a boring, then a confirmatory sample will be collected from the interval exhibiting the highest evidence of contamination based on visual, olfactory or PID evidence. If no evidence of contamination is observed a sample will be collected from approximately 15 to 22 feet bgs, to correspond to a depth where the majority of impacts have been observed on OU-1. If source material is observed, a sample will be collected from the non-impacted interval beneath the MGP-impacted material or from 15 feet bgs, whichever is deeper to confirm the vertical extent of impacts. Samples will be submitted for laboratory analysis of Volatile Organic Compounds (VOCs) using USEPA Method 8260C and Semi-Volatile Organic Compounds (SVOCs) using USEPA Method 8270D via standard turnaround time. Laboratory analytical methods are summarized in Table 2.

3.2.4 Delineation – Source Material

The basis for subsurface soil excavation is removal up to 15 feet bgs in accordance with the Restricted Residential Soil Cleanup Objectives (RRSCOs). Deeper excavation is necessary to remove source material. It is necessary to define where source material is likely present at depths greater than 15 feet or, conversely, confirm that excavation depths specified in the ROD hold true. These borings will be advanced using direct-push drilling methods. Thirteen (13) soil borings are proposed to delineate source material within the various excavation areas.

Eighteen-foot Excavation Area: Source material requires further delineation to confirm that the mapped excavation area is warranted and justified throughout this area of the Site. Given the existing data gaps source material needs to be investigated at the following locations:

- Between previous soil boring SB-114 and existing well MW-05 (GB-2)
- Between existing wells MW-02 and MW-08 (DB-2)
- Between previous soil boring SB-112 and existing well MW-02 (DB-4)
- Between previous soil boring SB-114 and existing well MW-02 (DB-5)
- Between previous soil borings SB-119 and SB-114 (DB-9)
- South of previous soil boring SB113 and between previous soil borings SB-113 and SB-112 (DB-10 and DB-12)

Twenty-two-foot Excavation Area: Source material requires further delineation to confirm that the mapped excavation area is warranted and justified throughout this area of the Site. Given the existing data gaps at depth source material needs to be investigated at the following locations:

- Between previous soil boring SB-119 and existing MW-04 (GB-1)
- Within the northern portion of Former Holder Pad between previous soil boring SB-119 and existing well MW-18 (DB-3)
- South of existing well MW-03 (PW-1)
- Between previous borings SB-119 and SB-14 (DB-7)
- Between borings SB-14 and SB-16 (DB-8)
- Within the southern perimeter of the Former Holder Pad between previous soil borings SB-14 and SB-118 (DB-11)

Two (2) of these borings will be converted into 1¼-inch I.D. observation wells as described in section 3.2.6 below.

Target depth of these borings will be approximately 25 to 30 feet bgs. The number and placement of the delineation borings may be adjusted based on field conditions.

The borings will be continuously logged, recording the presence of fill material or subsurface obstructions, the nature of each geologic unit encountered, observations regarding moisture content, the PID readings, and visual and olfactory observations regarding the presence of hydrocarbon-like residuals. Samples will be collected from borings and selectively submitted for chemical laboratory analysis. If no source material is observed in a boring, then a confirmatory sample will be collected from approximately 15 to 22 feet bgs, to correspond to a depth where the majority of impacts have been observed on OU-1. If source material is observed, a sample will be collected from the non-impacted interval beneath the MGP-impacted material or from 15 feet bgs, whichever is deeper, to confirm the vertical extent of impacts. Samples will be submitted for laboratory analysis of VOCs and SVOCs via standard turnaround time. Laboratory analytical methods are summarized in Table 2.

Table 3 summarizes standard operating procedures to be employed in accordance with DER-10. Appendix A contains SOPs that will be used during the PDI.

3.2.5 Geotechnical Borings

Currently, there is insufficient data to support development of an excavation shoring specification. Six geotechnical borings will be advanced to gather geotechnical information for the purpose of designing the excavation shoring. The proposed locations of geotechnical borings are presented in Figure 3. Boring locations were selected to be co-located with delineation borings and/or wells wherever possible. All borings will be advanced using a truck-mounted drilling rig equipped with 4¼-inch I.D. Hollow Stem Augers (HSA) to a depth of 65 feet bgs. If auger refusal is encountered prior to reaching a boring’s target total depth, flush-joint drill casing of appropriate size will be advanced through the augers using drive and wash methods to reach the desired depth. Continuous two (2)-inch Outside Diameter (O.D.) split spoon soil samples will be collected from each soil boring.

The borings are proposed at locations that provide comprehensive coverage across the proposed deep excavation boundaries at the Site. These borings are proposed to investigate geotechnical soil properties across the Site and define the variation of soil properties to the extent practical.

The geotechnical borings will be continuously logged, recording blow counts, the presence of fill material or subsurface obstructions, the nature of each geologic unit encountered, observations regarding moisture content, the PID readings, and visual and olfactory observations regarding the presence of hydrocarbon-like residuals. Borings, in general, will extend to a depth of approximately 65 feet bgs or to depths at least 35 feet into the glacial till unit) to collect data to determine the required bottom or “tip” elevation of the excavation shoring components. If bedrock is encountered at a depth that may be critical to shoring design a five- to ten-foot rock core may be advanced to obtain geotechnical information.

All boreholes will be abandoned using non-shrinking cement-bentonite grout to fill the void space left by the auger flights and/or flush-joint casing.

Table 3 summarizes standard operating procedures to be employed in accordance with DER-10. Appendix A contains SOPs that will be used during the PDI.

Sufficient geotechnical samples will be analyzed to provide a realistic representation of soil conditions. Thin-walled tube samples (Shelby tubes) will be collected for a representative portion of the fine grained soils (clay) encountered. The following logging and geotechnical analyses will be performed to facilitate excavation support design:

- Soil Classification per Unified soil classification System (USCS)
- Documentation of all stratigraphic changes and anomalies
- Standard Penetration Test (SPT): continuous in each boring
- Water Level Measurements collected during and after drilling of each boring
- Grain Size Distribution: two per boring; one in alluvium (variable material analyzed for each boring) and one in deep soils (glacial till)
- Moisture Content: two per boring; one in shallow (variable material analyzed for each boring) and one in deep soils (glacial till)
- Atterberg Limits: fine grained soils from each boring; test two shallow overburden samples and two deep overburden samples (glacial till), if possible.
- For cohesive soil:
    - Unconfined Compressive Strength Test to be performed every third sample
    - Shelby Tube or Dennison to be collected every third sample
    - Vane Shear Test performed on all cohesive soil samples
    - Pocket Penetrometer reading collected on all cohesive soil samples

Table 4 summarizes method references for geotechnical analyses. Sample quantities will be finalized based on subsurface conditions encountered.

3.2.6 Hydrogeologic Data Collection

A preliminary evaluation of the existing data indicates that excavation dewatering may generate a significant, but as yet unknown volume of water. Additional aquifer testing, including pumping tests, may facilitate design of more efficient dewatering and water treatment systems and reduce the overall remediation costs for the project. The need for this testing will be further assessed during the initial design stages. This will include an estimate of the possible range of dewatering rates given the available data, expected contaminant loadings, and options and possible flow rate limitation for treated water discharge. This evaluation will establish the need for any additional aquifer testing.

Review of existing data indicates that the hydrogeologic conditions of the Site are not adequately defined for the purposes of evaluating and designing dewatering options for the remedial excavation. Existing hydraulic conductivity testing data is limited as to data quality and representativeness. The aquifer testing will be conducted to facilitate the design of dewatering efforts for the remedial construction. The existing monitoring wells are screened through two or more Alluvium subunits, which is not appropriate for hydrogeologic testing of groundwater in the semi-confined Alluvial hydrogeologic unit. The proposed new observation wells and/or the larger diameter pumping well will be screened discretely within the lowermost Alluvial hydrogeologic unit and will be used for the hydrogeologic evaluation.

Hydraulic conductivity testing will be performed on seven (7) existing shallow overburden monitoring wells and two (2) newly-installed observation wells using slug and/or bail testing. Data from these tests will provide a more accurate characterization of the horizontal hydraulic conductivity (k) for the Alluvial hydrogeologic unit and allow an evaluation of both the potential variability and mean of this primary water-bearing zone. Further, a k test will be performed on deep overburden monitoring well MW-07, screened in the glacial till unit, to evaluate the hydraulic conductivity of this lower confining unit.

Groundwater elevations at existing and new observation wells will be measured to provide data to support dewatering design for construction. Although the design is currently scheduled to be completed in Fall 2015, data on seasonal groundwater fluctuation will be collected for as long a period as is possible. Additionally, aquifer response to substantial rain events (i.e. a spring baseline and then a day after a one-inch plus rain event will be collected. Data will be transferred from in-situ transducers to facilitate real-time monitoring and allow adjustment of sensors, if necessary.
NRT Team field personnel will observe soil and groundwater behavior during drilling to reveal potential constructability impediments. Aquifer testing (i.e., a pumping test) will also be performed to allow evaluation of hydraulic parameters. Based on the results of the drilling, hydraulic conductivity testing, and groundwater level measurements, the NRT Team and O&R will determine the framework for the duration, magnitude, and design of the focused aquifer pumping test program. If the test is required, a scope of work will be developed and submitted to NYSDEC.

One 4-inch I.D. pumping well (PW-1) and two 1¼-inch I.D. observation piezometers (OW-1 and OW-2) will be co-located with geotechnical and/or delineation borings, based on current knowledge of the Site subsurface conditions. Geologic and hydrogeologic information will be recorded as each boring/well is advanced to the top of the glacial till layer. After completion, the observation wells and pumping well will be developed to ensure proper communication with water-bearing zones of the Alluvial unit. The pumping well will be screened from the top of the water table to total depth to allow simultaneous pumping of all water-bearing units during the pumping test. Limited modeling of hydraulic conditions will be performed to depict groundwater elevation data and provide data for earth retention design requirements.

SOPs for planned activities, summarized in Table 3, are provided in Appendix A.

3.2.7 Water Discharge Assessment

The purpose of this activity is to assess construction dewatering discharge options and permitting requirements based on required sampling and available/allowable discharge capacities at the local Publicly Owned Treatment Works (POTW). The NRT Team will collect information from the NYSDEC, and the local POTW regarding discharge requirements/restrictions (i.e., capacity, general prohibitions, industrial pretreatment standards, and/or user-specific prohibitions/requirements such as local limits). This information will be used to evaluate options for dewatering discharge options and to identify applicable permitting requirements. This information will also be used in developing water disposal options for the proposed pumping test discussed in Section 3.2.6 above.

3.2.8 Drainage Swale Flow Modeling

Drainage swale hydraulics will be evaluated to develop specifications for the swale bypass system and ancillary hydraulic controls required to complete the proposed excavation. Evaluation will be performed using multiple data sources, which include:

- Drawings and other documents presenting the dimensions of the drainage swale and related stormwater conveyance elements
- Previous hydraulic studies of the existing stormwater management system (if available)
- Historic precipitation information (e.g. from the National Weather Service) including hydrographs for various design storm intervals (e.g., 5-, 10-, and 25-year storms) for the Site

A hydraulic model of the drainage swale and related elements will be developed using the information gathered and HydroCAD stormwater modeling software. The model will be used to evaluate Site responses to design storms. The results of the evaluation will be used to develop appropriate specifications for development of an approach and design to bypass the drainage swale, as needed, during remedial construction.

3.2.9 Exterior Structural Evaluation

Information regarding the construction materials and dimensions of structures adjacent to the Site will be beneficial for planning remediation activities. In particular, this information will be helpful to develop specifications for shoring construction and performance. The NRT Team will collect data from previous work (e.g., 93B IRM) and perform exterior inspections of adjacent structures, which will include photographic documentation. Photographs and field measurements will be taken from the Site and adjacent rights of way and no access to properties is anticipated.

3.2.10 Waste Characterization

No waste characterization data exists to evaluate various disposal options. The NRT Team will collect waste characterization samples, for profiling purposes, during select PDI activities in order to document waste profiles and evaluate disposal options. It is understood that all impacted soil will be sent for thermal treatment to a facility such as Bayshore, Clean Earth or ESMI. Disposal facility requirements will be identified for these facilities and samples analyses performed accordingly. Two (2) soil samples and one (1) groundwater sample will be analyzed for appropriate parameters that may include hazardous waste characteristic including corrosivity, ignitability, reactivity and select toxicity (TCLP VOCs, TCLP SVOCs, TCLP Metals, TCLP Pesticides, select TCLP herbicides) as well as PCBs and other facility required parameters. Results will be compared to NYSDEC's Universal Treatment Standards as set forth in 6 NYCRR Part 376.4(j).

In addition, abandoned piping present at the site will be exposed and examined via vacuum excavation. This effort will be performed in conjunction with the utility clearance and utility survey work described in Sections 3.2.1 and 3.2.2 above. If buried piping is observed to be coal tar-wrapped, up to two (2) samples will be collected and analyzed for waste characterization parameters including PCBs and asbestos so that disposal options may be evaluated.

3.2.11 Investigation-Derived Waste Management

All investigation-derived waste (IDW) generated during the PDI will be collected in properly labeled, new (not refurbished) 55-gallon drums or bulk containers (e.g. roll-off container lined with polyethylene sheeting for solids, fractionation tanks for liquids). IDW includes soil cuttings, recirculation water, decontamination pad and plastic sheeting, personal protective equipment (PPE), decontamination water, well development water, and pumped groundwater.

Drums and containers of material will be labeled as "PENDING ANALYSIS – INVESTIGATION-DERIVED WASTE" with a description of the source (e.g., soil cuttings, decontamination water, pumping test water, etc.) and temporarily stored pending characterization and proper disposal. The containerized soils will be disposed of offsite at a facility permitted to accept such material.

Containers will be properly labeled, and characterized for disposal as hazardous or non-hazardous waste. Soil will be analyzed for the following:

- Toxic Characteristic Leaching Procedure (TCLP) volatile organic compounds (VOCs)
- TCLP semi-volatile organic compounds (SVOCs)
- TCLP Metals

- Total Petroleum Hydrocarbons (TPH)
- Corrosivity
- Reactivity
- Flash Point
- Polychlorinated biphenyls (PCBs)
- pH

Table 2 summarizes analytical methods.

3.2.12 Community Air Monitoring Plan

Community air monitoring requires real-time monitoring for VOCs, particulates (i.e., dust), and MGP-related odors at the downwind perimeter of each designated work area when certain activities are in progress at the Site. The community air monitoring is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for potential receptors) from airborne contaminant releases related to investigation work activities. Real-time monitoring will be performed at upwind and downwind locations for VOCs and particulates during intrusive activities. The Community Air Monitoring Plan (CAMP), provided in Appendix B, specifies action levels which require increased monitoring and corrective actions to abate emissions and/or work shutdown.

3.2.13 Reporting

The NRT Team will prepare and submit a PDI Summary Report that summarizes the results of the PDI data collection and compilation activities, including a description of sampling methodology, results, discussion, and conclusions. Appended to the report will be a summary table of tabulated water level measurements, well hydrographs, groundwater contour map, a table of cumulative analytical results, and laboratory reports with chain of custody forms. The PDI Summary Report will document that required data for the design criteria and specifications has been collected. NRT anticipates that the PDI Summary Report will be submitted to NYSDEC approximately 60 days after the completion of the field work.

4 QUALITY ASSURANCE PROJECT PLAN

This section describes the quality assurance (QA) requirements for the PDI as specified in DER-10.

4.1 Project Organization

This PDI will be performed by NRT on behalf of O&R. NRT will arrange for the drilling and analytical services and provide an onsite field representative to perform the soil characterization, soil sampling/logging, hydrogeologic characterization, structural evaluation, subcontractor management, IDW management, community air monitoring as well as perform the data interpretation and reporting elements. Key contacts for this project are as follows:

4.1.1 O&R Project Manager

Maribeth McCormick
Orange and Rockland Utilities, Inc.
3 Old Chester Road
Goshen, New York 10924
Telephone: (845) 783-5534
Cell: (917) 557-1361

4.1.2 NRT Team Project Manager

John Magee, P.E.
Silar Services, Inc.
983 Butler Pike
Blue Bell, PA 19422
Telephone: (609) 975-2900
Cell: (609) 975-2900
Fax: (215) 646-7549
Email: jmagee@silarservices.com

As Project Manager, Mr. Magee will be the day-to-day contact with O&R for project management activities and will have primary responsibility for the safe and timely execution of a quality project for O&R. He will have full authority to assign resources necessary to complete the project. Mr. Magee will lead preparation of the Pre-Design Investigation Work Plan (PDIWP) and Remedial Design Work Plan (RDWP) and their components and ultimate responsibility for all other deliverables including the pre-design investigation report and the remedial design deliverables. As the Project Manager, Mr. Magee will attend all design meetings scheduled in Spring Valley, New York as requested and will participate in conference calls as needed.

4.1.3 NRT Team PDI Lead

Mark A. Williams, P.G. (Pa)
Associate Geologist
Sterling Environmental Engineering, P.C.
24 Wade Road
Latham, New York 12110
Telephone: (518) 456-4900
Fax: (518) 456-3532
Cell: (518) 222-6616
Email: mark.williams@sterlingenvironmental.com

Mr. Williams will be responsible for implementation of the PDI and collection of data to support the design and construction of the remedy.

4.1.4 NRT Team Quality Assurance Officer

Christopher A. Robb, PE
Senior Engineer
Natural Resource Technology, Inc.
234 W. Florida Street, Fifth Floor
Milwaukee, Wisconsin 53204
Telephone: (414) 837-3607
Direct: (414) 837-3527
Cell: (414) 719-4516
Fax: (414) 837-3608
Email: crobb@naturalrt.com

For the Clove and Maple Haverstraw MGP project. Mr. Robb will support John Magee's role as Project Manager and is charged with ensuring NRT's quality control processes and SOPs.

4.1.5 Laboratory Representative

The analytical laboratory has yet to be selected.

4.2 Sampling and Testing Procedures

The following section details the sampling and testing procedures that will be followed during this PDI. The chosen analytical laboratory for the project will be certified under the NYSDEC Environmental Laboratory Approval Program (ELAP) and the New York State Department of Health (NYSDOH) ELAP Contract Laboratory Program (CLP) for analyses of solid and hazardous waste.

All sampling equipment will be properly decontaminated before being reused or disposed of accordingly. Samples will be collected in pre-cleaned sample containers provided by the laboratory performing analysis with any necessary preservations added to the sample containers at the laboratory prior to sample collection. Coolers with ice will be used to store samples at 4 degrees Celsius (°C) until delivered to and analyzed by the laboratory.

4.2.1 Environmental Testing

Samples collected for environmental analysis will be analyzed for Total VOCs via EPA Method 8260C and Total SVOCs via EPA Method 8270D. These VOC/SVOC samples will require quality control samples, including field duplicate and matrix/matrix-spike duplicates at a frequency of one (1) per twenty (20) samples. In addition to the quality control samples proposed, trip blank(s) and an equipment blank (if applicable) will also be provided. Chain-of-Custody (COC) procedures will be followed to document that contamination of samples has not occurred during container preparation, shipment, and sampling. Table 2 provides a summary of these requirements.

IDW characterization will not require quality control samples, data validation, or electronic data submission.

4.2.2 Geotechnical Analyses

Samples collected for geotechnical analysis will be analyzed for the parameters specified in Section 3 and summarized in Table 4. SOPs for sample collection and field testing methods are summarized in Table 3 and included in Appendix A.

4.3 Sample Tracking and Custody

This section presents sample custody procedures for both the field and laboratory. Implementation of proper custody procedures for samples generated in the field is the responsibility of field personnel. Both laboratory and field personnel involved in the COC and transfer of samples will be trained on the purpose of the COC and specific procedures prior to implementation.

Evidence of sample traceability and integrity is developed by implementation of, and adherence to, the COC procedures. These procedures document the sample traceability from the selection and preparation of the sample containers by the laboratory, to sample collection, to sample shipment, to laboratory receipt and analysis. A sample is considered to be in a person's custody if the sample is:

- In a person's possession.
- Maintained in view after possession is accepted and documented.
- Locked and tagged with custody seals so that no one can tamper with it after having been in physical custody.
- In a secured area which is restricted to authorized personnel.

4.3.1 Field Sample Custody

A COC record accompanies the sample containers from selection and preparation at the laboratory, during shipment to the field for sample containment and preservation, and during return to the laboratory. Triplicate copies of the COC must be completed for each sample set collected.

The COC lists the field personnel responsible for taking samples, the project name and number, the name of the analytical laboratory to which the samples are sent, and the method of sample shipment. The COC also lists a unique description of every sample bottle in the set. If samples are split and sent to different laboratories, a copy of the COC record will be sent with each sample.

The “Comments” space on the COC is used to indicate if the sample is an MS/MSD, or any other sample information for the laboratory. Since they are not specific to any one sample point, trip and equipment blanks are indicated on separate rows. Once all bottles are properly accounted for on the form, a sampler will write his or her signature and the date and time on the first “Relinquished By” space. The sampler will also write the method of shipment, the shipping cooler identification number, and the shipper air bill number on the top of the COC. Errors will be crossed out with a single line in ink and initialed and dated by the author.

One copy of the COC is retained by sampling personnel and the other two copies are put into a sealable plastic bag and taped inside the lid of the shipping cooler. The cooler is wrapped tightly with clear packing tape. It is then relinquished by field personnel to personnel responsible for shipment, typically an overnight carrier. The packing tape must be broken to open the container. Breakage of the tape before receipt at the laboratory may indicate tampering. If tampering is apparent, the laboratory will contact the Project Manager and the sample(s) will not be analyzed.

4.3.2 Laboratory Sample Custody

The Project Manager or Field Team Leader will notify the laboratory of upcoming field sampling activities and the subsequent shipment of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped as well as the anticipated date of arrival.

The following laboratory sample custody procedures will be used:

- The laboratory will designate a sample custodian who will be responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody.
- Upon receipt of the samples, the custodian will check cooler temperature, and check the original COC documents and compare them with the labeled contents of each sample container for correctness and traceability. The sample custodian will sign the COC record and record the date and time received.

- Care will be exercised to annotate any labeling or description errors. In the event of discrepant documentation, the laboratory will immediately contact the Project Manager or Field Team Leader as part of the corrective action process. A qualitative assessment of each sample container will be performed to note any anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming COC procedure.
- The samples will be stored in a secured area and, if required, stored at a temperature of 4°C (+/- 2°C).
- A laboratory tracking record will accompany the sample or sample fraction through final analysis and final storage for control.

A copy of the tracking record will accompany the laboratory report and will become a permanent part of the project records.

4.4 Reporting

Data will be provided in electronic format, including the following specific requirements:

- All data generated will be submitted in an electronic data deliverable (EDD) that complies with the DEC's Electronic Data Warehouse standards (EDWS) or as otherwise directed by the New York state Department of Environmental Conservation (NYSDEC), Division of Environmental Remediation (DER).
- Preliminary or final reports will be submitted to the DER in an electronic format that complies with DEC’s Electronic Document Standards (EDS) or as otherwise directed.
- Data Usability Summary Reports (DUSR) will be prepared in accordance with NYSDEC procedures, which are included in Appendix C.

4.5 Data Quality Usability Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements to ensure that data of known and appropriate quality are obtained during sampling and analysis activities. Data developed during the PDI will be used to fulfill the overall objectives of the program. Evaluation of DQOs is preformed following procedures in U.S. Environmental Protection Agency (USEPA) National Functional Guidelines for Data Review. Generally, the validation uses 1) Method specification limits, 2) Laboratory statistically calculated limits based on historical data, and finally 3) Default limits from the USEPA National Functional Guidelines.

The quality assurance and quality control (QA/QC) objectives for all measurement data include precision, accuracy, representativeness, completeness, and comparability. These objectives are defined in the following subsections. They are formulated to meet the requirements of the USEPA SW-846, the analytical methods and their Contract Required Quantitation Limits (CRQLs), and Contract Required Detection Limits (CRDLs).

4.5.1 Precision

Precision is an expression of the reproducibility of measurements of the same parameter under a given set of conditions. Specifically, it is a quantitative measurement of the variability of a group of measurements compared to their average value. Precision is usually stated in terms of standard deviation, but other estimates such as the coefficient of variation (relative standard deviation), range (maximum value minus minimum value), relative range, and relative percent difference (RPD) are common.

For this project, field sampling precision will be determined by analyzing coded duplicate samples (labeled so that the laboratory does not recognize them as duplicates) for the same parameters, and then, during data validation, calculating the RPD for field duplicate sample results.

The data quality objectives for analytical precision, calculated as the RPD between duplicate analyses, will be statistically calculated laboratory control limits based on historical data. Should there be insufficient data to calculate limits; the validation default RPD limits will be used: 20% for aqueous samples and 35% for soils.

4.5.2 Accuracy

Accuracy is a measure of the degree of agreement between a measured value and the true or expected value of the quantity of concern, or the difference between a measured value and the true or accepted reference value. The accuracy of an analytical procedure is best determined by the analysis of a sample containing a known quantity of material, and is expressed as the percent of the known quantity which is recovered or measured (percent recovery).

Sampling accuracy may be determined through the assessment of the analytical results of field blanks and trip blanks for each sample set. Analytical accuracy is typically assessed by examining the percent recoveries of surrogate compounds that are added to each sample (organic analyses only), and the percent recoveries of matrix spike compounds added to selected samples and laboratory blanks. Additionally, initial and continuing calibrations must be established and be within method control limits. Instrument and method analytical accuracy can then be determined for any sample set.

The data quality objectives for analytical precision, calculated as the percent recovery, will be statistically calculated laboratory control limits based on historical data. Should there be insufficient data to calculate limits, the validation default percent recovery limits will be used: 70-130% for organic analyses, and 75-125% (matrix spike recovery) and 80-120% (laboratory control spike (LCS) recovery) for inorganic analyses.

4.5.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter which is most concerned with the proper design of the sampling program. Samples must be representative of the environmental media being sampled. Selection of sample locations and sampling procedures will incorporate consideration of obtaining the most representative sample possible.

Field and laboratory procedures will be performed in such a manner as to ensure, to the degree that is technically possible, that the data derived represents the in-place quality of the material sampled. Every effort will be made to ensure that chemical compounds will not be introduced into the sample via sample containers, handling, and analysis. Decontamination of sampling devices and digging equipment will be performed between samples. Analysis of field blanks, trip blanks, and method blanks will also be performed to monitor for potential sample contamination from field and laboratory procedures.

The assessment of representativeness also must consider the degree of heterogeneity in the material from which the samples are collected. Sampling heterogeneity will be evaluated during data validation through the analysis of coded field duplicate samples. The analytical laboratory will also follow acceptable procedures to assure the samples are adequately homogenized prior to taking aliquots for analysis, so the reported results are representative of the sample received.

COC procedures will be followed to document that contamination of samples has not occurred during container preparation, shipment, and sampling.

4.5.4 Completeness

Completeness is defined as the percentage of measurements made which are judged to be valid. The QC objective for completeness is generation of valid data for at least 90% of the analyses requested.

4.5.5 Comparability

Comparability expresses the degree of confidence with which one data set can be compared to another. The comparability of all data collected for this project will be ensured by:

- Using identified standard methods for both sampling and analysis phases of this project.
- Requiring traceability of all analytical standards and/or source materials to the USEPA or National Institute of Standards and Technology (NIST).
- Requiring that all calibrations be verified with an independently traceable standard from a source other than that used for calibration.

- Using standard reporting units and reporting formats including the reporting of QC data.
- Performing a complete data validation on all of the analytical results, including the use of data qualifiers in all cases where appropriate.
- Requiring that all validation qualifiers be considered any time an analytical result is used for any purpose.

These steps will ensure all future users of either the data or the conclusions drawn from them will be able to judge the comparability of these data and conclusions.

4.5.6 Sensitivity

Soil, water, and waste samples will be analyzed according to the USEPA SW-846 "Test Methods for Evaluating Solid Waste," November 1986, 3rd edition and subsequent updates. The methods to be used for the laboratory analysis of soil samples are presented in Table 2. These methods were selected because they attain the quantitation limits and DQOs required by the project, which are also compiled on the table.

4.6 Equipment Decontamination Procedures

The following decontamination procedure will be followed for all non-disposable sampling equipment before being reused.

- Equipment will be washed thoroughly with a non-phosphate detergent.
- The equipment will then be rinsed with analyte-free water.

After decontamination, equipment will be carefully stored to avoid contamination between sampling events.

All downhole drilling tooling will be washed thoroughly using brushes, steam cleaners, and/or pressure washers and an appropriate biodegradable cleaning solution for the level of contamination present. All downhole tooling that has been used in a boring advancement, well development or aquifer testing will be decontaminated before reuse in a subsequent borehole/well as well as before demobilization.

5 HEALTH AND SAFETY PROCEDURES

5.1 Site Hazards

There are physical hazards that may be present at the Site associated with existing conditions and with investigation activities. Potential physical hazards include the following:

- Traffic - Requires care when entering and leaving the Site.
- Overhead and underground utilities - Overhead power lines near road. Potential underground utilities during drilling and well installation.
- Mechanical equipment including Geoprobe and drill rigs.
- Slips, trips, and falls - General site hazards. Debris along work area(s), debris inside and outside of offsite buildings, and rough or steeply sloped surfaces.
- Exposure to hazardous wildlife and plants.

A number of environmental investigations have been performed at the Site between 1996 and 2009. These investigations were documented in the RI Report (CMX, 2009), which concludes that coal tar is present in subsurface soils and groundwater at the Site.

All NRT Team personnel will be bound by the provisions of the Site-Specific Health and Safety Plan (HASP) and O&R's standard contractor H&S requirements. All field staff will be required to participate in a preliminary project safety meeting to familiarize themselves with the anticipated hazards and respective onsite controls. The discussion will cover the entire HASP subject matter, putting emphasis on critical elements of the plan; such as the emergency response procedures, personal protective equipment, site control strategies, and monitoring requirements. In addition, daily tailgate safety meetings will be held to discuss: the anticipated scope of work, required controls, identify new hazards and controls, incident reporting, review the results of inspections, any lessons learned or concerns from the previous day. Attendance rosters from all safety meetings will be signed by all present and incorporated into the project records. NRT subcontractors will formally agree to sign off on the NRT Team's HASP. If the subcontractor has additional or more stringent requirements, they will be submitted to NRT and O&R for review. Further detail on Health and Safety protocols for the Site are presented in the Site-Specific HASP (Appendix D).

6 SCHEDULE

The primary PDI activities will begin upon NYSDEC approval of this PDIWP. It is O&R's intention to begin topographic, property line, and utility survey work prior to NYSDEC approval of the PDIWP. The field portion of the work is expected to require four to six weeks of onsite activities. This will begin as soon as practicably possible after approval of the PDIWP, but will be dependent on subcontractor scheduling. O&R will inform NYSDEC at least 10 calendar days prior to conducting the work. The PDI Summary Report will be submitted to the NYSDEC approximately 60 days after the completion of the field work.

7 REFERENCES

AECOM, July 18, 2013, Remedial Design Work Plan (Operable Unit #2), Clove and Maple Ave Former MGP Site, Haverstraw, Rockland County (NY), NYSDEC Site #: 3-44-049, Prepared for: Orange and Rockland Utilities, Prepared by: AECOM – Chelmsford, MA.

CMX, 2009. Remedial Investigation Report, Former Clove and Maple Manufactured Gas Plant Site, 120 Maple Avenue, Haverstraw, NY. NYSDEC Site Number 3-44-049. Prepared for: Orange and Rockland Utilities, Prepared by: CMX.

GEI, 2011. Feasibility Study, Clove and Maple Avenues Former Manufactured Gas Plant, Village Haverstraw, Rockland County, New York, NYSDEC Site No. 3-44-049. October 14, 2011.

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NYSDEC, 2002. DER-4, Management of Coal Tar Waste and Coal Tar Contaminated Soils and Sediment from former MGPs (TAGM - 4061), January 2002.

NYSDEC 2006a. NYCRR PART 370 - 374 and PART 376 Environmental Remediation Programs.

NYSDEC, 2006b. 6 NYCRR PART 375 Environmental Remediation Programs Subparts 375-1 to 375-4 & 375-6, December 2006.

NYSDEC, 2012. Record of Decision, O&R, Haverstraw Clove & Maple MGP, Haverstraw, Rockland County, New York, Site No.344049. March 2012.

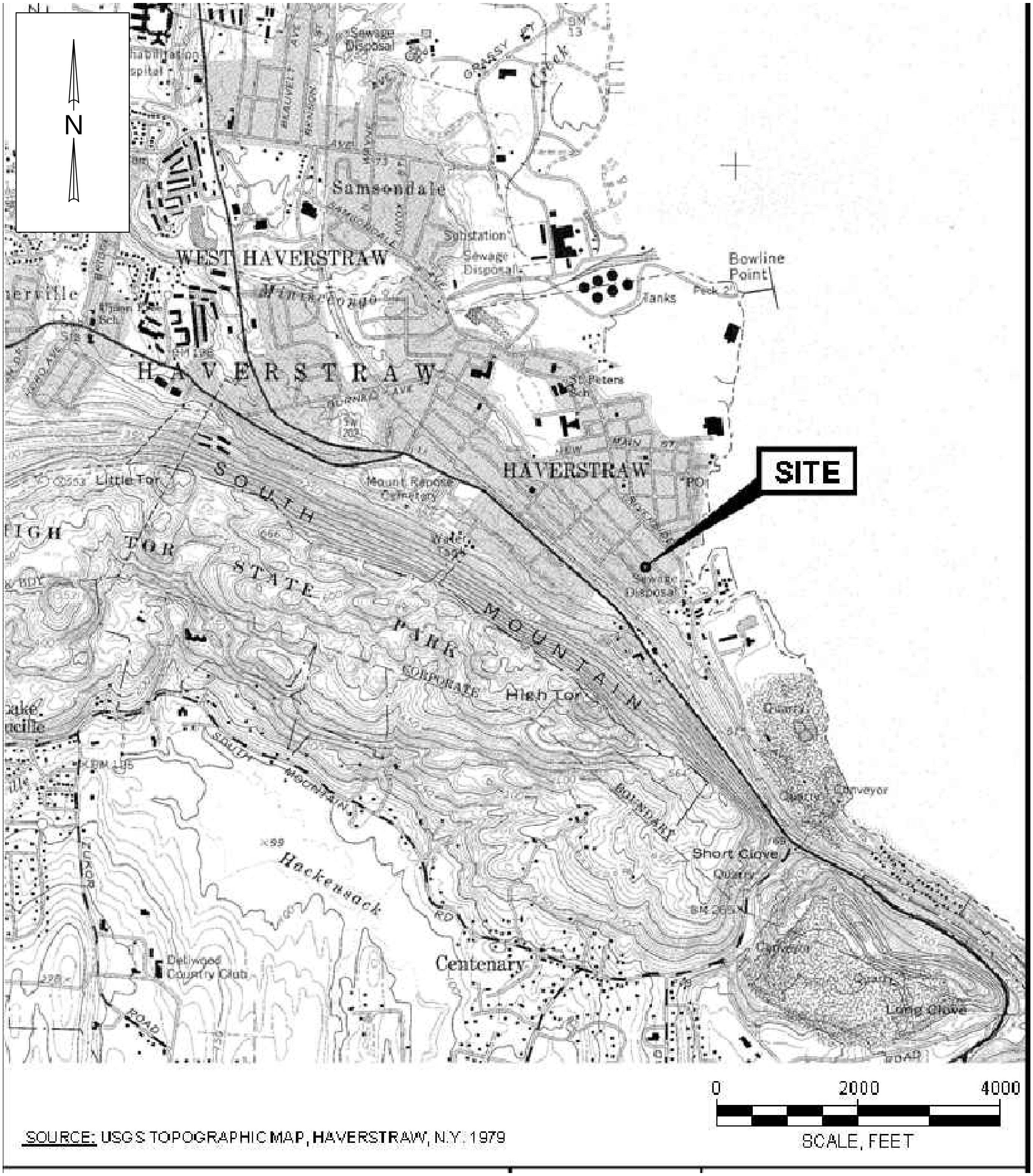
NYSDEC, 2010a. DER-10, Technical Guidance for Site Investigation and Remediation. May 2010.

NYSDEC, 2010b. DER-31, Green Remediation. September 2010.

RETEC, 1997. Surface Soil Investigation and Risk Assessment Report for Former MGP Site at Clove and Maple in Haverstraw, prepared by Remediation Technologies, Inc., August 13, 1997.

RETEC, 2005. Clove and Maple Avenue Former MGP Sites, Haverstraw, NY. Soil Gas, Indoor and Ambient Air Sampling of February 2005. Preliminary Evaluation of Results, prepared by The RETEC Group, Inc., March 23, 2005.

FIGURES



SITE LOCATION MAP

NATURAL RESOURCE TECHNOLOGY

PRE-DESIGN INVESTIGATION WORK PLAN
ORANGE AND ROCKLAND UTILITIES, INC.
CLOVE AND MAPLE FORMER MGP SITE
HAVERSTRAW, NEW YORK

PROJECT NO.
2254/1.0

DRAWING NO.
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FIGURE NO.
1

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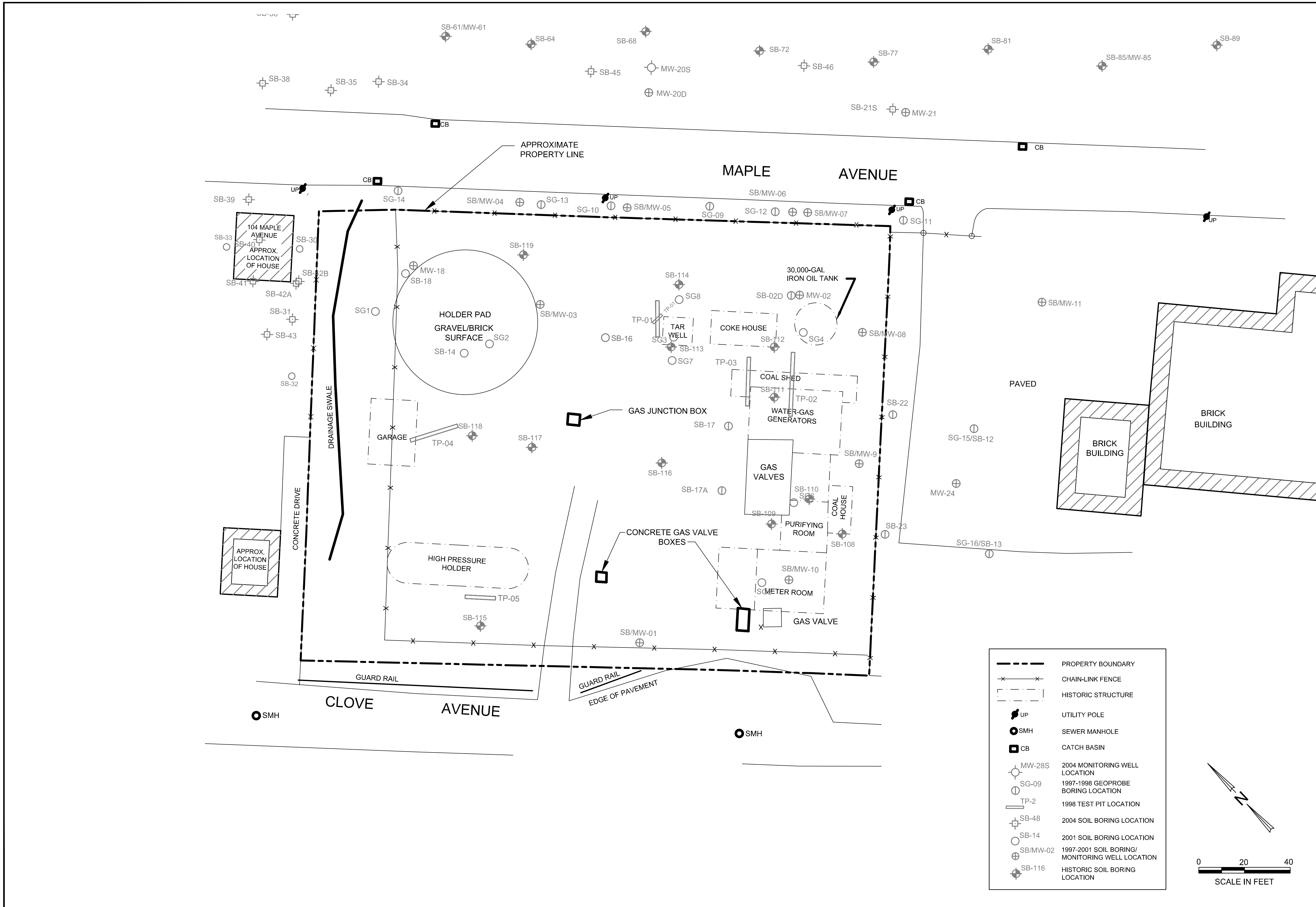

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SITE LAYOUT

PRE-DESIGN INVESTIGATION WORK PLAN
ORANGE AND ROCKLAND UTILITIES, INC.
CLOVE AND MAPLE FORMER MGP SITE
HAVERSTRAW, NEW YORK

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2254/1.0

FIGURE NO.
2

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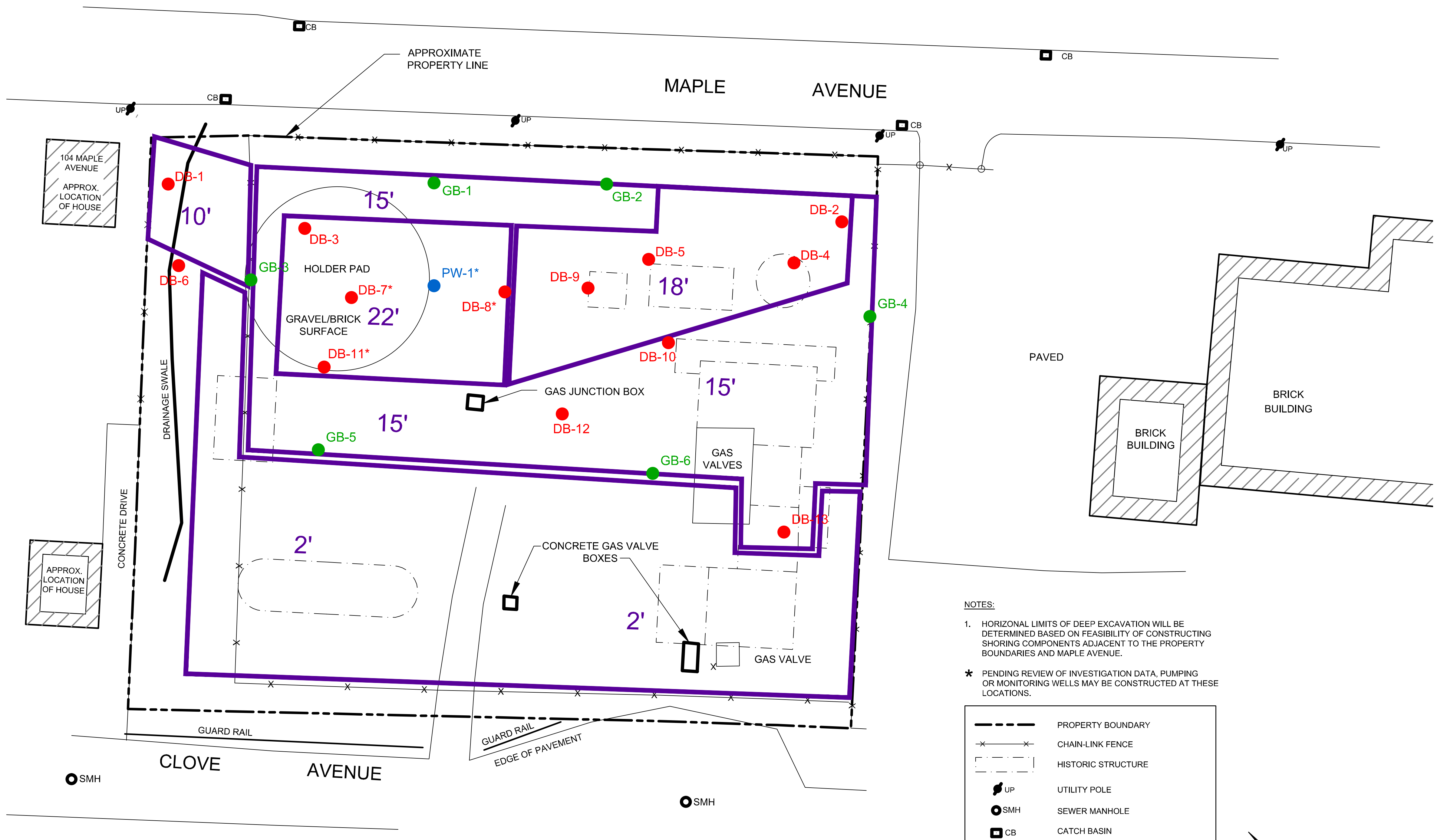

NOTES:

1. HORIZONAL LIMITS OF DEEP EXCAVATION WILL BE DETERMINED BASED ON FEASIBILITY OF CONSTRUCTING SHORING COMPONENTS ADJACENT TO THE PROPERTY BOUNDARIES AND MAPLE AVENUE.

* PENDING REVIEW OF INVESTIGATION DATA, PUMPING OR MONITORING WELLS MAY BE CONSTRUCTED AT THESE LOCATIONS.

	PROPERTY BOUNDARY
	CHAIN-LINK FENCE
	HISTORIC STRUCTURE
UP	UTILITY POLE
SMH	SEWER MANHOLE
CB	CATCH BASIN
DB-1	PROPOSED DELINEATION LOCATION
GB-1	PROPOSED GEOTECHNICAL AND DELINEATION LOCATION
PW-1	PROPOSED DELINEATION LOCATION AND LOCATION OF 4" ID PUMPING WELL
	APPROXIMATE LIMITS OF EXCAVATION ESTABLISHED IN ROD

N

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SCALE IN FEET

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CHECKED BY: JRR DATE: 03/06/15

APPROVED BY: JFM DATE: 03/06/15

DRAWING NO: 2254-1-B03

REFERENCE: .

PROPOSED INVESTIGATION LOCATIONS

PRE-DESIGN INVESTIGATION WORK PLAN
ORANGE AND ROCKLAND UTILITIES, INC.
CLOVE AND MAPLE FORMER MGP SITE
HAVERSTRAW, NEW YORK

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2254/1.0

FIGURE NO.
3

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TABLES

Table 1
Proposed Investigative Activities
Orange & Rockland Utilities
Haverstraw - Clove and Maple Avenues Former MGP Site
(Operable Unit 1)

Investigative Activity	Proposed Investigative Activities	Proposed Sample Depths	Proposed Sample Analyses	Rationale
Utility Clearance and Survey	Perform utility location and topographic and bboundary survey to meet the requirements of DER- 33.	NA	NA	Topographic, utility and boundary survey is necessary to create base map for Remedial Design as well as basis for environmental easements/deed restrictions.
Delineation - Subsurface Soil	Soil Borings GB-5 and GB-6 south of previous soil boring SB-118.	Approximately 25 to 30 feet bgs.	Benzene, Ethyl Benzene, Toluene & Xylenes (VOCs) Polynuclear Aromatic Hydrocarbons (SVOCs)	Delineate southern limit of subsurface soil excavation to 15 feet bgs in the vicnity of previous soil boring SB-118.
	Soil Boring DB-13 in area of Former Coal House and Purifier Room	Approximately 25 to 30 feet bgs.	VOCs and SVOCs	Verify that subsurface soil excavation to 15 feet bgs at the former coal house and purifying room is necessary.
	Soil Borings DB-1, DB-6 and GB-3 in and adjacent to the drainage swale	Approximately 20 to 22.5 feet bgs.	VOCs and SVOCs	Delineate subsurface soil impacts in the drainage swale to define the limits of excavation.
Source Material Delineation	Soil Borings GB-2, DB-2, DB-4, DB-5, DB-9, DB-10 and DB-12.	Approximately 25 to 30 feet bgs.	VOCs and SVOCs	Delineate area identified in the Record of Decision (ROD) as requiring subsurface soil excavation to 18 feet below grade to remove source material.
	Soil Borings GB-1, DB-3, PW-1, DB-7, DB-8, DB-11.	Approximately 25 to 30 feet bgs.	VOCs and SVOCs	Delineate area identified in the Record of Decision (ROD) as requiring subsurface soil excavation to 22 feet below grade to remove source material.
Geotechnical Borings	Soil borings GB-1 through GB-6 at locations co-located with delineation borings and/or well borings.	Approximately 65 feet bgs	• Grain Size Distribution: two per boring; one in shallow soils for each boring and one in deep soils (glacial till) • Moisture Content: two per boring; one in shallow soils for each boring and one in deep soils (glacial till) • Atterberg Limits: fine grain soils from each boring; test two shallow samples and two deep samples (till), if possible • For cohesive soil: o Unconfined Compressive Strength Test: every third sample o Shelby Tube: every third sample o Vane Shear Test: all samples with cohesive soil o Pocket Penetrometer reading: all samples with cohesive soil	Collect data necessary to support development of excavation shoring specification.
Hydrogeologic Investigation	Perform seven slug tests on select (existing) shallow overburden monitoring wells. Perform a k test on deep overburden monitoring well MW-07, screened in the glacial till.	Various.	Analyze tests to determine hydraulic conductivities (k).	Further define hydrogeologic conditions of the Site and provide data to evaluate dewatering options for the remedial excavation.
	Install 4-inch inside diameter (I.D.) pumping well (PW-1) and two 1¼-inch I.D. observation piezometers (OW-1 and OW-2) to be co-located with geotechnical and/or delineation borings. Perform pumping test to be defined based on the results of the k tests described above.	To be determined.	Pumping test analysis.	Further define hydrogeologic conditions of the Site and provide data to evaluate dewatering options for the remedial excavation.
	Collect data on seasonal groundwater fluctuation, Water level data will be obtained using from in-situ transducers to facilitate real-time monitoring and allow adjustment of sensors, if necessary.	Various.	Evaluate aquifer response to substantial rain events.	Further define hydrogeologic conditions of the Site and provide data to evaluate dewatering options for the remedial excavation.
Construction Water Discharge Evaluation	Review discharge permit requirements based upon required sampling and available/allowable discharge capacities at local POTW.	NA	NA	Assess construction dewatering discharge options and permit requirements.
Drainage Swale Flow Evaluation	Collect data from the Village on the storm sewer system that discharges to the drainage swale.	NA	Perform simple hydrologic model to evaluate stormwater flow and bypass options during soil excavation in the swale.	Collect information needed to evaluate stormwater flow in the drainage swale.
Structure Evaluation	Collect data from previous work (93B IRM) and perform exterior inspections of adjacent structures. Include extensive photographic documentation.	NA	Qualitative evaluation of potrntial impacts.	Collect information needed to evaluate potential impacts to nearby structures during construction activities
Waste Characterization	Collect waste characterization samples during other PDI activities in order to evaluate disposal options	Various.	Various (see Table 2)	Collect data for initial characterization of material for disposal.

NATURAL RESOURCE TECHNOLOGY

Table 2

Environmental Sampling Analytical Methods
Orange & Rockland Utilities
Haverstraw - Clove and Maple Avenues MGP Site (Operable Unit 1)

Sample Type	Matrix	Holding Time	Method
VOCs TCL	Soil	7 days	U.S. EPA Method 8260C
SVOCs TCL	Soil	14 days	U.S. EPA Method 8270D
Metals (14 Metals)*	Soil	180 days	U.S. EPA Method 6010B/7471A
Total Cyanide	Soil	14 days	U.S. EPA Method 9012A
TPH	Soil	14 days	U.S. EPA Method 8100 or 8015DRO
Total PCBs	Soil	14 days for extraction/40 days for analysis	U.S. EPA Method 8082
% Sulfur	Soil	28 days	ASTM D129-64
BTU Content	Soil	28 days	ASTM D240-87
TCLP VOCs	Soil	14 days (TCLP extraction); 7 days (after extraction)	U.S. EPA Method 1311
TCLP SVOCs	Soil	14 days (extraction); 40 days (after extraction)	U.S. EPA Method 1311
TCLP Metals	Soil	180 days (TCLP extraction)	U.S. EPA Method 1311/6010B
TCLP Herbicides	Soil	14 days (TCLP extraction); 7 days (preparative extraction); 40 days (after extraction)	U.S. EPA Method 1311/8151A
TCLP Pesticides	Soil	14 days (TCLP extraction); 7 days (preparative extraction); 40 days (after extraction)	U.S. EPA Method 1311/8081A
Ignitability (Flashpoint)	Soil	N/A	U.S. EPA Method 1010
Corrosivity (as pH)	Soil	7 days 9045C	U.S. EPA Method
Reactive Sulfide	Soil	7 days	U.S. EPA Method 8030B/9034
Reactive Cyanide	Soil	14 days	U.S. EPA Method 9012A
Paint Filter		180 days	SW-846 Method 9095A
% Solids		28 days	SM20 2540G

*Metals include Arsenic, Barium, Cadmium, Chromium (total), Lead, Mercury, Selenium, Silver, Antimony, Beryllium, Nickel, Thallium, Vanadium, and Zinc.

Table 3

List of Standard Operating Procedures and ASTM Methods
Orange & Rockland Utilities
Haverstraw - Clove and Maple Avenues MGP Site (Operable Unit 1)

Field Activity	Standard Operating Procedure/ASTM Method
Direct Push Borings	■ Description of Soil and Manufactured Gas Plant Residuals ■ SOP - Subsurface Soil Sampling by Direct Push Methods ■ ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ■ ASTM D 4220 - Standard Practices for Preserving and Transporting Soil Samples ■ ASTM D 5434 - Field Logging of Subsurface Explorations of Soil and Rock
Geotechnical Borings	■ Description of Soil and Manufactured Gas Plant Residuals ■ SOP - Subsurface Soil Sampling by Split Spoon ■ ASTM D 1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils ■ ASTM D 1587 - Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes ■ ASTM D 2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation ■ ASTM D 2488- Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ■ ASTM D 4220 - Standard Practices for Preserving and Transporting Soil Samples ■ ASTM D 5434 - Field Logging of Subsurface Explorations of Soil and Rock ■ ASTM D 6032 - Determining Rock Quality Resignation for Rock Core ■ ASTM D 6151 - Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
Sample Collection	■ SOP - Packaging and Shipment of Environmental Samples ■ SOP - Decontamination of Field Equipment
Aquifer Testing	■ SOP - Monitoring Well Construction and Installation ■ SOP - Monitoring Well Development ■ SOP - Aquifer Testing

Table 4

Geotechnical Analyses
Orange & Rockland Utilities
Haverstraw - Clove and Maple Avenues MGP Site (Operable Unit 1)

Sample Type	Matrix	Method
Grain Size Distribution	Soil	ASTM D422
Moisture Content	Soil	ASTM D2216
Atterberg Limits Testing	Soil (Fine grained soils only)	ASTM D2850
Unconfined Compressive Strength Test	Soil	ASTM D2166 / D2166M
Shelby Tube	Soil	ASTM D1587
Vane Shear Test	Soil (Cohesive soils only)	ASTM D2573

Appendix A: Standard Operating Procedures

List of Standard Operating Procedures and ASTM Methods
Orange & Rockland Utilities
Haverstraw - Clove and Maple Avenues Former MGP Site (Operable Unit 1)

Field Activity	Standard Operating Procedure/ASTM Method
Direct Push Borings	▪ Description of Soil and Manufactured Gas Plant Residuals ▪ SOP - Subsurface Soil Sampling by Direct Push Methods ▪ ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ▪ ASTM D 4220 - Standard Practices for Preserving and Transporting Soil Samples ▪ ASTM D 5434 - Field Logging of Subsurface Explorations of Soil and Rock
Geotechnical Borings	▪ Description of Soil and Manufactured Gas Plant Residuals ▪ SOP - Subsurface Soil Sampling by Split Spoon ▪ ASTM D 1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils ▪ ASTM D 1587 - Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes ▪ ASTM D 2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation ▪ ASTM D 2488- Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ▪ ASTM D 4220 - Standard Practices for Preserving and Transporting Soil Samples ▪ ASTM D 5434 - Field Logging of Subsurface Explorations of Soil and Rock ▪ ASTM D 6032 - Determining Rock Quality Resignation for Rock Core ▪ ASTM D 6151 - Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
Sample Collection	▪ SOP - Packaging and Shipment of Environmental Samples ▪ SOP - Decontamination of Field Equipment
Aquifer Testing	▪ SOP - Monitoring Well Construction and Installation ▪ SOP - Monitoring Well Development ▪ SOP - Aquifer Testing

Description of Soil and Manufactured Gas Plant residuals

1.1 Purpose

The primary purpose of this Procedure for Describing Soil & Manufactured Gas Plant Residuals (the "Procedure") is to provide and ensure the use of a consistent methodology for describing the materials observed in subsurface samples collected at former manufactured gas plant ("MGP") sites. At most MGP sites, the predominant subsurface materials are native or reworked soils and fill. In some areas, however, residuals from prior MGP operations could account for a significant percentage of the overall matrix. It is also possible to encounter residual materials at the site that are unrelated to the former MGP operations. **It is critically important that all field notes and associated logs accurately represent the characteristics of the soil and MGP or other residuals as well as the proportions of soil versus residuals.**

At the same time it is also important that all field notes and logs refrain from speculation as to the origin or source of the materials being described. Proper determinations regarding the source or origin of MGP residuals or other non-native materials observed in the field requires consideration of all information at hand, including laboratory data, site history, operations at abutting properties, and other similar considerations that are unavailable and/or unknown to those conducting field work. Speculative references in field note and logs can hinder, rather than facilitate, the proper identification of the residual and therefore should be avoided. To assist in the proper determination of the origin or source of materials encountered at an MGP site, the terms and procedures delineated below should be followed. These terms and procedures were developed based upon many years of collective professional experience regarding the characteristics of MGP sites.

> **You will note that this Procedure calls for the use of descriptive terms such as "tar-like material (TLM)" and "oil-like material (OLM)". Such terms are intended to ensure that conclusions regarding the source or origin of materials observed during sampling are based on more than simple observation.** While these terms are appropriate for field notes and logs, they should not be used in reports, unless it is absolutely necessary to describe what was observed during sampling. Instead, reports should reflect the author's consideration of the field observations, laboratory data, site history and other available information and describe MGP residuals and other non-native materials succinctly and accurately using terms that are consistent with the source of the material (e.g., "tar", "coal tar", "fuel oil", "coal tar oil", "purifier wastes").

This Procedure is not intended to conflict with a standard, practice or analytical method required by a regulatory agency, nor with the best professional judgment of a qualified professional. In the event that use of any part of this Procedure is perceived to conflict with an agency requirement or a qualified professional's best professional judgment, the possible conflict must be discussed with the client and resolved prior to conducting any new or continuing any on-going site characterization work. (Field notebooks and logs should not be altered after the fact).

1.2 Key Terms for Describing MGP Residuals

It is important to note the following four characteristics when describing MGP residuals: nature of the material, color, any discernible odors, and the material's viscosity (for oil- and tar-like material). Table 1 provides a matrix of typical MGP residual ("MGPR") characteristics. Additional detail is provided below.

I. Material - when describing MGP residual material, the following terms/acronyms should be used in field notes and logs. Note that coal tar has a wide range of properties ranging from the less viscous oils (e.g. crude phenol, anthracene oil) to the highly viscous, sometimes asphaltic, pitch. The primary purpose for distinguishing oily residuals from tar in this Procedure reflects the differing potential for environmental impact.

<u>TLM (tar-like material)</u> - or pitch is typically a black, viscous, separate-phase material that would not be considered a fluid or ***liquid*** even though at elevated temperatures it becomes more fluid. TLM will not migrate through porous media at ambient temperatures in the subsurface, and can sometimes be asphaltic in its appearance. When encountered in the subsurface, TLM is found as a distinct, separate mass that is not interspersed within the soil matrix, although it may contain some aggregate as a result of mechanical mixing prior to or during its deposition.

<u>OLM (oil-like material)</u> - is non-aqueous phase liquid (NAPL) substance with varying viscosities and densities. OLM may be a petroleum product or a low viscosity substance derived from the same process that results in TLM. For purposes of field description, OLM can be distinguished from TLM based on its distribution within the soil matrix (i.e., OLM coats soil grains). OLM that exhibits MGP residual characteristics, such as odor, should be differentiated from OLM related to petroleum or other sources. The distinguishing characteristic should be identified in the field notes and log.

When describing groundwater samples use of LNAPL and DNAPL are encouraged to characterize the density of the OLM. An LNAPL (Light non aqueous phase liquid) is defined as a NAPL that floats on a waters surface because it is less dense that water, and a DNAPL (Dense non aqueous phase liquid) is defined as a NAPL that sinks in a water column because it is more dense that water. The specific gravity of OLM derived from tar is sometimes very similar to that of water (i.e., close to 1.00). The presence of an emulsified liquid should also be noted if observed in a ground water sample. An emulsion refers to a dispersion of small drops of one liquid into an immiscible liquid such as an LNAPL or DNAPL.

> **<u>CLINKER</u> - are agglomerated ash; clinker can be found as vesicular chunks of material that vary in size, but are typically one or two inches in diameter, and may also be produced from a variety of coal burning processes including those not related to MGP sites.**

<u>WF (wood fibers)</u> - this designation should be reserved for wood chips/fibers that contain blue staining, MGP residual-type odor[s], and/or infusion with OLM/TLM. Without this supporting evidence fragments of wood should be described as to the probable origin (e.g., root matter, timber, lumber, or "wood fiber, source unknown").

<u>ASH</u> - is a lightweight substance (relative to mineral soil) that can vary in color from white and gray to black, and may be partially combusted containing fragments of coal. This material may have a granular texture and its presence is quite often the result of coal burning associated with non-MGP sources, such as electric power generation.

II. Color - among other considerations, the color of MGP residuals (as well as the affected soil grains) can be a function of the parent material, the oxidation state, and staining. The term "staining" should be used with discretion, since it implies that only the surface of the material has the described color. Colors commonly associated with MGP residuals are:

White – this color may be indicative of lime that was sometimes used in the gas purification processes, typically at smaller MGPs. The presence of lime increases the solubility of the cyanide compounds in the immediate vicinity of the lime, so its presence in the soil column should be noted. The color white may also be attributed to the presence of ash, and hard to distinguish from lime.

Orange - this color may be indicative of high iron content, which may be inherent in the parent material, or may indicate the presence of iron-bearing, oxide box wastes.

Yellow – this color may be indicative of elemental sulfur resulting from the gas purification process. Note that reduced sulfur compounds can be black, and may be associated with organic compound odors (e.g., naphthalene). This condition can make the soil appear to be affected by OLM or TLM when it is not.

Blue - indicates the presence of ferrocyanides; sometimes this coloration is so intense that it approaches a deep purple color; when mixed with a black substance, the ferrocyanides may impart a green color to the MGP residuals, or affected soil.

Grey – ash can impart a grey color, and can be mixed with ash ranging from white to black. Coke can also be grey, with a silver appearance.

Black - this color may be due to the presence of coal fragments, soot, TLM, or OLM, or may be the color of the parent material (e.g., magnetite).

III. Odor - the three broad categories of odors that may be present at a MGP site are those associated with MGP process residuals, petroleum (often used as feedstocks for gas manufacture and/or the subsequent use of gasoline or heating fuels), and "other". These odor categories may be further distinguished based on field experience, as indicated below.

MGP Residual Odors

- tar (hot asphalt or roofing tar)
- naphthalene (mothballs)
- styrene (sweet, fiberglass-like)
- light-end odor (akin to gasoline, but not the same)
- acrid, caustic odor (some oxide box wastes)

Petroleum Odor

- diesel/No.2 fuel oil
- kerosene
- gasoline

Other

- solvents (e.g., chlorinated compounds) or alcohols
- organic (e.g., septage, or decaying organic matter)

Odors may be very difficult to define, and will vary from person to person. If one is uncertain, classification of an odor within the three categories listed above should not be attempted.

IV. Viscosity - this characteristic is particularly important for TLM and OLM. Some TLM will begin to "flow" (e.g., assume the shape of a glass container) if exposed to sunlight or summer temperatures. Other masses of TLM are hard enough, especially when cold, that "chips" can be dislodged. Other types of TLM may be mixed with aggregate, and take on the appearance and character of asphalt pavement. Likewise, OLM found in the subsurface may exhibit various consistencies that may be indicative of "weathering". These observations are important characteristics of TLM and OLM to note in the field logs.

V. NAPL – direct and indirect evidence of a NAPL in solid/saturated media can be obtained by careful observations, practical field screening and/or quantitative laboratory testing. The observation of NAPL, either LNAPL or DNAPL, in a collected ground water sample or the observation of NAPL released from a subsurface soil sample (e.g., core sample) are indications of the presence of a NAPL or OLM. In many cases the visual evidence is not this dramatic and it may be necessary for the scientist conducting the field logging to use some simple tests to screen a solid sample for the presence of NAPLs. These tests are described briefly below:

- "wick" test – place soil on a paper towel to see if NAPL wicks out of the sample into the paper towel
- "jar" test – place soil sample in a jar of water to see if a sheen develops, or if NAPL separates out of the soil matrix
- "Brown Paper Bag" test - place soil sample inside a brown paper lunch bag (waxed). Let sit for several minutes and observe if OLM has stained/discolored the bag. If no OLM present no discoloration will occur (water should not penetrate the light wax coating the paper).

If quantification of the percent saturation is a desired measurement, a variety of laboratory techniques can be considered:

- centrifuging of samples
- standard soil analysis
- EPRI field methods

As new technologies are developed and accepted by State and Federal agencies, the qualified professionals conducting field work for a client should discuss the process or procedure with the client before using at a site.

VI. Sheens – can be common at MGP sites, and may be apparent on soil grains, interstitial pore water, and where groundwater surfaces at seeps near drainage features. The sheen can be organic in origin, or quite often inorganic. Reducing conditions associated with the degradation of organic compounds, such as BTEX and naphthalene, can liberate inorganics native to the geologic formation (most commonly iron and manganese). Inorganic sheens can form when the reduced metals (and thus dissolved, moving with the groundwater) are exposed to aerobic conditions when groundwater discharges to surface water bodies. For example, iron bacteria that live at near-neutral pH are commonly found where ferrous iron is moving from anaerobic to aerobic conditions. These are the same types of bacteria that can cause iron fouling of pumping well screens. Discharged groundwater will often have an MGP Residual odor due to the dissolved organic compounds, so the inorganic sheen might inadvertently be attributed to separate-phase organics migrating with the groundwater.

An organic sheen occurs when the light reflected from the underlying water is refracted by a thin layer of oil, and thus the "rainbow" appearance. If disturbed, the organic sheen will coalesce, whereas the inorganic sheen "breaks" apart and has a blocky appearance.

1.3 Procedure for Subsurface Soil Logging

Sample Description Format - The basis for describing samples will be the Unified Soil Classification System (USCS), and should include the following important characteristics:

- name/modifier (e.g., gravelly sand, silty sand)
- consistency (firm, loose, plastic)
- moisture (dry, damp, moist, wet saturated)
- color
- structure (e.g., layering, fractures, no visible structure - not applicable for fill or MGP residuals)
- geologic origin, if known (e.g., till, alluvium - not applicable for fill or MGP residuals)
- odor
- viscosity (tar- and oil-like material only)

Attached is a key to the classification and description of soil using the USCS, which provides the necessary detail and a few examples. For consistency, the sequence of description should be the same as that provided in the attached examples.

Fill Material Description - In addition to native soils, fill material, which may not contain any apparent MGP residuals, is also commonly encountered at former MGPs, and may include imported soils, bricks (e.g., red clay and kiln), glass, wood timbers, and metal debris among other materials. Soils/fill may also exhibit a wide variety of colors that may be indicative of MGP residuals. Evidence of releases not associated with MGP residuals, such as petroleum releases, may also be found at MGP sites. Field descriptions should provide clear descriptions that when combined with analytical results; site history and other information will assist in distinguishing between MGP and non-MGP residuals.

Typical MGP Residuals Encountered - Soils and fill at former MGP sites may contain varying amounts and types of MGP residuals depending on the years of operation and the types of processes used to generate and purify the gases. As discussed above, the types of MGP residuals commonly encountered include the following.

- Ash
- TLM - tar-like material
- OLM - oil-like material
- Clinker
- WF - wood fibers that are heavily blue stained or contain other MGP residuals
- coal or coke fragments

In most instances, subsurface samples are comprised primarily of soil, which may contain various proportions of MGP residuals. Field notes should accurately document the percentage of MGP residuals in a sample (e.g., 85% gravelly sand, 10% clinker, and 5% ash), and the distribution of MGP residuals within the sample (e.g., a two-inch seam of ash).

When describing MGP residuals it is important to base the description on **appearance** (e.g., black, highly-viscous, TLM containing no appreciable aggregate) and **not** the assumed source (e.g., black tar from the former tar & liquor tank). Although the sample description should be based on appearance only, additional notation regarding the location of the sample is desirable. For example, an abundance of MGP residuals exposed in a test pit may be indicative of source material, whereas the presence of MGP-related constituents remote from any known source may be an indication of MGP residuals mobility (e.g., blue-stained, native soils found at depth in a soil boring). Therefore, field descriptions should allow the reader to clearly distinguish between fill materials and native soils affected by compound migration.

KEY TO CLASSIFICATION AND DESCRIPTION OF SOIL

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS

MAJOR DIVISIONS			Group Symbol	Typical Name
COURSE-GRAINED SOIL (>50% retained on # 200 sieve)	GRAVEL (>50% of coarse fraction retained on # 4 sieve)	Fines <5%	**GW**	Gravel, well graded
			GP	Gravel, poorly graded
		Fines 5-12%	**GW-GM** **GW-GC**	Gravel, well graded
			GP-GM **GP-GC**	Gravel, poorly graded
		Fines >12%	**GM** **GM-ML** **GM-MH**	Silty gravel
			GC **GC-CL** **GC-CH**	Clayey gravel
	SAND (≥50% of course fraction passes #4 sieve)	Fines < 5%	**SW**	Sand, well graded
			SP	Sand, poorly graded
		Fines 5-12%	**SW-SM** **SW-SC**	Sand, well graded
			SP-SM **SP-SC**	Sand, poorly graded
		Fines >12%	**SM** **SM-ML** **SM-MH**	Silty Sand
			SC **SC-CL** **SC-CH**	Clayey sand

	CHARACTERISTICS OF FRACTION PASSING #40 SIEVE					
		DRY STRENGTH (crushing charac-teristic)	DILATENCY (reaction to shaking)	TOUGHNESS (consistency near plastic limit)		
FINE-GRAINED SOIL (≥50% passes #200 sieve)	Liquid limit <50	None to slight	Quick to slow	None	**ML**	Silt, nonplastic to slightly plastic
		Medium to high	None to very slow	Medium	**CL**	Clay, nonplastic to slightly plastic
		Slight to medium	Slow	Slight	OL	Organic silt or silt-clay nonplastic to slightly plastic
	Liquid limit >50	Slight to medium	Slow to none	Slight to medium	**MH**	Silt, moderately to highly plastic
		High to very high	None	High	**CH**	Clay, moderately to highly plastic
		Medium to high	None to very slow	Slight to medium	**OH**	Organic clay, moderately to highly plastic
Highly organic soil		Decaying vegetation			**Pt**	Peat
Minor Constituents		0-10% Trace	10-20% Little	20-35% Some	**35-50% And**	

SOIL DESCRIPTIONS

Name/modifier, gradation (beginning with coarsest fraction) or plasticity, consistency, moisture content, color, structure (as appropriate), geologic origin or formation name (if known), USCS group symbol

Examples:

Gravelly sand, well graded, 15-20% gravel to 1-inch maximum, medium to coarse sand, <5% fines, dense, moist, light yellowish brown, stratified, glacial outwash (SW)

Sandy silt, nonplastic, 5-10% subangular gravel to 1.5 inch maximum, 20-30% fine to coarse sand, very dense, damp, dark olive gray, occasional root molds, till (ML)

DENSITY / CONSISTENCY (BASED ON SPT BLOW COUNTS)

COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
Descriptor	Blows/foot	**Descriptor**	**Blows/foot**
Very loose	0 to 4	Very soft	0 to 2
Loose	5 to 10	Soft	2 to 4
Medium dense	11 to 30	Firm	4 to 8
Dense	31 to 50	Stiff	8 to 15
Very dense	>50	Very stiff	15 to 30
		Hard	>30

MOISTURE CONTENT

↑ ↑ ↑ ↑ Wetter ↑ ↑ ↑ ↑

SATURATED

WET

MOIST

DAMP

DRY

TABLE 1 - TYPICAL CHARACTERISTICS OF MGP RESIDUALS

MGP Residual	Matrix Description	Color	Odor	Moisture Content/ Viscosity
ASH	a lightweight substance with a texture that varies from clay-like to a gritty, sometimes granular material depending on the degree of combustion (may contain coal fragments)	typically black, sometimes white or grey	very little; may take on odors of other MGPR in the area	typically dry, unless moistened due to soil water or OLM, TLM, etc.
TLM	viscous material that resembles roofing tar	typically a dark black	similar to asphalt or driveway sealer	many types of TLM will “flow” (e.g., take on the shape of a container); the viscosity will vary depending on its moisture content and the amount of aggregate mixed into the TLM prior to disposal
OLM	dark liquid substance that resembles fuel oil	typically dark amber to black; may be light colored to clear	similar to TLM, but the presence of lighter PAHs (commonly naphthalene) and other aromatics are more apparent	highly variable; can range from a viscosity that is similar to water, or to that of No. 2 , 4, or 6 fuel oil
CLINKER	vesicular, sometimes glass-like and lightweight; pebble to cobble sized	brown to grey; glossy	very little; may take on odors of other MGPR in the area	typically dry, unless moistened due to soil water
WF	chips or fibers of wood typically “cemented” into blocky masses	brown to black, or bright blue; orange	depends on the degree of OLM/TLM saturation; dry material exhibits acrid odor; moist material may have TLM odor	typically dry, unless moistened due to soil water, or OLM/ TLM presence.

SOP - Subsurface Soil Sampling by Direct Push Methods

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the requirements for collecting subsurface soil using direct push technology (DPT) sampling techniques at the Clove and Maple Avenue Former MGP site (Site).

2.0 Background

2.1 Definitions

DPT Rig - A hydraulically-operated hammer device installed on the back of a van, pickup truck, or skid used to advance a hollow-stem rod and sampler into the subsurface soil (up to bedrock refusal) to collect subsurface soil samples.

Probe-Driven Sampler - A sampling device used to collect soil samples with a DPT Rig. The sampler consists of 5-foot steel core barrel with an acetate liner to contain the sample.

Extension Rod - Stainless steel rod used to remove stop-pin and drive-point assembly.

Drive Point - Solid steel retractable point used to advance sample collection device to the required sample depth.

Probe Rod - Hollow, flush-threaded, steel rod similar to a drill rod.

Stop-Pin - Steel plug that threads into the top of the drive cap to hold the drive point in place during advancement of the probe rods.

Drive Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when advancing the probe rods with the hydraulic hammer.

Pull Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when retracting the probe rods.

2.2 Associated Procedures

- Field Measurement of Total Organic Vapors
- Field Data Collection Documents, Content, and Control
- Lithologic Logging
- Sample Custody
- Packaging and Shipping Environmental Samples
- Field Equipment Decontamination
- Guide to Handling Investigation Derived Waste
- Photographic Documentation of Field Activities
- Control of Measurement and Test Equipment

2.3 Discussion

The DPT rig consists of a hydraulically-operated hammer device mounted on the back of a van, a pickup truck or a skid. The DPT system hydraulically advances small-diameter hollow rods and sampler to the desired sampling depth. The specific type of DPT sampling equipment for soil sample collection is then deployed. This work will be performed by a subcontractor with NRT oversight.

The use of DPT technology is a cost-effective alternative to using conventional drilling techniques for collecting subsurface soil samples given the site-specific geologic and hydrogeologic conditions and sample requirements. Advantages of using the DPT system include:

- Areas usually considered inaccessible by drill rigs because of terrain and vegetation, overhead wires, size constraints, etc., may be accessed with a van or pickup truck-mounted DPT rig.
- Investigation-derived wastes such as soil cuttings and purge water are minimized due to its small diameter rods and its displacement of soil horizontally, not vertically.
- Areas where traditional surface sampling equipment (e.g., Slide Hammer or Hand Auger) cannot penetrate the hard surface, a DPT rig may be used to obtain the sample(s).

3.0 General Responsibilities

DPT Subcontractor - Subcontractor retained to perform all DPT drilling activities.

Field Team Leader (FTL) - The FTL is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and the Field Sampling Plan (FSP) and this SOP.

Site Health and Safety Technician - The person who will use field screening instruments to monitor all field activities for VOCs and radiological contaminants and pre-shipment sample coolers.

Site Geologist - The person responsible for overseeing sample collecting, recording sampling information, and for logging each soil sample.

4.0 Required Equipment at the Sampling Location

General

- Site-specific plans (e.g., PDIWP, FSP, HASP, and all appropriate SOPs)
- Monitoring/screening instruments required by the HASP
- Field logbook
- Plastic sheeting
- Appropriate sample containers
- Decontamination supplies
- Insulated coolers
- Trash bags
- Bags of ice
- Sample labels
- Paper towels
- Plastic zip-loc bags
- Stainless steel trowel
- Nitrile or appropriate gloves
- EnCore™ samplers and T-handle

- Personal protective equipment
- Plastic spoons or knives
- Global Positioning System (GPS)
- 2-way radios

DPT Soil Sampling Equipment

- DPT Rig (tracked vehicle, van or truck-mounted) with the following:
  - Probe rods 5-foot [ft]) lengths
  - Extension rods (5-ft) lengths, couplers, and handle
  - Piston stop-pins (two each per rig, minimum)
  - Drive caps and pull caps (two each per rig, minimum)
  - Carbide-tipped drill bit for working in concrete or asphalt-covered areas
  - O-rings
- Assembled soil samplers (5-foot long continuous split-barrel with acetate sleeve)

5.0 Procedures

Subsurface and surface soil sampling procedures are discussed below. NRT will oversee DPT operations and handle the samples. It is the DPT subcontractor's responsibility to operate the DPT equipment.

1. Review PDIWP and site-specific health and safety plan before initiating sampling activity.
2. Don the appropriate personal protective clothing as indicated in the site-specific HASP.
3. Locate sampling location(s) in accordance with PDIWP and document pertinent information in the appropriate field logbook. Confirm GPS coordinates of each location.
4. Use clean (decontaminated) sampling tools to obtain sample material from each specified sample location.
5. Carefully remove stones, vegetation, debris, etc. from the ground surface in the sampling location area. Clear the sample location using a new and/or appropriately decontaminated tool as described to expose a fresh sampling surface.
6. The Site Health and Safety Technician will perform contaminant screening using hand-held instruments at each sample location before sampling and for each sample collected. The most recent spoils materials will be segregated to minimize cross-contamination. The breathing zone and excavated materials will be monitored continuously. If levels are detected above HASP action levels, work will be temporarily discontinued. Site work will not resume at that location until further guidance is provided by O&R. Contact information is provided in the HASP.
7. If the sampling site is in an asphalt-covered area, drill a hole using the rotary function and a specially designed (1.5-inch or 2.0-inch diameter) carbide-tipped drill bit. Otherwise, the area needs to be cleared of heavy underbrush and immediate overhead obstructions.

5.1 Subsurface Soil Sampling

Assembly

- Assemble the sampling device as follows:
  1) Screw the cutting shoe to the bottom end of the sample tube, unless using standard probe drive sampler which has a built-in cutting edge.
  2) Screw the piston tip onto the piston rod.
  3) Screw the drive head onto the top end of the sample tube.

4) Insert the acetate liner into sample tube.
5) Slide the piston rod into the sample tube, leaving the piston tip sticking out of the bottom end of the sample tube.
6) Screw the piston stop-pin onto the top end of the piston rod in a counter-clockwise direction.

- Attach the assembled sampler onto the leading probe rod.

Probing

- Thread the drive cap onto the top of the probe rod and advance the sampler.
- Advance the sampler using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Stop-Pin Removal

- Move the probe unit back from the top of the probe rods and remove the drive cap.
- Lower the extension rods into the inside diameter of the probe rods using extension rod couplers to join the extension rods.
- Attach the extension rod handle to the top extension rod and rotate the handle clockwise until the leading extension rod is screwed into the piston stop-pin. Continue to rotate the handle clockwise until the stop-pin disengages from the drive head.
- Remove the extension rods and attached piston stop-pin from the probe rods.

Continuous Sampling

Direct push sampling will be performed with a dual–tube sampling method using a specialty continuous coring sampler (4-ft with inner acetate sleeve). The sampler is driven in 4-ft intervals slightly ahead of stainless steel casing, and retrieved after each interval push as described above.

- Replace the drive cap.
- Advance the probe rods using the hydraulic hammer the length of the sample tube (4 ft).
- Replace the drive cap with the pull cap and retract the probe rod(s). Secure the rod(s) with a clamp or by hand during removal so they do not fall back down the resulting borehole.
- Detach the sampler from the lead probe rod, verifying that sufficient sample volume was recovered (Note: The length of sample contained within the tube is approximately equal to the length of exposed piston rod).
- Disassemble the sampler. Remove the acetate liner. Use cutting tool to cut length of liner (2 times) to remove an approximate 1-inch strip to access the sample material.
- The Site Health and Safety Technician will perform contaminant screening along the length of the acetate liner using hand-held instruments. The most recent spoils materials will be segregated to minimize cross contamination. The breathing zone and excavated materials will be monitored continuously. If levels are detected above HASP action levels, work will be temporarily discontinued and O&R will be contacted. Site work will not resume at that location until further guidance is provided by O&R. Contact information is provided in the HASP.
- If the PID indicates elevated VOCs or there is staining or discoloration evident, immediately collect BTEX/PAHs samples using EnCore™ samplers per Section 5.2.
- If there is no indication of contamination, collect the required number of Encore samplers for BTEX/PAHs analysis, then collect soil from the target interval as stated in the PDIWP, and place into glass jars using disposable plastic spoons or knives.
- Wipe sealed jars with a clean Kimwipe or paper towel.

- Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses, and attach to sample container.
- Place sample containers in ziploc plastic bags and seal the bags. Place samples in a cooler with ice to maintain a temperature of 4°C (+/-2°C).
- Proceed with additional sample depth collection.
- When sampling is complete, place cuttings back into the borehole and top off with bentonite pellets, as necessary, to bring former borehole to ground surface. Place plastic sheeting and gloves in garbage bag and transfer decontamination water to storage container.
- Decontaminate the sampling equipment.
- Complete the field logbook entry, field sample data sheet for each sample, and lithologic log, being sure to record all relevant information before leaving the sample location.
- Demobilize from sample location.

5.2 Method for Collecting Soil Samples for Volatile Organic Compound Analysis

The following text contains the recommended SW-846 Test Method 5035 procedure for sampling of soil samples for volatile organic compound (VOC) analysis, which includes the EnCore™ Sampler Method for low-level VOC analyses.

- When collecting grab samples for VOC analysis, it is necessary to minimize sample disturbance and minimize analyte loss.
- Wear new, clean gloves while handling sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected to avoid cross-contamination.
- The VOC samples shall be collected first as grab samples. EnCore™ samplers will be used to collect subsamples for the required analytical protocols specified in the PDIWP. The VOC samples will be collected directly from the appropriate interval within the acetate sleeve – in a section of staining, odor, and/or PID response, or at the target depth. Additional DPT cores may be necessary for all analyses.
- Once the sleeve is retrieved, quickly screen the open end of the sleeve and the sample borehole for VOCs.
- Remove EnCore™ sampler and cap from package and attach T-handle to sampler body. Ensure the sampler is locked into the T-handle before sampling.
- Push the sampler into the freshly-exposed sample in the acetate liner until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
- Extract the sampler and wipe the sampler sides with a clean paper towel or Kimwipe so that the sampler cap can be tightly attached. 8. While locked into the T-handle, push the sampler cap on the head of the sampler with a twisting motion to secure it to the sampler body.
- Remove the sampler from the T-handle and rotate the sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.
- **Repeat** procedure for each of the remaining samplers.
- Complete the sample labels by filling in the appropriate information (i.e., sample identification, date and time of sample collection, requested analyses, and securing the label to the container.
- Store samples at 4°C (+/-2°C) until samples are delivered to the FTL or sample coordinator for sample packing and shipment to the designated analytical laboratory. Encore™ samplers must be shipped and delivered to the analytical laboratory for extraction within 48 hours.
- Decontaminate all non-disposable sampling equipment.

Note: A water trip blank will be included with sample coolers containing VOC samples.

5.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analyses

The requirements for collecting samples of subsurface soil for nonvolatile organic or inorganic analyses are as follows:

- Wear new, clean gloves while handling sample containers and sampling devices. Change out gloves at each sampling location, or each time a new sample is to be collected to avoid cross-contamination.
- The non-VOC samples will be collected after VOCs; a separate sampler with acetate liner may be needed. Collect the sample from a 6-inch section from the appropriate interval within the acetate sleeve – in a section of staining, odor, or PID response, or at the target depth. Before sampling, quickly screen the length of the acetate liner for VOCs.
- Using a decontaminated stainless steel or plastic spoon or trowel, scoop soil from the acetate liner (from the 6-inch target interval) into the required glass sample jars.
- Wipe the sample containers with a clean paper towel or Kimwipe to remove any residual soil from the sample container surface.
- Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses per PDIWP, and attach to sample jar(s).
- Place sample containers in individual ziploc plastic bags and seal the bags. Place baggies onto ice in an insulated cooler to maintain at 4°C (+/-2°C) until samples are delivered to the FTL or sample coordinator for sample packing and shipment to the designated analytical laboratory.
- Decontaminate all non-disposable sampling equipment.

5.4 Method for Surface Soil Collection by Direct Push Technology

Collection of surface soil samples with the Direct Push Technology (DPT) is allowed when hard soil conditions prevent collection via slide hammer. The following text contains the recommended procedure for sampling

Assembly

Assemble the sampling device (sampler) as follows:

- Screw the cutting shoe to the bottom end of the sampler, unless using standard probe drive sampler which has a built-in cutting edge.
- Screw the piston tip onto the piston rod.
- Screw the drive head onto the top end of the sampler.
- Insert a stainless steel sleeve (5 ¾ inches x 1 ¾ inches each) into the sampler.
- Slide the piston rod into the sample tube, leaving the piston tip sticking out of the bottom end of the sampler.
- Screw the piston stop-pin onto the top end of the piston rod in a counter-clockwise direction.

Probing

- Thread the drive cap onto the top of the probe rod and advance the sampler.
- Advance the sampler using the hydraulic hammer 6-inches into the surface to collect the sample and retrieve the sampler.

Stop-Pin Removal

- Move the probe unit back from the top of the probe rods and remove the drive cap.
- Lower the extension rods into the inside diameter of the probe rods using extension rod couplers to join the extension rods.
- Attach the extension rod handle to the top extension rod and rotate the handle clockwise until the leading extension rod is screwed into the piston stop-pin. Continue to rotate the handle clockwise until the stop-pin disengages from the drive head.
- Remove the extension rods and attached piston stop-pin from the probe rods.
- Disassemble the sampler. Remove the stainless steel sleeve representing the surface sample.
- The Site Health and Safety Technician will perform contaminant screening at the top and bottom of the stainless steel sleeve using hand-held instruments. The breathing zone and extracted materials will be monitored continuously. If levels are detected above HASP action levels, work will be temporarily discontinued and O&R will be contacted. Site work will not resume at that location until further guidance is provided by O&R. Contact information is provided in the HASP.
- If the PID indicates elevated VOCs or there is staining or discoloration evident, immediately collect BTEX/PAHs samples from the bottom of the stainless steel sleeve using EnCore™ samplers.
- If there is no indication of contamination, collect the required number of Encore™ samplers for BTEX/PAHs analyses, immediately cap both ends of the stainless steel ring with Teflon and caps. Label the top and bottom of the sample.
- Wipe the capped sleeve with a clean Kimwipe or paper towel.
- Fill out the sample label with the appropriate sample information (e.g., sample identification, date/time of sample collection, requested analyses per PDIWP and attach to sample container.
- Place sample containers in zip-top plastic bags and seal the bags. Place samples in a cooler with ice to maintain a temperature of 4°C (+/-2°C). Store samples at 4°C (+/-2°C) until samples are delivered to the FTL or sample coordinator for sample packing and shipment to the designated analytical laboratory
- **Repeat** surface sampling process with steps 1 through 4 if additional volume is needed at the location to address the analytical requirement per the PDIWP. Move the sample tool entry point 6 inches away from initial sample point and collect the next sample.
- Repeat steps to retrieve and process the sample. Proceed with additional subsurface sample depth collection, if required.
- When sampling is complete, place cuttings back into the borehole and top off with bentonite pellets, as necessary, to bring former borehole to ground surface. Place plastic sheeting and gloves in garbage bag and transfer decontamination water to storage container.
- Decontaminate the sampling equipment.
- Complete the field logbook entry, field sample data sheet for each sample, and lithologic log, being sure to record all relevant information before leaving the sample location.
- Demobilize from sample location.

6.0 Restrictions/Limitations

Before conducting the DPT sampling event, underground utilities and structures must be demarcated on the ground surface. A subcontractor will be used to locate and mark the utility lines. The selected sampling location shall be a safe distance from the demarcated utility. In some cases, records regarding utility locations may not exist. Prior to advancement of boreholes, the locations will be pre-cleared to a depth of five (5) feet using a combination of manual methods or using water jetting/vacuum excavation or limited test pitting excavation to expose the utilities. Once clear, drilling and excavation activities will proceed slowly and carefully for the top ten (10) feet of each investigation location. Proposed sampling locations may be shifted to avoid subsurface and overhead utilities as appropriate.

When grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and analyte loss. The representativeness of a VOC grab sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

Geoprobe® Systems, September 1991, The Probe-Drive Soil Sampling System.

Designation: D 2488 – 00

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula*.

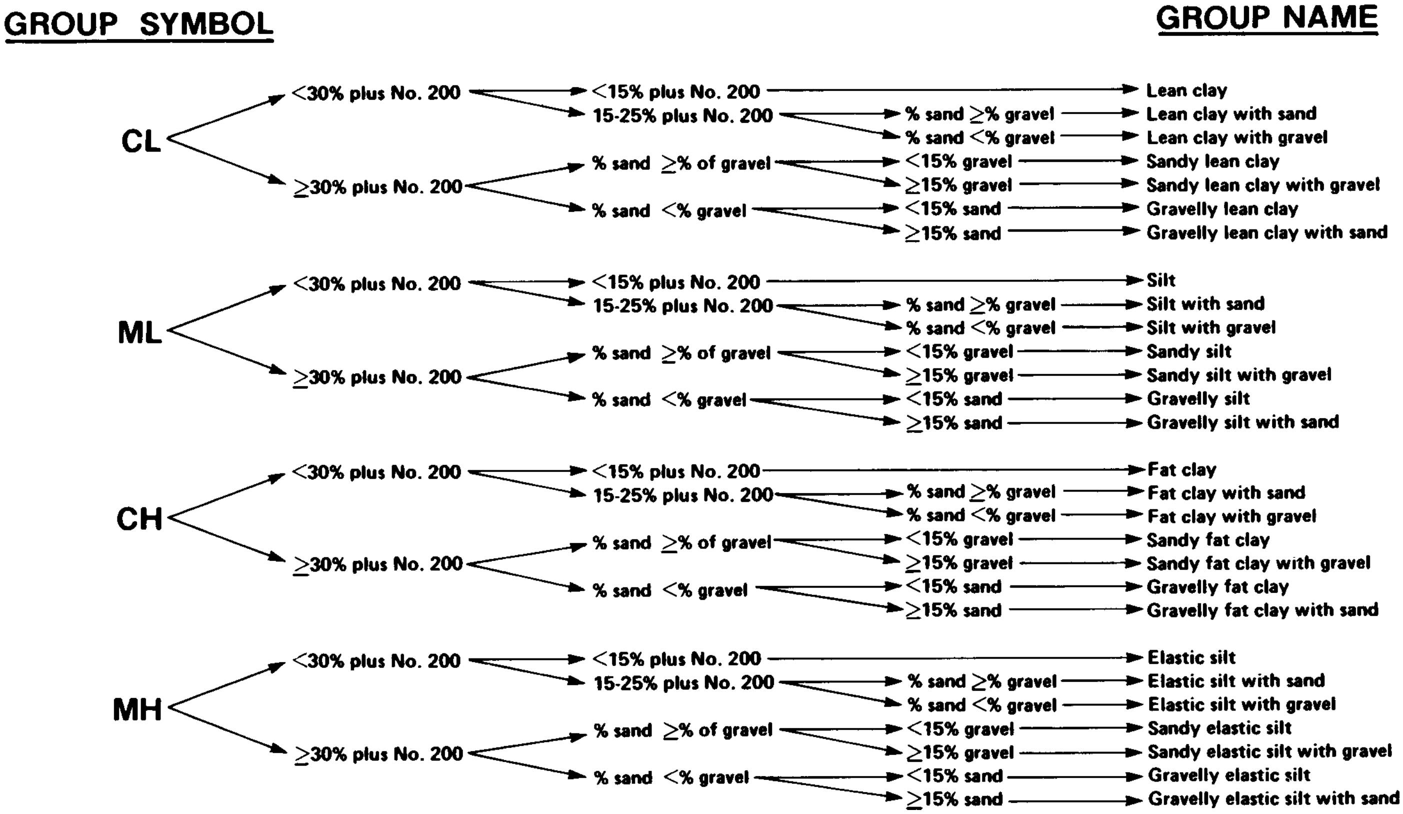
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens*.

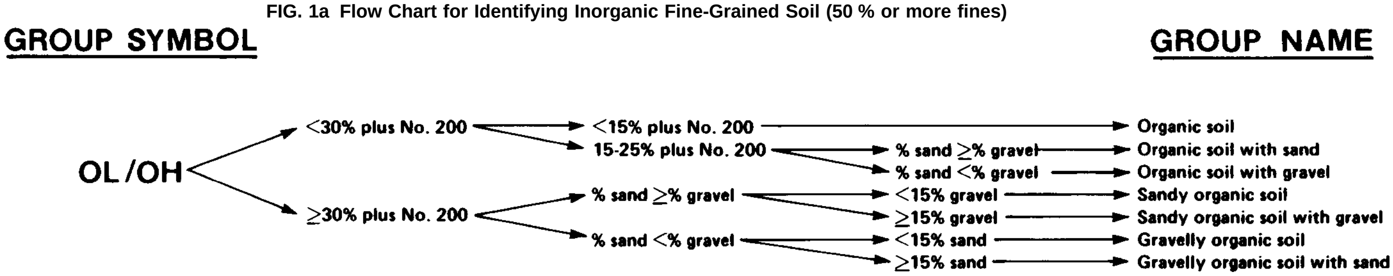
7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

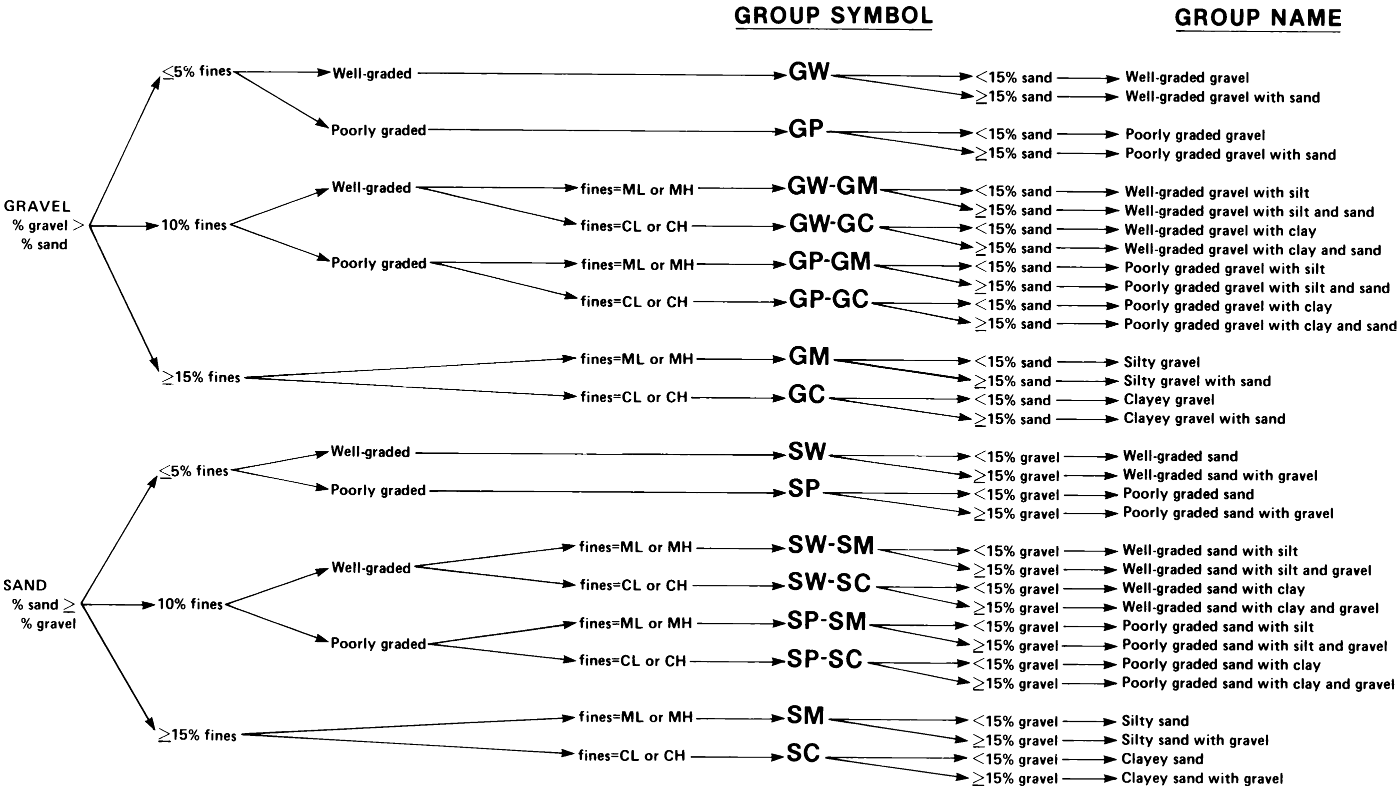
NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3⁄8 in.)	200 g (0.5 lb)
19.0 mm (3⁄4 in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

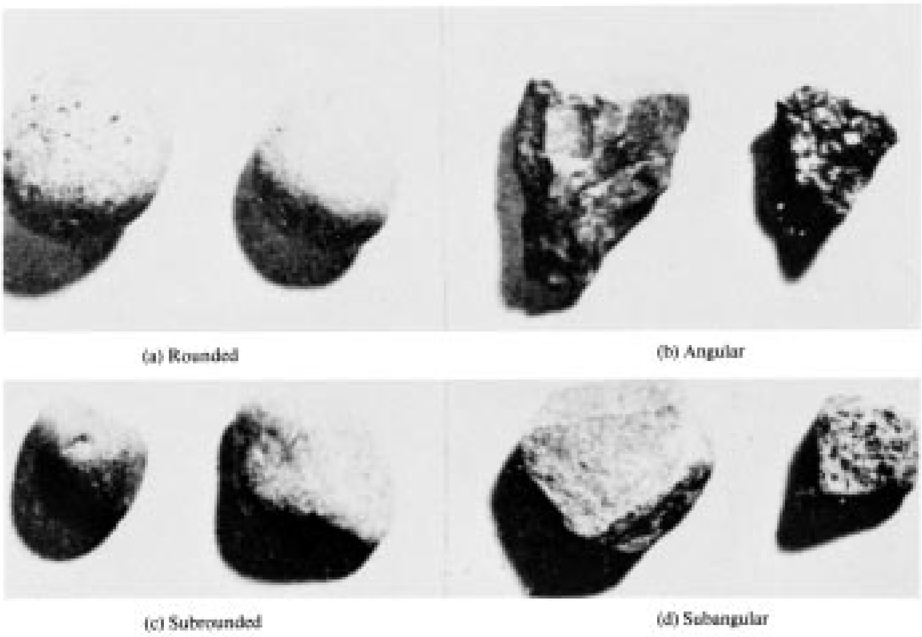


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

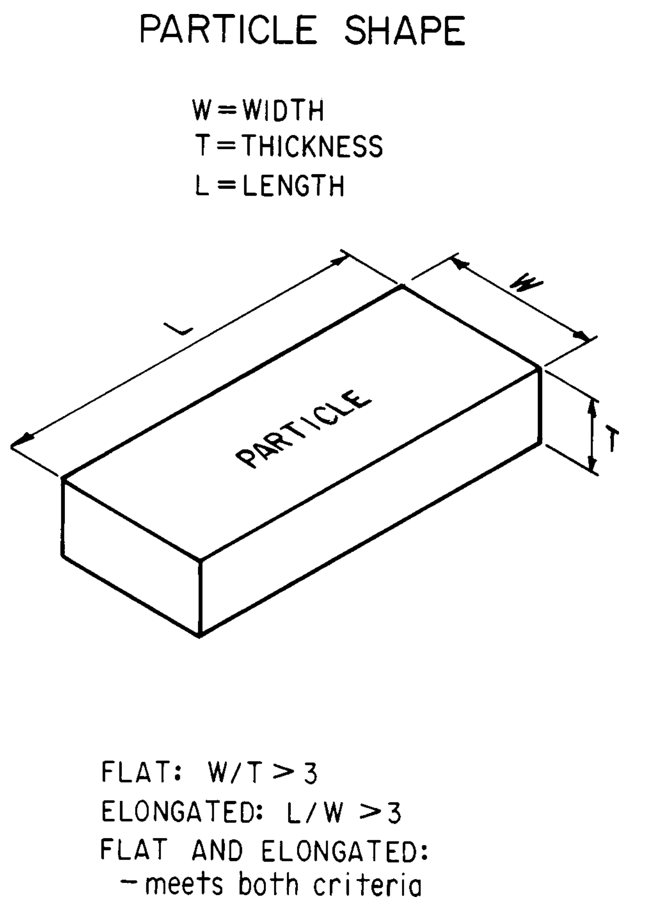


FIG. 4 Criteria for Particle Shape

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Dilatancy

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Toughness

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Dilatancy

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

hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

TABLE 8 Criteria for Describing Toughness

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

TABLE 9 Criteria for Describing Dilatancy

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

TABLE 10 Criteria for Describing Toughness

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

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %

Few—5 to 10 %

Little—15 to 25 %

Some—30 to 45 %

Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:

s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition ($1993^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

Standard Practices for Preserving and Transporting Soil Samples[1]

This standard is issued under the fixed designation D 4220; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope *

1.1 These practices cover procedures for preserving soil samples immediately after they are obtained in the field and accompanying procedures for transporting and handling the samples.

1.2 *Limitations*—These practices are not intended to address requirements applicable to transporting of soil samples known or suspected to contain hazardous materials.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* See Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

D 420 Guide to Site Characterization for Engineering, Design, and Construction Purposes[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 3550 Practice for Ring-Lined Barrel Sampling of Soils[2]

D 4564 Test Method for Density of Soil in Place by the Sleeve Method[2]

D 4700 Guide for Soil Sampling from the Vadose Zone[2]

3. Terminology

3.1 Terminology in these practices is in accordance with Terminology D 653.

4. Summary of Practices

4.1 The various procedures are given under four groupings as follows:

4.1.1 *Group A*—Samples for which only general visual identification is necessary.

4.1.2 *Group B*—Samples for which only water content and classification tests, proctor and relative density, or profile logging is required, and bulk samples that will be remolded or compacted into specimens for swell pressure, percent swell, consolidation, permeability, shear testing, CBR, stabilimeter, etc.

4.1.3 *Group C*—Intact, naturally formed or field fabricated, samples for density determinations; or for swell pressure, percent swell, consolidation, permeability testing and shear testing with or without stress-strain and volume change measurements, to include dynamic and cyclic testing.

4.1.4 *Group D*—Samples that are fragile or highly sensitive for which tests in Group C are required.

4.2 The procedure(s) to be used should be included in the project specifications or defined by the designated responsible person.

5. Significance and Use

5.1 Use of the various procedures recommended in these practices is dependent on the type of samples obtained (Practice D 420), the type of testing and engineering properties required, the fragility and sensitivity of the soil, and the climatic conditions. In all cases, the primary purpose is to preserve the desired inherent conditions.

5.2 The procedures presented in these practices were primarily developed for soil samples that are to be tested for engineering properties, however, they may be applicable for samples of soil and other materials obtained for other purposes.

6. Apparatus

6.1 The type of materials and containers needed depend upon the conditions and requirements listed under the four groupings A to D in Section 4, and also on the climate and transporting mode and distance.

6.1.1 *Sealing Wax*, includes microcrystalline wax, paraffin, beeswax, ceresine, carnaubawax, or combinations thereof.

6.1.2 *Metal Disks*, about $\frac{1}{16}$ in. (about 2 mm) thick and having a diameter slightly less than the inside diameter of the tube, liner, or ring and to be used in union with wax or caps and tape, or both.

6.1.3 *Wood Disks*, prewaxed, 1 in. (25 mm) thick and having a diameter slightly less than the inside diameter of the liner or tube.

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[1] These practices are under the jurisdiction of ASTM Committee D18 on Soil and Rock and are the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved April 15, 1995. Published June 1995. Originally published as D 4220 – 83. Last previous edition D 4220 – 89.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

***A Summary of Changes section appears at the end of this standard.**

6.1.4 *Tape*, either waterproof plastic, adhesive friction, or duct tape.

6.1.5 *Cheesecloth*, to be used in union with wax in alternative layers.

6.1.6 *Caps*, either plastic, rubber or metal, to be placed over the end of thin-walled tubes (Practice D 1587), liners and rings (Practice D 3550), in union with tape or wax.

6.1.7 *O'ring (Sealing End Caps)*, used to seal the ends of samples within thin-walled tubes, by mechanically expanding an O'ring against the tube wall.

NOTE 1—Plastic expandable end caps are preferred. Metal expandable end caps seal equally well; however, long-term storage may cause corrosion problems.

6.1.8 *Jars*, wide mouthed, with rubber-ringed lids or lids lined with a coated paper seal and of a size to comfortably receive the sample, commonly ½ pt (250 mL), 1 pt (500 mL) and quart-sized (1000 mL).

6.1.9 *Bag*, either plastic, burlap with liner, burlap or cloth type (Practice D 1452).

6.1.10 *Packing Material*, to protect against vibration and shock.

6.1.11 *Insulation*, either granule (bead), sheet or foam type, to resist temperature change of soil or to prevent freezing.

6.1.12 *Sample Cube Boxes*, for transporting cube (block) samples. Constructed with ½ to ¾ in. (13 to 19 mm) thick plywood (marine type).

6.1.13 *Cylindrical Sample Containers*, somewhat larger in dimension than the thin-walled tube or liner samples, such as cylindrical frozen food cartons.

6.1.14 *Shipping Containers*, either box or cylindrical type and of proper construction to protect against vibration, shock, and the elements, to the degree required.

NOTE 2—The length, girth and weight restrictions for commercial transportation must be considered.

6.1.15 *Identification Material*—This includes the necessary writing pens, tags, and labels to properly identify the sample(s).

7. Precautions

7.1 Special instructions, descriptions, and marking of containers must accompany any sample that may include radioactive, chemical, toxic, or other contaminant material.

7.2 Interstate transportation containment, storage, and disposal of soil samples obtained from certain areas within the United States and the transportation of foreign soils into or through the United States are subject to regulations established by the U.S. Department of Agriculture, Animal, and Plant Health Service, Plant Protection and Quarantine Programs, and possibly to regulations of other federal, state, or local agencies.

7.2.1 Samples shipped by way of common carrier or U.S. Postal Service must comply with the Department of Transportation Hazardous Materials Regulation, 49CRF Part 172.

7.3 Sample traceability records (see Fig. 1) are encouraged and should be required for suspected contaminated samples.

7.3.1 The possession of all samples must be traceable, from collection to shipment to laboratory to disposition, and should be handled by as few persons as possible.

7.3.2 The sample collector(s) should be responsible for initiating the sample traceability record; recording the project, sample identification and location, sample type, date, and the number and types of containers.

7.3.3 A separate traceability record shall accompany each shipment.

7.3.4 When transferring the possession of samples the person(s) relinquishing and receiving the samples shall sign, date, record the time, and check for completeness of the traceability record.

8. Procedure

8.1 *All Samples*—Properly identify samples with tags, labels, and markings prior to transporting them as follows:

8.1.1 Job name or number, or both,

8.1.2 Sampling date,

8.1.3 Sample/boring number and location,

8.1.4 Depth or elevation, or both,

8.1.5 Sample orientation,

8.1.6 Special shipping or laboratory handling instructions, or both, including sampling orientation, and

8.1.7 Penetration test data, if applicable (Test Method D 1586).

8.1.8 Subdivided samples must be identified while maintaining association to the original sample.

8.1.9 If required, sample traceability record.

8.2 *Group A*—Transport samples in any type of container by way of available transportation. If transported commercially, the container need only meet the minimum requirements of the transporting agency and any other requirements necessary to assure against sample loss.

8.3 *Group B*:

8.3.1 Preserve and transport these samples in sealed, moistureproof containers. All containers shall be of sufficient thickness and strength to ensure against breakage and moisture loss. The container types include: plastic bags or pails, glass or plastic (provided they are waterproof) jars, thin walled tubes, liners, and rings. Wrap cylindrical and cube samples in suitable plastic film or aluminum foil, or both, (Note 3) and coat with several layers of wax, or seal in several layers of cheesecloth and wax.

8.3.2 Transport these samples by any available transportation. Ship these samples as prepared or placed in larger shipping containers, including bags, cardboard, or wooden boxes or barrels.

NOTE 3—Some soils may cause holes to develop in aluminum foil, due to corrosion. Avoid direct contact where adverse affects to sample composition are a concern.

8.3.3 *Plastic Bags*—Place the plastic bags as tightly as possible around the sample, squeezing out as much air as possible. They shall be 3 mil or thicker to prevent leakage.

8.3.4 *Glass-Plastic Jars*—If the jar lids are not rubber ringed or lined with new waxed paper seals, seal the lids with wax.

8.3.5 *Plastic Pails*—If the plastic pail lids are not air tight, seal them with wax or tape.

8.3.6 *Thin-Walled Tubes*:

8.3.6.1 *Expandable Packers*—The preferred method of

Sample Identification/Traceability Record
(Controlled Document)

Project: ______________________ W.O. # __________

Shipped by: ______________________

Shipped to: ______________________ Attention of:

Comments: ______________________ Hazardous materials suspected? (yes/no)

Sampling Point	Location	Field ID #	Date	Sample Type	No. of Containers	Analysis/Test Required	(optional) Lab ID

Sampler(s) (signature) ______________________

Field ID	Relinquished by: (signature)	Date/Time		Received by: (signature)	Date/Time		Comments

Shipment prepared by: (signature) __________ Date/Time __________ Shipment method: __________

Received for Lab by: (signature) __________ Date/Time __________ Comments __________

Receiving Laboratory: Please return original form after signing for receipt of samples.

FIG. 1 Example Layout of Record Form

sealing sample ends within tubes is with plastic, expandable packers.

8.3.6.2 *Wax With Disks*—For short-term sealing, paraffin wax is acceptable. For long term sealing (in excess of 3 days) use microcrystalline waxes or combine with up to 15 % beeswax or resin, for better adherence to the wall of the tube and to reduce shrinkage. Several thin layers of wax are preferred over one thick layer. The minimum final thickness shall be 0.4 in. (10 mm).

8.3.6.3 *End Caps*—Seal metal, rubber, or plastic end caps with tape. For long term storage (longer than 3 days), also dip them in wax, applying two or more layers of wax.

8.3.6.4 *Cheesecloth and Wax*—Use alternating layers (a minimum of two each) of cheesecloth and wax to seal each end of the tube and stabilize the sample.

NOTE 4—Where necessary, spacers or appropriate packing materials, or both, must be placed prior to sealing the tube ends to provide proper confinement. Packing material must be nonabsorbent and must maintain its properties to provide the same degree of continued sample support.

8.3.7 *Liners and Rings*—Refer to 8.3.6.3 or 8.3.6.4.

8.3.8 *Exposed Samples*:

8.3.8.1 *Cylindrical, Cubical or Other Samples Wrapped in Plastic*, such as polyethylene and polypropylene, or foil should be further protected with a minimum of three coats of wax.

8.3.8.2 *Cylindrical and Cube Samples Wrapped in Cheesecloth and Wax*, shall be sealed with a minimum of three layers of each, placed alternatively.

8.3.8.3 *Carton Samples (Frozen Food Cartons)*—Samples placed in these containers must be situated so that wax can be poured completely around the sample. The wax should fill the void between the sample and container wall. The wax should be sufficiently warm to flow, but not so hot that it penetrates the pores of the soil. Generally, the samples should be wrapped in plastic or foil before being surrounded with wax.

8.4 *Group C*:

8.4.1 Preserve and seal these samples in containers as covered in 8.3. In addition, they must be protected against vibration and shock, and protected from extreme heat or cold.

8.4.2 Samples transported by the sampling or testing agency personnel on seats of automobiles and trucks need only be placed in cardboard boxes, or similar containers into which the sealed samples fit snugly, preventing bumping, rolling, dropping, etc.

8.4.3 For all other methods of transporting samples, including automobile trunk, bus, parcel services, truck, boat, air, etc., place the sealed samples in wood, metal, or other type of suitable shipping containers that provide cushioning or insulation, or both, for each sample and container. Avoid transporting by any agency whose handling of containers is suspect.

8.4.4 The cushioning material (sawdust, rubber, polystyrene, urethane foam, or material with similar resiliency) should completely encase each sample. The cushioning between the samples and walls of the shipping containers should have a minimum thickness of 1 in. (25 mm). A minimum thickness of 2 in. (50 mm) shall be provided on the container floor.

8.4.5 When required, the samples should be shipped in the same orientation in which they were sampled. Otherwise, special conditions shall be provided such as freezing, controlled drainage, or sufficient confinement, or a combination thereof, to maintain sample integrity.

8.5 *Group D*:

8.5.1 The requirements of 8.4 must be met, in addition to the following:

8.5.1.1 Samples should be handled in the same orientation in which they were sampled, including during transportation or shipping, with appropriate markings on the shipping container.

8.5.1.2 For all modes of private or commercial transportation, the loading, transporting and unloading of the shipment containers should be supervised as much as possible by a qualified person.

NOTE 5—A qualified person may be an engineer, geologist, soil scientist, soils technician or responsible person designated by the project manager.

8.6 *Shipping Containers* (see Figs. 2-7 for typical containers):

8.6.1 The following features should be included in the design of the shipping container for Groups C and D.

8.6.1.1 It should be reuseable,

8.6.1.2 It should be constructed so that the samples can be maintained, at all times, in the same position as when sampled or packed, or both,

8.6.1.3 It should include sufficient packing material to

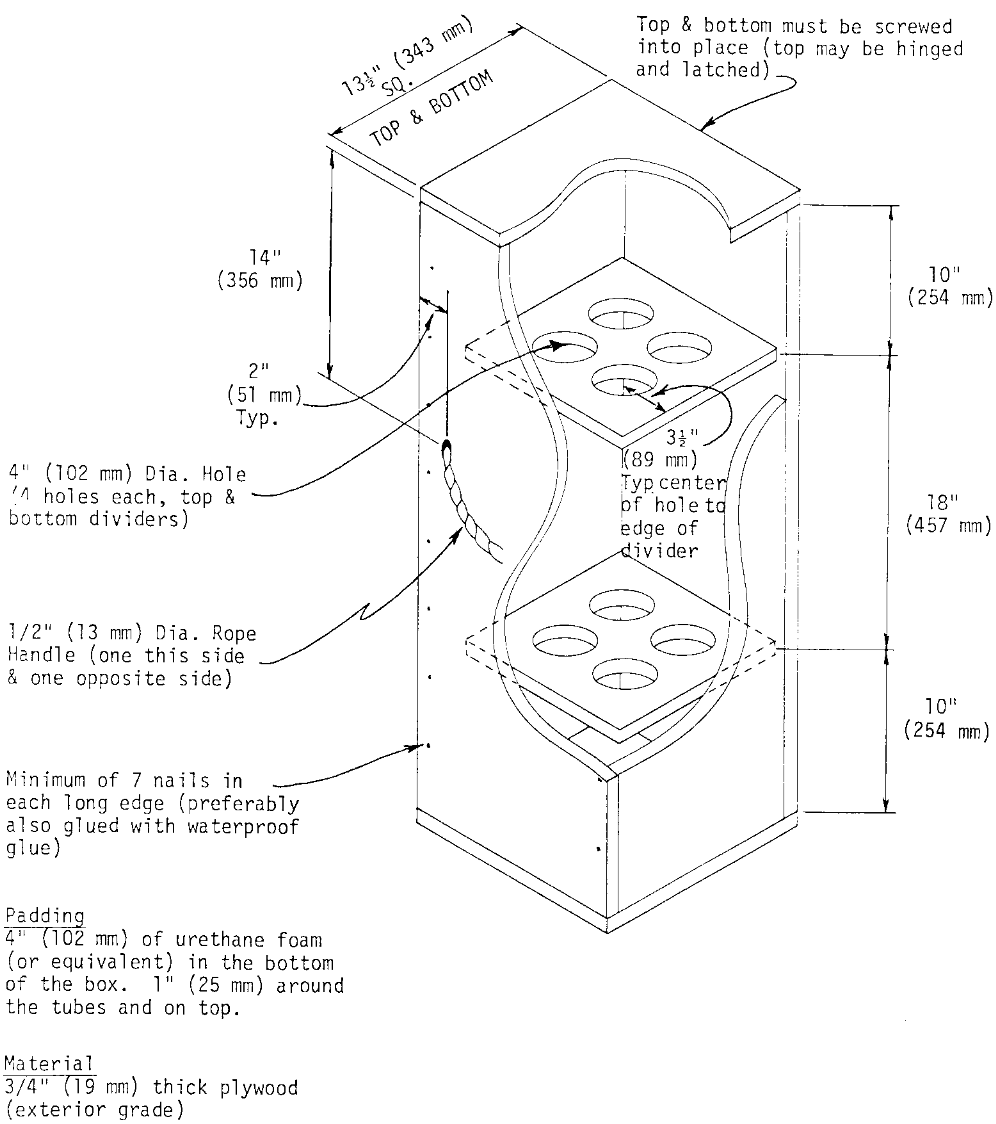
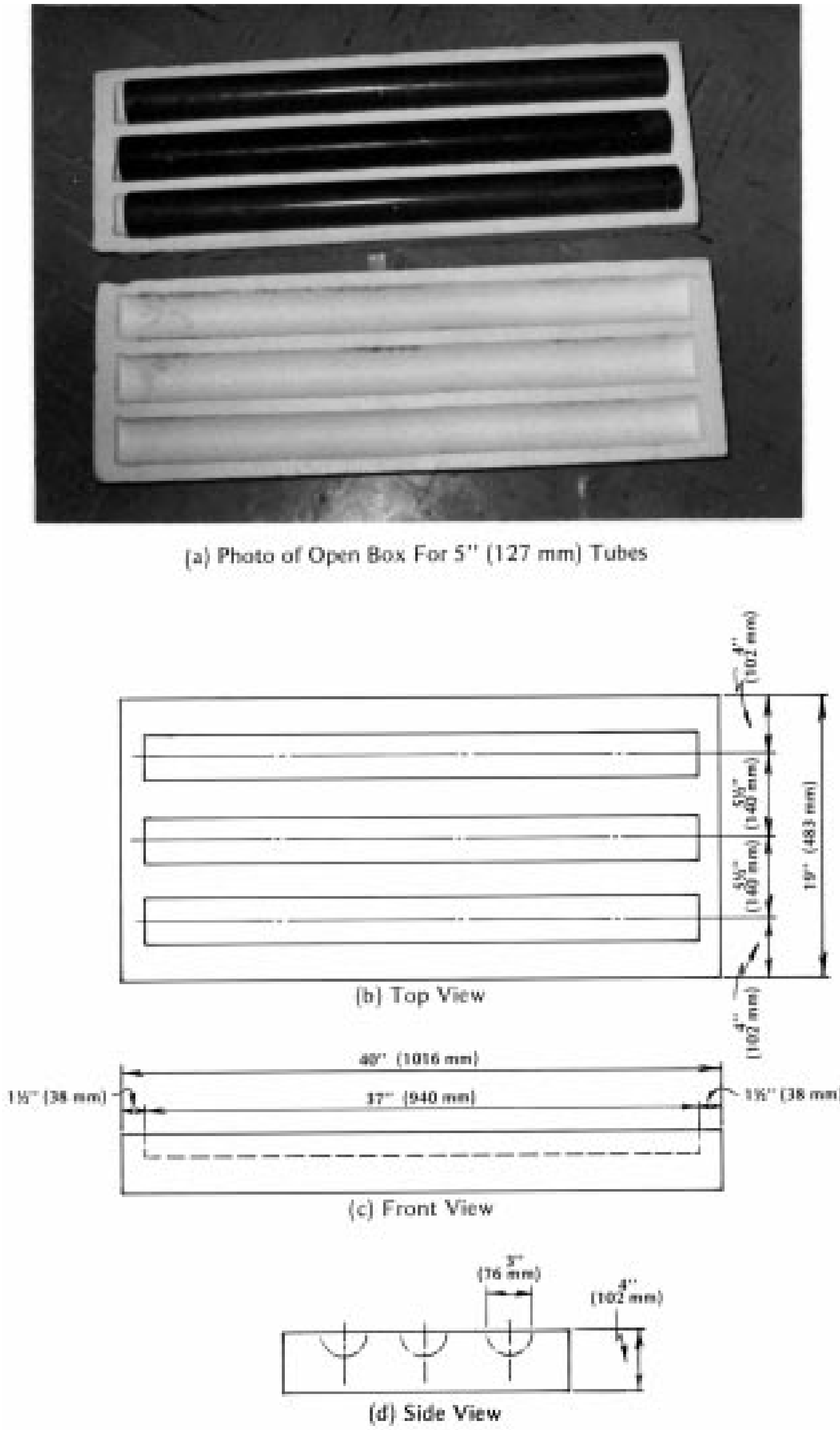


FIG. 2 Shipping Box for 3-in. (76-mm) Thin-Walled Tubes



NOTE 1—Top and bottom halves are identical.

FIG. 3 Styrene Shipping Container for 3-in. (76-mm) Thin-Walled Tubes

cushion or isolate, or both, the tubes from the adverse effect of vibration and shock, and

8.6.1.4 It should include sufficient insulating material to prevent freezing, sublimation and thawing, or undesirable temperature changes.

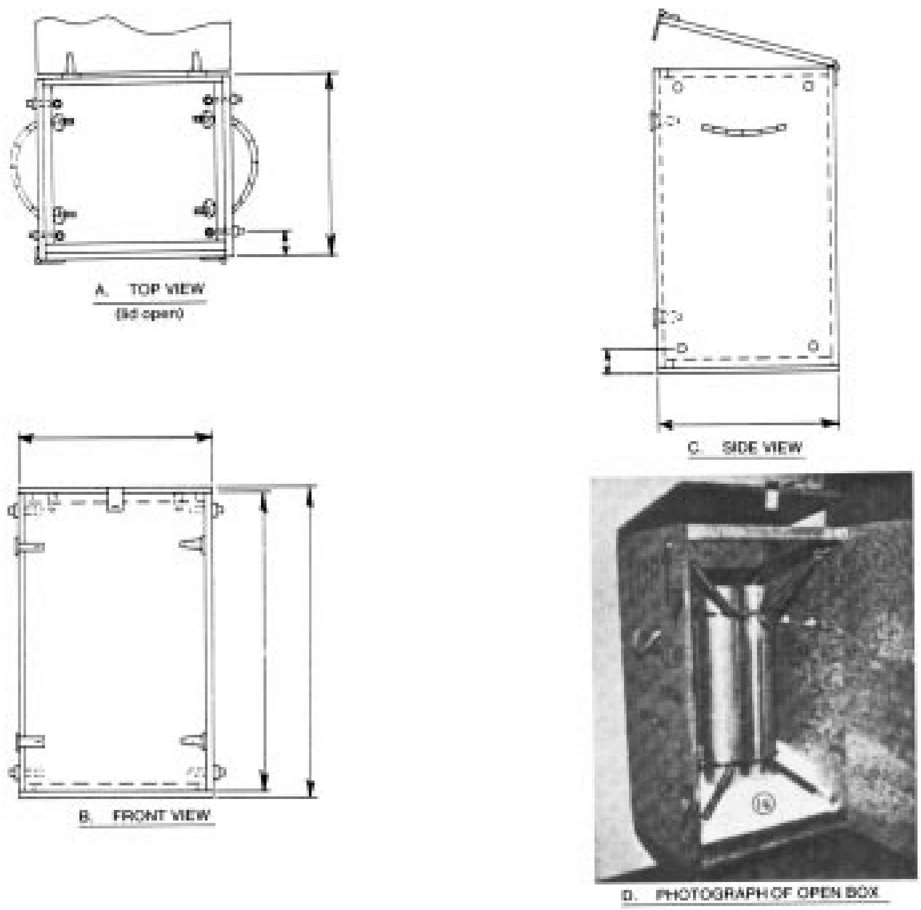
8.6.2 *Wood Shipping Containers*:

8.6.2.1 Wood is preferred over metal. Outdoor (marine) plywood having a thickness of ½ and ¾ in. (13 to 19 mm) may be used. The top (cover) should be hinged and latched, or fastened with screws.

8.6.2.2 The cushioning requirements are given in 8.4.4.

8.6.2.3 For protection against freezing or extreme temperature variation, the entire shipping container should be lined with a minimum insulation thickness of 2 in. (50 mm).

8.6.3 *Metal Shipping Containers*—The metal shipping containers must incorporate cushioning and insulation material to



BILL OF MATERIALS

Item No.	Description of Item	Quantity
1	*Plywood*, 4 ft by 8 ft by ¾ in. (1220 mm by 2440 mm by 19.1 mm) exterior, Grade AC	1 Sheet
2	*Hinge*, strap, 4 in. (102 mm), heavy duty with screws	4 Each
3	*Hasp*, hinged, 4½ in. (114 mm), with screws	3 Each
4	*Screw, Wood, Steel, Flathead*, No. 10 by 1¾ in. (44.5 mm)	72 Each
5	*Bolt, Machine*, ⅜ in. (9.5 mm), with nut to secure hasps	3 Each
6	*Washer*, flat, ⅜ in. (9.5 mm)	3 Each
7	*Eye Bolt*, ½ by 2 in. (6.4 mm by 51 mm), zinc-plated, with nut	8 Each
8	*Washer*, flat, ¼ in. (6.4 mm), for hasp bolt	8 Each
9	*S Hooks*, 2 in. (51 mm), open, zinc-plated	8 Each
10	*Clamp*, adjustable, hose, steel, worm screw adjustment	2 Each
11	*Spring*, expansion	8 Each
12	*Adhesive*, woodworking	1 lb (454 g)
13	*Rope*, nylon, ½-in. (12.7-mm) diameter, solid braided	5 ft (1524 mm)
14	*Cushioning Material*, expanded polystyrene foam	10 ft^3(0.28 m^3)

Notes– (a) All wooden components can be sawed from one sheet of plywood.

(b) This shipping box will accommodate approximately three 3-in. (76-mm) diameter tubes or two 5-in (127-mm) diameter tubes up to 30 in. (762 mm) in length. For longer tubes the inside height of the box must be a minimum of 6-in. (152 mm) greater than the length of the tube.

(c) All joints to be glued and fastened with screws.

(d) Stencil all sides as follows (See Views B and C).

TO PROTECT FROM FREEZING

(e) After suspending samples as indicated above, all void space must be filled with a suitable resilient packing material.

FIG. 4 Suspension System Container for Thin-Walled Tubes

minimum thicknesses in accordance with 8.6.2, although slightly greater thicknesses would be appropriate. Alternatively, the cushion effect could be achieved with a spring suspension system, or any other means that would provide similar protection.

8.6.4 *Styrene Shipping Containers*—Bulk styrene with slots cut to the dimensions of the sample tube or liner. A protective outer box of plywood or reinforced cardboard is recommended.

8.6.5 *Other Containers*—Containers constructed with laminated fiberboard, plastic or reinforced cardboard outer walls, and properly lined, may also be used.

9. Reporting

9.1 The data obtained in the field shall be recorded and should include the following:

9.1.1 Job name or number, or both,

9.1.2 Sampling date(s),

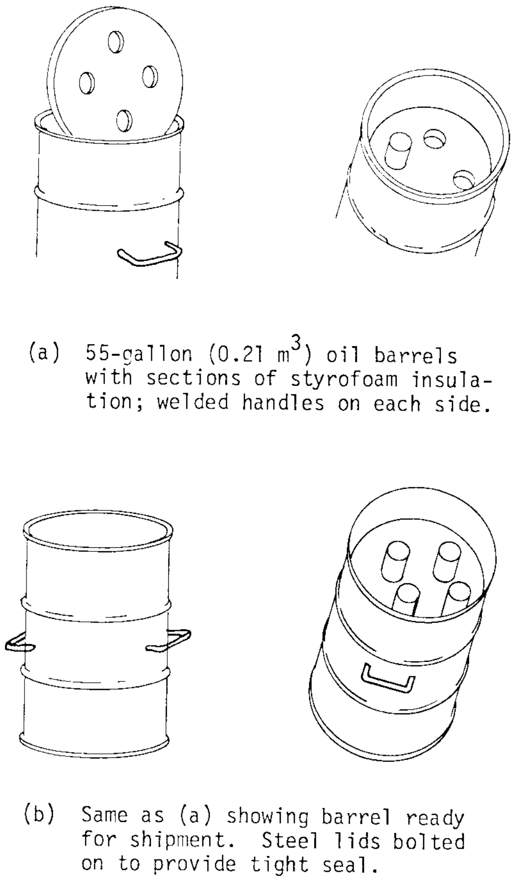
9.1.3 Sample/boring number(s) and location(s),

9.1.4 Depth(s) or elevation(s), or both,

9.1.5 Sample orientation,

9.1.6 Groundwater observation, if any,

9.1.7 Method of sampling, and penetration test data, if applicable,



NOTE 1—Two in. (51 mm) of foam rubber covers 2 in. of styrofoam at the base. One in. (25 mm) of foam rubber overlays the top of the tubes, and the remaining space to the lid is filled with styrofoam.

FIG. 5 Shipping Barrel for Thin-Walled Tubes

9.1.8 Sample dimensions,

9.1.9 Soil description (Practice D 2488),

9.1.10 Names of technician/crewman, engineer, project chief, etc.,

9.1.11 Comments regarding contaminated or possible contaminated samples,

9.1.12 If used, a copy of traceability records,

9.1.13 Weather conditions, and

9.1.14 General remarks.

10. Precision and Bias

10.1 This practice provides qualitative and general information only. Therefore, a precision and bias statement is not applicable.

11. Keywords

11.1 preservation; soil samples; transportation

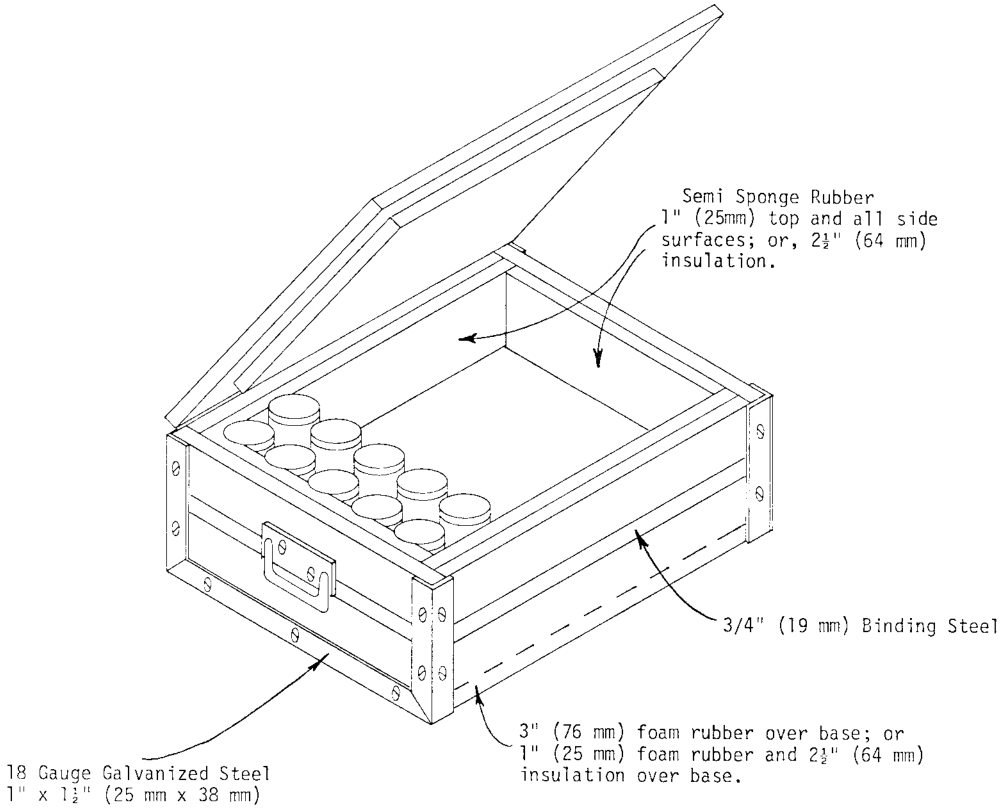


FIG. 6 Shipping Box for Liner (Short Tube) or Ring Samples

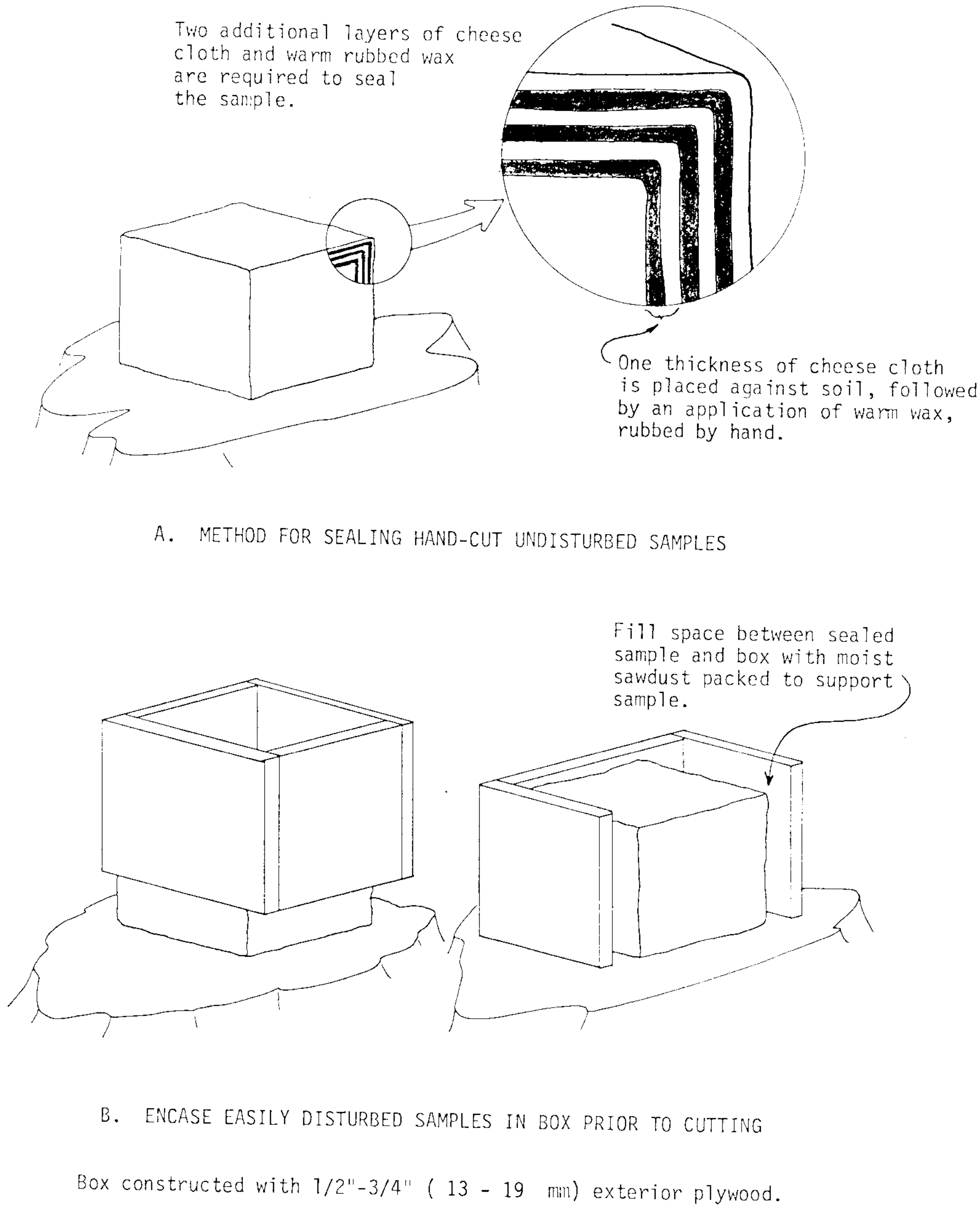


FIG. 7 Preparing and Packaging a Block Sample

SUMMARY OF CHANGES

This section identifies the location of changes to these practices that have been incorporated since the last issue. Committee D-18 has highlighted those changes that affect the technical interpretation or use of these practices.

(1) Section 11 was added since the last revision.

(2) Section 2 was expanded since the last revision.

Standard Guide for
Field Logging of Subsurface Explorations of Soil and Rock[1]

1. Scope*

1.1 This guide describes the type of information that should be recorded during field subsurface explorations in soil and rock.

1.2 This guide is not intended to specify all of the information required for preparing field logs. Such requirements will vary depending on the purpose of the investigation, the intended use of the field log, and particular needs of the client or user.

1.3 This guide is applicable to boreholes, auger holes, excavated pits, or other subsurface exposures such as road side cuts or stream banks. This guide may serve as a supplement to Guide D 420.

1.4 This guide may not be suited to all types of subsurface exploration such as mining, agricultural, geologic hazardous waste, or other special types of exploration.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care of which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 420 Guide to Site Characterization for Engineering, Design, and Construction Purposes
D 653 Terminology Relating to Soil, Rock, and Contained Fluids
D 1452 Practice for Soil Investigation and Sampling by Auger Borings
D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils
D 1587 Practice for Thin-Walled Tube Geotechnical Sampling of Soils
D 2113 Practice for Diamond Core Drilling for Site Investigation
D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)
D 2573 Test Method for Field Vane Shear Test in Cohesive Soil
D 3441 Test Method for Deep, Quasi-Static, Cone and Friction/Cone Penetration Tests of Soil
D 3550 Practice for Ring-Lined Barrel Sampling of Soils
D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)
D 4220 Practices for Preserving and Transporting Soil Samples
D 4403 Practice for Extensometers Used in Rock
D 4544 Practice for Estimating Peat Deposit Thickness
D 4622 Test Method for Rock Mass Monitoring Using Inclinometers
D 4623 Test Method for Determination of In Situ Stress in Rock Mass by Overcoring Method—USBM Borehole Deformation Gage
D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems
D 4645 Test Method for Determination of the In-Situ Stress in Rock Using the Hydraulic Fracturing Method
D 4719 Test Method for Pressuremeter Testing in Soils
D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)
D 4879 Guide for Geotechnical Mapping of Large Underground Openings in Rock

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[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of D18.07 onIdentification and Classification of Soils.

Current edition approved Nov. 1, 2003. Published December 2003. Originally approved in 1993. Last previous edition approved in 2003 as D 5434 – 97(2003).

[2] For referenced ASTM standard, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards*volume information, refer to the standard's Document Summary page of the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

D 5079 Practices for Preserving and Transporting Rock Core Samples

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

3.2 *Description of Term Specific to This Standard:*

3.2.1 *field log*—a record prepared during subsurface explorations of soil and rock to document procedures used, test data, descriptions of materials and depths where encountered, ground water conditions, and other information.

4. Summary of Guide

4.1 This guide describes the type of information that should be recorded during the execution of field subsurface explorations in soil and rock. The information described relates to the project, personnel, methods of investigation and equipment used, visual description of subsurface materials and ground water conditions, in-situ testing, installation of monitoring equipment, and other data that may be appropriate.

5. Significance and Use

5.1 The preparation of field logs provides documentation of field exploration procedures and findings for geotechnical, geologic, hydrogeologic, and other investigations of subsurface site conditions. This guide may be used for a broad range of investigations.

5.2 The recorded information in a field log will depend on the specific purpose of the site investigation. All of the information given in this guide need not appear in all field logs.

NOTE 1—- The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Summary of Work

6.1 Soil and rock field logs should include the following written information:

6.1.1 Project information should include:

6.1.1.1 Name and location of the project or project number, or both,

6.1.1.2 Name of personnel onsite during the exploration, such as drilling crew, supervisor, geologist, engineer, and technicians,

6.1.1.3 Names and addresses of organizations involved,

6.1.1.4 Name of person(s) preparing log,

6.1.1.5 Reference datum for project if available and description of datum, and

6.1.1.6 General remarks as appropriate.

6.1.2 Exploration information should include:

6.1.2.1 Exploration number and location (station and coordinates if available and applicable, position relative to a local permanent reference which is identified, or markings of exploration location),

6.1.2.2 Type of exploration, such as drill hole, auger hole, test pit, or road cut,

6.1.2.3 Date and time of start and finish,

6.1.2.4 Weather conditions including recent rain or other events that could affect subsurface conditions,

6.1.2.5 Depth and size of completed exploration,

6.1.2.6 The condition of exploration prior to and after backfilling or sealing, or both, and

6.1.2.7 Method of backfilling or sealing exploration, or both.

6.1.3 Explorations by drill hole or auger hole should include the following drilling information:

6.1.3.1 Type and make (manufacture and model if known) of drilling machine or description and name of contractor,

6.1.3.2 Method of drilling or advancing and cleaning the borehole. State if air, water, or drilling fluid is used. Describe type, source of water and additives, concentration, and tests performed on fluid,

6.1.3.3 Size, type, and section length of drilling rods (rod designations should conform with Table 3 of Method D 2113) and drilling bits used.

6.1.3.4 Dates and times of each stage of operation and time to complete intervals,

6.1.3.5 Size of hole (diameter and depth),

6.1.3.6 Ground elevation at top of borehole,

6.1.3.7 Orientation of drill hole, if not vertical (azimuth or bearing and angle),

NOTE 2—Even with careful drilling, the actual subsurface path of both vertical and inclined drill holes may be different from the intended direction of drilling. Deflection of the drill bit due to inclined bedding and hard boulders are some of the many reasons a drill hole might deviate from the intended direction. Drill holes that deviate from the intended direction can give erroneous data if not corrected. This can lead to significant interpretation errors of subsurface conditions and geologic structure. Depending on intended use of the data, it may be prudent to perform a borehole survey so the borehole spatial data can be corrected.

6.1.3.8 Size and description of casing, if appropriate, method of casing installation (driven, drilled, or pushed) and depth of cased portion of boring (casing size designations should conform with Table 2 of Method D 2113), hollow-stem augers,

6.1.3.9 Methods used for cleaning equipment or drilling tools, or both, when required, and

6.1.3.10 Describe and state depth of any drilling problems such as borehole instability (cave in, squeezing hole, flowing sands), cobbles, lost drilling fluid, lost ground, obstruction, fluid return color changes, and equipment problems.

6.1.4 Exploration by test pit, road cut, stream cut, etc., should include:

6.1.4.1 Method of exploration,

6.1.4.2 Equipment used for excavation,

6.1.4.3 Type of shoring used, and

6.1.4.4 Excavation problems: instability of cut (sloughing, caving, etc.), depth of refusal, difficulty of excavating, etc.

6.1.5 Subsurface information should include:

6.1.5.1 Depth of changes and discontinuities in geologic material and method used to establish change (such as Practice D 4544).

6.1.5.2 Description of material encountered with origin or formation name, if possible, and type of samples used for description. The system or method of soil (such as Practices D 2488 and D 4083) or rock description should be referenced.

6.1.5.3 Description of nature of boundary between strata (gradual or abrupt, as appropriate) and other relevant structural features such as breccia, slickensides, solution zones, discolorations by weathering or hydrothermal fluids, and other stratigraphic information.

6.1.6 Soil or rock sampling and testing information should include:

6.1.6.1 Depth of each sample and number (if used),

6.1.6.2 Method of sampling (reference to appropriate ASTM standard, for example, Practice D 1452, Test Method D 1586, Method D 1587, Practice D 3550, or other method).

6.1.6.3 Description of sampler: inside and outside dimensions, length, type of metal, type of coating, and type of liner,

6.1.6.4 Method of sampler insertion: pushed, cored, or driven,

6.1.6.5 Sampler penetration and recovery lengths of samples (rock quality designation (RQD) and rate of coring in the case of rock),

6.1.6.6 Method of sample extrusion. Mark direction of extrusion,

6.1.6.7 Method of preserving samples and preparing for transport (refer to Practices D 4220 or D 5079),

6.1.6.8 Mark top and bottom of samples and orientation, if possible,

6.1.6.9 Depth and description of any in-situ test performed (reference to applicable ASTM standard, for example, Test Methods D 1586, D 2573, D 3441, D 4623, D 4633, D 4645, D 4719, or other tests if applicable),

6.1.6.10 Description of any other field tests conducted on soil and rock during the exploration such as pH, hydraulic conductivity, pressuremeter geophysical, pocket penetrometer, soil gas/vapor analysis, or other tests, and

6.1.6.11 Destination or recipient of samples and method of transportation.

6.1.7 Ground water information should include:

6.1.7.1 Depths and times at which ground water is encountered, including seepage zones, if appropriate,

6.1.7.2 In the case of drilling using drilling fluid, depth of fluid surface in boring and drilling depth at the time of a noted loss or gain in drilling fluid,

6.1.7.3 Depth to ground water level at the completion of drilling and removal of drill steel and description of datum (note condition of borehole, for example, cased or uncased). Date and time measured,

6.1.7.4 Depth to ground water level at some reported time period following completion of drilling and description of datum, when possible.

6.1.7.5 Method or equipment used to determine depth of ground water level, such as Test Method D 4750,

6.1.7.6 Method and depth of ground water samples obtained, including size of samples taken and description of sampler, and

6.1.7.7 Description of any field tests conducted on ground water samples such as pH, temperature, conductivity, turbidity, or odor.

6.1.8 Information regarding installation of instrumentation or monitoring equipment should include:

6.1.8.1 Type of equipment installed, for example, piezometers, monitoring well screens, inclinometer, including sizes and types of materials,

6.1.8.2 Depth and description of equipment installed (reference to applicable ASTM standard, for example, Test Method D 4622, Practice D 4403, or other standards or procedures),

6.1.8.3 Methods used for installation of equipment and method used for sealing annular space, and

6.1.8.4 Methods used to protect equipment (casing cap or locks).

6.2 Soil and rock field logs should include the following pictorial information:

6.2.1 Maps, drawings, or sketches of area of exploration and subsurface surfaces observed. Include pertinent surface information such as neighboring outcrops, as appropriate. Describe system of mapping, such as Guide D 4879 for rock, or legend for symbols of materials. Include dimensions, directions, and slopes, and

6.2.2 Photographs of activities, surfaces, or core. Describe sequence, dates and time, direction, objects used for scale, and subject.

7. Keywords

7.1 drilling; explorations; geologic investigations; ground water; logging; preliminary investigations; sampling; soil investigations; subsurface investigations

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (D5434–97(03)) that may impact the use of this standard.

(1) Section 2 — Added Practice D 3740 to the Referenced Documents Section.

(2) Section 5 — Added Note 1 on the use of Practice D 3740.

(2) Section 6— Added Note 2 after Section 6.1.3.7.

STANDARD OPERATING PROCEDURE
SURFACE AND SUBSURFACE SOIL SAMPLING

TABLE OF CONTENTS

1.0 SURFACE SOIL SAMPLING

1.1 Equipment

Hand Augers (multiple size stainless steel buckets)
Power Auger (if required for 2+ foot depth)
Stainless steel trowels
Shovels (to remove gravel and debris)
Plastic sheeting and/or aluminum foil
Decontamination equipment, as required
Hand tools (for equipment or other needs)
Digital Camera
Watch
Labels
Cooler
Field log book
Logs, Daily Field Report form, etc.
Site HASP
Appropriate sample bottles
Plastic bags (sealable)
Compass
200 foot tape

1.2 Procedures

Surficial soil samples shall be collected as follows. Vegetation at the sample location is removed by cutting or scraping away with a stainless steel trowel. While establishing the hole, remove gravel or other debris before obtaining the sample. Advance the auger or trowel to a depth of approximately six inches and then remove from the hole. Using pre-cleaned stainless steel equipment, extrude the soil directly into the sampling containers. If dedicated sampling equipment is not used, sampling equipment must be decontaminated before collecting another sample. See SOP for details on Sampling Equipment Decontamination.

Samples for VOC analysis must be collected first. Fill VOC sample containers as full as possible to minimize headspace losses. Fill separate containers with a sufficient quantity of soil for analyses of other required parameters. Immediately place the samples on ice at 4°C. Enter all data into a permanent field log book. Describe soil samples as indicated below in Section 3.0, Lithologic Logging. See SOP for details on Sample Preservation, Storage, Handling and Documentation.

2.0 SUBSURFACE SOIL SAMPLING

2.1 Equipment

Drill rig and equipment Stainless steel split spoon Shelby tubes/Dennison Samplers/Pocket penetrometer
Sample containers - environmental and geotechnical analyses
Photoionization detector
Decontamination equipment (as necessary)
Indelible pens
Boring log form, etc.
Cooler, ice, and Ziploc® baggies
Plastic sheeting and/or aluminum foil
Compass
200 foot tape measure
Watch
Digital Camera

2.2 Methods

Subsurface soil samples can be obtained by several methods depending on the type of samples required and the soil conditions. The usual method is to collect samples using a 2.0 to 3.0-inch diameter, 2.5 to 5 ft. long, continuous-drive, split-barrel sampler, which is advanced with the augers during drilling. This technique has several advantages, the primary one being good sample recovery over a large interval, and accuracy in that cuttings are less likely to be included in the sample than in other methods. Disturbance to the soil is minimal so that subtle structures such as laminations or voids are less likely to be destroyed and geologic contacts are more readily observed and logged. In loose soil and/or where large debris or cobbles impede the progress of the sampler, sample recovery with a continuous sampler may be poor and a different sampling technique may be used.

When continuous drive sampling is not practical, a 24-inch stainless steel split-barrel sampler can be driven a total of 24 inches into the undisturbed materials by dropping a 140-lb weight 30 inches. A 3-inch diameter split spoon may be used to increase the chances of sufficient volume recovery for sampling purposes. The geologist will record in 6-inch increments the number of blows required to drive the sampler and note the total sample recovery in the boring log. In the event of poor sample recovery, the supervising geologist may elect to offset within 10 feet to obtain the missing sample interval. A note will be embedded on the boring log if the offset boring is unsuccessful.

At times where samples are required from shallow depths (less than 10 feet) it may be more feasible to collect samples using a hand auger. In this case a clean, 4-inch diameter hand auger shall be advanced to the top of the desired sample interval. Collect the sample with a stainless steel trowel or sampling trier and place in a laboratory-cleaned glass container and labeled accordingly. Samples for VOC analysis must be collected first to minimize potential loss of volatiles. To minimize the potential for cross-contamination, use dedicated stainless steel trowels or sampling triers at each location. Between each use, decontaminate sampling equipment in accordance with SOP details on Sampling Equipment Decontamination.

2.2 Sample Collection Procedures

2.2.1 Field Screening Samples

Soil samples should be collected for field screening every two feet, or at zones of obvious contamination, and at the water table. NRT will perform the field screening in accordance with our SOP. The geologist will note the field screening results on the boring log.

2.2.2 Laboratory Samples

After collecting the field screening samples, NRT will collect soil samples for laboratory analysis in accordance with the PDIWP. Samples for VOC analysis must be collected first to minimize potential loss of volatiles. NRT will place VOC soil samples in a laboratory-supplied container. Fill sample containers as full as possible to prevent headspace degradation of VOC. Properly label the container and immediately place the sample into coolers packed with ice to maintain a temperature of less than 4°C. When the headspace screening is complete for each boring, the laboratory sample that corresponds to the highest headspace sample is selected for laboratory analysis. If field screening showed no elevated headspace readings, the sample collected from at or just above the water table should be submitted for analysis. In some instances, it may be necessary to submit the samples from both the water table and the highest headspace reading. The location of samples submitted for laboratory analysis
should be selected to provide the information necessary to evaluate the exposure pathways.

Sample containers for VOC analysis should be stored together in coolers separate from containers for other analytical parameters. See SOP 7 for details on sample preservation, storage, handling, and documentation.

3.0 LITHOLOGIC LOGGING

The lithology of the sample along with any other pertinent information shall be logged by NRT's geologist. Particular consideration will be given to grain-size distribution (relative percentages of different size materials), soil density, moisture content, presence of lamination or layering, and soil consistency. In addition, the geologist will estimate the mineralogy for coarser grained material. NRT will classify soil samples and enter onto the boring log using the Unified Soil Classification System (USCS), following methods outlined in ASTM Standard D 2488 (American Society for Testing and Materials, 1984b). A final boring log will be prepared using observations of the driller and on-site geologist, and from laboratory or geotechnical analysis.

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Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

NOTE 1—Practice D 6066 can be used when testing loose sands below the water table for liquefaction studies or when a higher level of care is required when drilling these soils. This practice provides information on drilling methods, equipment variables, energy corrections, and blow-count normalization.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]

D 6066 Practice for Determining the Normalized Penetration Resistance Testing of Sands for Evaluation of Liquefaction Potential[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.1.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.1.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 $\pm$ 2 lb (63.5 $\pm$ 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.1.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.1.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.1.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.1.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.1.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.1.12 *SPT*—abbreviation for standard penetration test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

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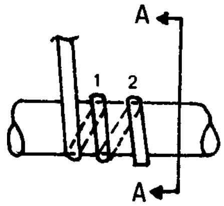
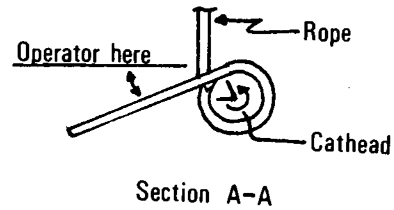
[2] *Annual Book of ASTM Standards*, Vol 04.08.

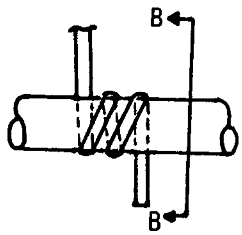
[3] *Annual Book of ASTM Standards*, Vol 04.09.

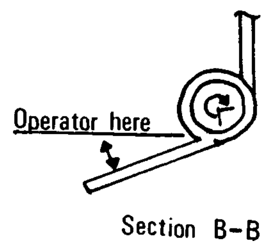
***A Summary of Changes section appears at the end of this standard.**





(*a*) counterclockwise rotation approximately 1¾turns





(*b*) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

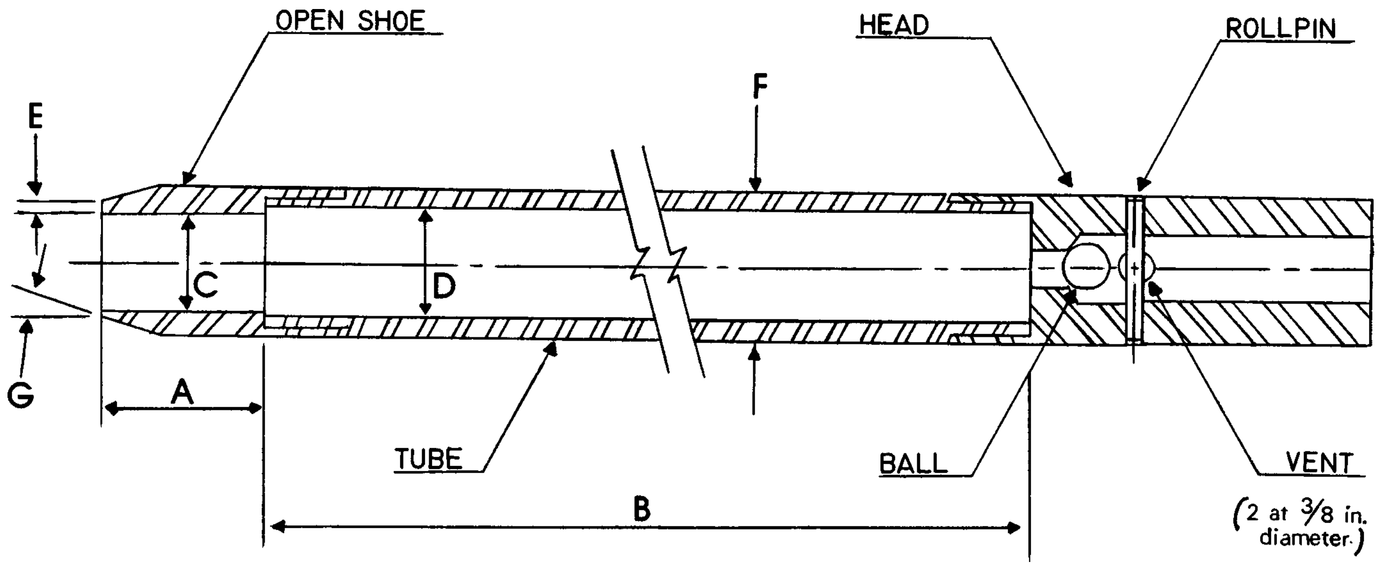
NOTE 2—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 3—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 4—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 5—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 *Precision*—A valid estimate of test precision has not been determined because it is too costly to conduct the necessary inter-laboratory (field) tests. Subcommittee D18.02 welcomes proposals to allow development of a valid precision statement.

9.2 *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.4 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5 The variability in *N*-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting *N* on the basis of comparative energies. A method for energy measurement and *N*-value adjustment is given in Test Method D 4633.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; split-barrel sampling; standard penetration test

SUMMARY OF CHANGES

(1) Added note to Section 1, Scope. The note refers to a related standard, Practice D 6066.

(2) Added Practice D 6066 to Section 2 on Referenced Documents.

Designation: D 1587 – 00

Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston, plug, or rotary-type samplers should comply with Section 6.3 of this practice which describes the thin-walled tubes.

NOTE 1—This practice does not apply to liners used within the samplers.

1.2 This Practice is limited to soils that can be penetrated by the thin-walled tube. This sampling method is not recommended for sampling soils containing gravel or larger size soil particles cemented or very hard soils. Other soil samplers may be used for sampling these soil types. Such samplers include driven split barrel samplers and soil coring devices (D 1586, D 3550, and D 6151). For information on appropriate use of other soil samplers refer to D 6169.

1.3 This practice is often used in conjunction with fluid rotary drilling (D 1452D 5783) or hollow-stem augers (D 6151). Subsurface geotechnical explorations should be reported in accordance with practice (D 5434). This practice discusses some aspects of sample preservation after the sampling event. For information on preservation and transportation process of soil samples, consult Practice D 4220. This practice does not address environmental sampling; consult D 6169 and D 6232for information on sampling for environmental investigations.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided for information purposes only. The tubing tolerances presented in Table 2 are from sources available in North America. Use of metric equivalent is acceptable as long as thickness and proportions are similar to those required in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Standard Terminology Relating to Soil, Rock, and Contained Fluids[2]
D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]
D 1586 Penetration Resistance and Split Barrel Sampling of Soils[2]
D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]
D 3550 Practice for Ring-Lined Barrel Sampling of Soils[2]
D 3740 Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[2]
D 4220 Practices for Preserving and Transporting Soil Samples[2]
D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock[3]
D 5783 Guide for Use of Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices[3]
D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling[3]
D 6169 Guide for Selection of Soil and Rock Sampling

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved August 10, 2000. Published December 2000. Originally published as D 1587–58T. Last previous edition D 1587–83.

[2] *Annual Book of ASTM Standards*, Vol 04.08.
[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

TABLE 1 Suitable Thin-Walled Steel Sample Tubes[A]

Outside diameter (D_o):			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Inside clearance ratio, %	<1	<1	<1

[A] The three diameters recommended in Table 1 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

TABLE 2 Dimensional Tolerances for Thin-Walled Tubes

Nominal Tube Diameters from Table 1[A] Tolerances						
Size Outside Diameter	2 in.	50.8 mm	3 in.	76.2 mm	5 in.	127 mm
Outside diameter, D_o	+0.007 -0.000	+0.179 -0.000	+0.010 -0.000	+0.254 -0.000	+0.015 -0.000	0.381 -0.000
Inside diameter, D_i	+0.000 -0.007	+0.000 -0.179	+0.000 -0.010	+0.000 -0.254	+0.000 -0.015	+0.000 -0.381
Wall thickness	±0.007	±0.179	±0.010	±0.254	±0.015	±0.381
Ovality	0.015	0.381	0.020	0.508	0.030	0.762
Straightness	0.030/ft	2.50/m	0.030/ft	2.50/m	0.030/ft	2.50/m

[A] Intermediate or larger diameters should be proportional. Specify only two of the first three tolerances; that is, D_o and D_i, or D_o and Wall thickness, or D_i and Wall thickness.

Devices Used With Drill Rigs for Environmental Investigations[3]

D 6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities[4]

3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *inside clearance ratio, %*—the ratio of the difference in the inside diameter of the tube, D_i, minus the inside diameter of the cutting edge, D_e, to the inside diameter of the tube, D_i expressed as a percentage (see Fig. 1).

3.2.2 *ovality*—the cross section of the tube that deviates from a perfect circle.

4. Summary of Practice

4.1 A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the in-situ soil at the bottom of a boring, removing the soil-filled tube, and applying seals to the soil surfaces to prevent soil movement and moisture gain or loss.

5. Significance and Use

5.1 This practice, or Practice D 3550 with thin wall shoe, is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice. are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 5740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Drilling Equipment*—When sampling in a boring, any drilling equipment may be used that provides a reasonably clean hole; that minimizes disturbance of the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

6.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

6.3 *Thin-Walled Tubes*, should be manufactured to the dimensions as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. (50 to 130 mm) and be made of metal having adequate strength for the type of soil to be sampled. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used but the tube dimensions should be proportional to the tube designs presented here.

6.3.1 *Length of Tubes*—See Table 1 and 7.4.1.

6.3.2 *Tolerances*, shall be within the limits shown in Table 2.

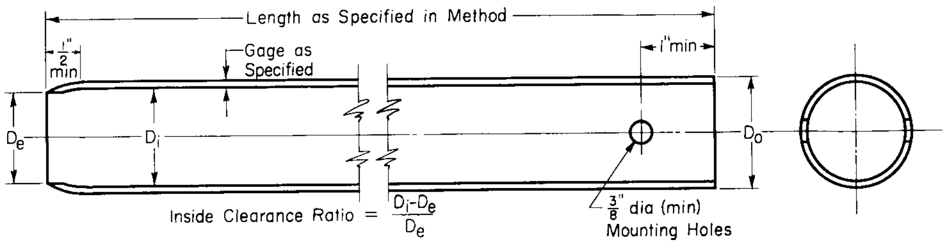
6.3.3 *Inside Clearance Ratio*, should be not greater than 1 % unless specified otherwise for the type of soil to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See 3.2.1 and Fig. 1 for definition of inside clearance ratio.

6.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating, unless the soil is to be extruded less than 3 days. The type of coating to be used may vary depending upon the material to be sampled. Plating of the tubes or alternate base metals may be specified. Galvanized tubes are often used when long term storage is required. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, zinc oxide, and others.

NOTE 3—Most coating materials are not resistant to scratching by soils that contain sands. Consideration should be given for prompt testing of the sample because chemical reactions between the metal and the soil sample con occur with time.

6.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube,

[4] *Annual Book of ASTM Standards,* Vol 11.04.



NOTE 1—Minimum of two mounting holes on opposite sides for D_o smaller than 4 in. (101.6 mm).

NOTE 2—Minimum of four mounting holes equally spaced for D_o 4 in. (101.6 mm) and larger.

NOTE 3—Tube held with hardened screws or other suitable means.

NOTE 4—2-in (50.8 mm) outside-diameter tubes are specified with an 18-gage wall thickness to comply with area ratio criteria accepted for "undisturbed samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gage tubes are generally readily available.

Metric Equivalent Conversions

in.	mm
3⁄8	9.53
1⁄2	12.7
1	25.4
2	50.8
3	76.2
4	101.6
5	127

FIG. 1 Thin-Walled Tube for Sampling

comprises the thin-walled tube sampler. The sampler head shall contain a venting area and suitable check valve with the venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

7. Procedure

7.1 Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the drilling and sampling operation.

7.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted.

NOTE 4—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

7.3 Lower the sampling apparatus so that the sample tube's bottom rests on the bottom of the hole and record depth to the bottom of the sample tube to the nearest 0.1-ft (.03 m)

7.3.1 Keep the sampling apparatus plumb during lowering, thereby preventing the cutting edge of the tube from scraping the wall of the borehole.

7.4 Advance the sampler without rotation by a continuous relatively rapid downward motion and record length of advancement to the nearest 1 in. (25 mm).

7.4.1 Determine the length of advance by the resistance and condition of the soil formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3-in. (75 mm) for sludge and end cuttings.

NOTE 5—The mass of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 1.

7.5 When the soil formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

7.6 Withdraw the sampler from the soil formation as carefully as possible in order to minimize disturbance of the sample. The tube can be slowly rotated to shear the material at the end of the tube, and to relieve water and/or suction pressures and improve recovery. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 minutes) may improve sample recovery.

8. Sample Measurement, Sealing and Labeling

8.1 Upon removal of the tube, remove the drill cuttings in the upper end of the tube and measure the length of the soil sample recovered to the nearest 0.25 in. (5 mm) in the tube. Seal the upper end of the tube. Remove at least 1 in. (25 mm) of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube.

8.1.1 Tubes sealed over the ends, as opposed to those sealed with expanding packers, should be provided with spacers or appropriate packing materials, or both prior to sealing the tube ends to provide proper confinement. Packing materials must be nonabsorbent and must maintain their properties to provide the same degree of sample support with time.

8.1.2 Depending on the requirements of the investigation, field extrusion and packaging of extruded soil samples can be performed. This allows for physical examination and classification of the sample. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. In some cases, further extrusion may cause sample disturbance reducing suitability for testing of engineering properties. In other cases, if damage is not significant, cores can be extruded and preserved for testing (D 4220). Bent or damaged tubes should be cut off before extruding.

8.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample (see Section 9). Assure that the markings or labels are adequate to survive transportation and storage.

NOTE 6—Top end of the tube should be labeled "top".

9. Field Log

9.1 Record the information that may be required for preparing field logs in general accordance to ASTM D 5434 "Guide for Field Logging of Subsurface Explorations of Soil and Rock". This guide is used for logging explorations by drilling and sampling. Some examples of the information required include;

9.1.1 Name and location of the project,

9.1.2 Boring number,

9.1.3 Log of the soil conditions,

9.1.4 Surface elevation or reference to a datum to the nearest foot (0.5 m) or better,

9.1.5 Location of the boring,

9.1.6 Method of making the borehole,

9.1.7 Name of the drilling foreman and company, and

9.1.8 Name of the drilling inspector(s).

9.1.9 Date and time of boring-start and finish,

9.1.10 Depth to groundwater level: date and time measured,

9.2 Recording the appropriate sampling information is required as follows:

9.2.1 Depth to top of sample to the nearest 0.1 ft. (.03 m) and number of sample,

9.2.2 Description of thin-walled tube sampler: size, type of metal, type of coating,

9.2.3 Method of sampler insertion: push or drive,

9.2.4 Method of drilling, size of hole, casing, and drilling fluid used,

9.2.5 Soil description in accordance with Practice D 2488,

9.2.6 Length of sampler advance (push), and

9.2.7 Recovery: length of sample obtained.

10. Keywords

10.1 geologic investigations; sampling; soil exploration; soil investigations; subsurface investigations; undisturbed

SUMMARY OF CHANGES

In accordance with committee D18 policy, this section identifies the location of changes to this standard since the last edition, 1994, which may impact the use of this standard.

(1) Editorial corrections to various sections based on comments received from Committee Balloting

(2) Added D 6232 to Section 2.

(3) Changed Note 7 to Section 8.1.2.

(4) Renumbered Note 8.

Designation: D 2113 – 99

Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation[1]

This standard is issued under the fixed designation D 2113; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the guidelines, requirements, and procedures for core drilling, coring, and sampling of rock for the purposes of site investigation. The borehole could be vertical, horizontal, or angled.

1.2 This practice is described in the context of obtaining data for the design, construction, or maintenance of structures, and applies to surface drilling and drilling from adits and exploratory tunnels.

1.3 This practice applies to core drilling in hard and soft rock.

1.4 This practice does not address considerations for core drilling for geo-environmental site characterization and installation of water quality monitoring devices (see Section 2).

1.5 The values stated in inch-pound units are to be regarded as standard. The SI values given in parentheses are provided for information purposes only.

1.6 This practice does not purport to comprehensively address all of the methods and the issues associated with coring and sampling of rock. Users should seek qualified professionals for decisions as to the proper equipment and methods that would be most successful for their site investigation. Other methods may be available for drilling and sampling of rock, and qualified professionals should have flexibility to exercise judgment as to possible alternatives not covered in this practice. This practice is current at the time of issue, but new alternative methods may become available prior to revisions; therefore, users should consult with manufacturers or producers prior to specifying program requirements.

1.7 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Also, the user must comply with prevalent regulatory codes, such as OSHA (Occupational Health and Safety Administration) guidelines, while using this practice. For good safety practice, consult applicable OSHA regulations and other safety guides on drilling **(1)**.

2. Referenced Documents

2.1 *ASTM Standards:*

D 420 Guide to Site Characterization for Engineering Design, and Construction Purposes[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 4630 Test Method for Determining Transmissivity and Storage Coefficient of Low Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test[2]

D 5079 Practices for Preserving and Transporting Rock Core Samples[2]

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock[3]

D 5782 Guide for the Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and Installation of Subsurface Water Quality Monitoring Devices[3]

D 5783 Guide for Use of Direct Rotary Drilling With Water-Based Drilling Fluid for Geoenvironmental Exploration and Installation of Subsurface Water Quality Monitoring Devices[3]

D 5876 Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices[3]

D 6032 Test Method for Determining Rock Quality Designation (RQD) of Rock Core[3]

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling[3]

2.2 *American Petroleum Institute Standard:*

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[1] This Practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved May 10, 1998 and January 10, 1999. Published October 1999. Originally published as D 2113 – 62T. Last previous edition D 2113 – 83 (1993)$^{\epsilon 1}$.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

API RP 13B Recommended Practice Standard Procedure for Testing Drilling Fluids[4]

2.3 *NSF Standard:*

NSF 60-1988[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *blind hole*, *n*—borehole that yields no fluid recovery of the drilling fluids.

3.1.2 *casing*, *n*—hollow tubes of steel used to support bore hole walls or where fluid losses must be stopped.

3.1.3 *caving hole*, *n*—borehole whose walls or bottom are unstable and cave or collapse into the drilled borehole.

3.1.4 *core barrels, n*—hollow tubes of steel used to collect cores of drilled rock.

3.1.5 *core bits*, *n*—coring bits with surface set or impregnated diamonds in tungsten carbide mix of hardened steel, polycrystalline bits, or tungsten carbide (TC) inserts, mounted on a cylindrical coring bit that does the actual core cutting.

3.1.6 *drill rig*, *n*—includes drilling machine, mast or derrick, circulating pumps, and mounting platform.

3.1.7 *drill rod*, *n*—hollow steel tubes that are connected to the drill bit or core barrel and to the rotary head of the drilling machine.

3.1.8 *drill platform*, *n*—a platform for drilling rig.

3.1.8.1 *Discussion*—The platform may need to be constructed at the drilling site to provide a firm base upon which the drill rig is then placed. Platforms are also constructed in the vicinity of the drill hole for workers to hold equipment, serve as a datum, and to allow safe operations.

3.1.9 *drilling machine*, *n*—includes power unit, hoisting unit, controlled-feed rotary drill head, and water or mud pump.

3.1.10 *overshot*, *n*—a latching mechanism at the end of the hoisting line, specially designed to latch onto or release pilot bit or core barrel assemblies when using *wireline drilling*. **(D 5786)**

3.1.11 *pilot bit assembly*, *n*—designed to lock into the end section of drill rod for *wireline drilling* without sampling. The pilot bit can be either drag, roller cone, or diamond plug types. The bit can be set to protrude from the rod coring bit depending on the formation being drilled. **(D 5786)**

3.1.12 *squeezing hole*, *n*—borehole whose walls move into the drilled opening and squeeze on the drill rods.

3.1.13 *wireline drilling*, *n*—a rotary drilling process using special enlarged inside diameter drilling rods with special latching pilot bits or core barrels raised or lowered inside the rods with a wireline and overshot latching mechanism. **(D 5786)**

3.2 Additional terms are defined in Terminology D 653.

4. Summary of Practice

4.1 *Drilling*:

4.1.1 Drilling is accomplished by circulating a drilling medium through the drill bit while rotating and lowering or advancing the string of drill rods as downward force is applied to a cutting bit. The bit cuts and breaks up the material as it penetrates the formation, and the drilling medium picks up the cuttings generated by the cutting action of the bit. The drilling medium, with cuttings, then flows outward through the annular space between the drill rods and drill hole, and carries the cuttings to the ground surface, thus cleaning the hole. The string of drill rods and bit is advanced downward, deepening the hole as the operation proceeds.

4.1.1.1 Fluid drilling is accomplished by circulating water or a water-based fluid with additives. Additives such as bentonite or polymers are frequently added to water to lubricate and cool the bit and to circulate (transport) cuttings to the surface. Drill fluid can also act to prevent cave or collapse of the drill hole. After the drilling fluid reaches the surface, it flows to a ditch or effluent pipe and into a settling pit where the cuttings settle to the bottom. Cuttings are sometimes run through a shaker to remove the larger particles. From the settling pit, the drilling fluid overflows into the main pit, from which it is picked up by the suction line of the mud pump and recirculated through the drill string.

NOTE 1—The decrease of mud velocity upon entering the mud pit may cause gelling of the mud and prevent cuttings from settling. Agitation of the mud in the pit can remedy the problem.

4.1.1.2 Air drilling is performed where introduction of fluids is undesirable. Air rotary drilling requires use of an air compressor with volume displacement large enough to develop sufficient air velocity to remove cuttings. Cuttings can be collected at the surface in cyclone separators. Sometimes a small amount of water or foam may be added to the air to enhance return of cuttings. Air drilling may not be satisfactory in unconsolidated and cohesionless soils under the ground water table.

4.2 *Coring*:

4.2.1 Coring is the process of recovering cylindrical cores of rock by means of rotating a hollow steel tube (core barrel) equipped with a coring bit. The drilled core is carefully collected in the core barrel as the drilling progresses.

4.3 *Sampling*:

4.3.1 Once the core has been cut and the core barrel is full, the drill rods or overshot assembly are pulled and the core retrieved. Samples are packaged and shipped for testing (see Practices D 5079).

5. Significance and Use

5.1 Rock cores are samples of record of the existing subsurface conditions at given borehole locations. The samples are expected to yield significant indications about the geological, physical, and engineering nature of the subsurface for use in the design and construction of an engineered structure. The core samples need to be preserved using specific procedures for a stipulated time (Practices D 5079). The period of storage depends upon the nature and significance of the engineered structure.

5.2 Rock cores always need to be handled such that their properties are not altered in any way due to mechanical damage or changes in ambient conditions of moisture and temperature or other environmental factors.

[4] Available from American Petroleum Institute, 2101 L St. NW, Washington, DC

[5] Available from NSF International, P.O. Box 130140, Ann Arbor, MI 48113–0140.

6. Apparatus

6.1 *General*—Fig. 1 shows the schematic of a typical rock core drill setup **(2)**. Essential components of the drilling equipment include the drilling rig with rotary power, hoisting systems, casing, rods, core barrels, including bits and liners, and pumps with circulating system. In addition, equipment should include necessary tools for hoisting and coupling and uncoupling the drill string and other miscellaneous items such as prefabricated mud pits and racks for rod stacking and layout. Normally, a drilling platform of planking is built up around the drilling site.

6.1.1 Rock coring operations can proceed at high rotation rates. It is imperative the drill rig, rods, and core barrels are straight and have a balanced center of gravity to avoid whipping and resulting damage to cores and expensive bits.

6.2 *Drilling Rig*— The drill rig provides the rotary power and downward (or advance) force or hold-back force on the core barrel to core the rock. The preferred diamond drill coring equipments are designs with hydraulic or gear-driven variable speed hollow spindle rotary drill heads, although some core rigs are manufactured with gear or chain pulldown/retract systems. Precise control over bit pressure can best be accomplished by a variable setting hydraulic pulldown/retract system. Hydraulic systems are often equipped with a detent valve, which allows downfeed (or advance) rate to be set at a certain speed regardless of tool weight or down pressure exerted on the coring bit. Hydraulic feed drill rigs should be supplied with a hydraulic pressure gage that can be related to bit pressures. Deep hole drill rigs should be equipped with hydraulic hold-back control so, if required, the full weight of the drill rods is not exerted on the bit when drilling downward. Diamond drill rigs can apply high rotation rates as high as 1000 rpm as opposed to normal rotary drills operating at 60 to 120 rpm **(3)**. Most diamond core drills are equipped with a mast and powered hoist for hoisting heavy drill strings. A second wireline hoist is helpful for wireline drilling.

6.2.1 The drill machine frame is either skid or truck mounted and should be equipped with a slide base for ease in working around the drill hole. In special cases, the drilling machine may be mounted on a trailer, barge (for overwater drilling), or columns (for underground work). Some drill rigs are designed to be broken down into several pieces for transport into remote areas. The drilling machine may be powered by hydraulics, air, electricity, gas, or diesel. Most surface skid or truck mounted rigs are diesel or gas powered.

6.2.2 Drilling directions are rarely vertical in underground applications, and smaller rigs are frequently equipped with swivel heads to accommodate drilling at angles. Special accommodations must be made for holding and breaking rods when drilling at high angles into crowns of adits. Either top drive drill or column mount machines with hydraulic or pneumatic rod jacks are equipped to handle up holes. For

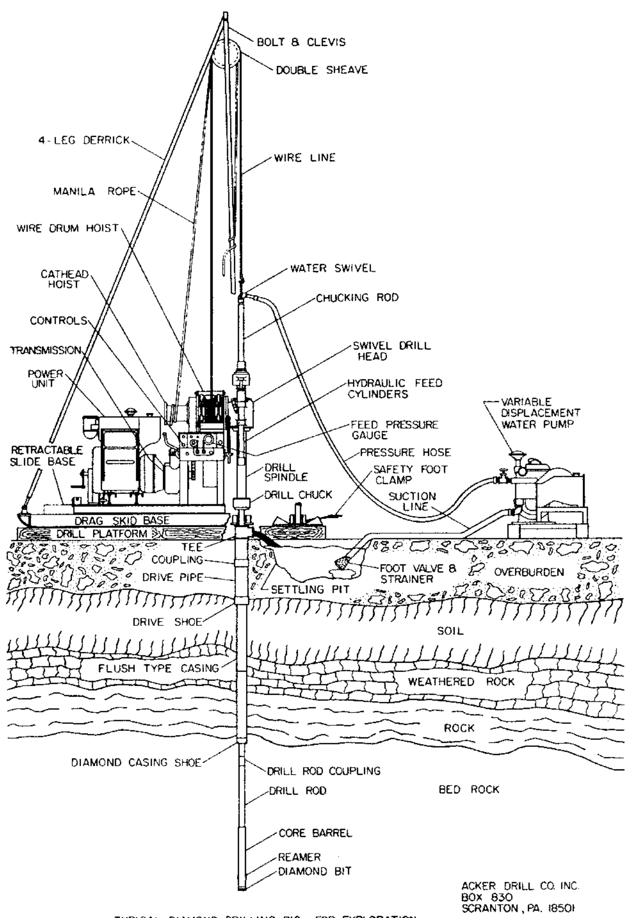


FIG. 1 Schematic of Typical Diamond Core Drill Set-up (2)

confined space drilling operations, drills are column mounted or mounted on small skids. Special power sources may be required for underground work due to air quality considerations. Remote power pack stations usually electric, hydraulic, compressed air, or a combination of the three. Electrically powered hydraulic systems are most common in underground use today

6.3 *Fluid or Air Circulation Systems*:

6.3.1 *Selection of Drill Media*—The two primary methods for circulating drill cuttings are water or water-based fluids or air with or without additives. The predominant method of drilling is water-based fluids. Water-based drilling is effective in a wide range of conditions both above and below the water table. Air drilling is selected when water-sensitive soils such as swelling clays or low density collapsible soils are encountered. Air drilling may also be required above the water table if special testing is required in the unsaturated zone. Air drilling is also convenient in highly fractured igneous rocks and porous formations where water-based fluid losses are unacceptable. The primary functions of the drill fluid are:

6.3.1.1 Remove drill cuttings,

6.3.1.2 Stabilize the borehole,

6.3.1.3 Cool and lubricate the bit,

6.3.1.4 Control fluid loss,

6.3.1.5 Drop cuttings into a settling pit,

6.3.1.6 Facilitate logging of the borehole, and

6.3.1.7 Suspend cuttings in the drill hole during coring.

6.3.1.8 No single drill fluid mixture can satisfy all of the above requirements perfectly. In the sections below, considerations for materials that could be used in drilling medium are given.

6.3.2 The pressure hose conducts the drilling fluid or air from the circulation pump or compressor to the swivel.

6.3.3 The swivel directs the drilling fluid or air to a rotating kelly or drill-rod column.

6.3.4 *Rotary Drilling with Water-based Drilling Fluids*:

6.3.4.1 The mud pit is a reservoir for the drilling fluid, and, if properly designed and used, provides sufficient flow velocity reduction to allow separation of drill cuttings from the fluid before recirculation. The mud pit can be a shallow, open metal tank with baffles or an excavated pit with some type of liner, and designed to prevent loss of drilling fluid. The mud pit can be used as a mixing reservoir for the initial quantity of drilling fluid, and, in some circumstances, for adding water and additives to the drilling fluid as drilling progresses. It may be necessary to have additional storage tanks for preparing fluids while drilling progresses.

6.3.4.2 The suction line, sometimes equipped with a foot valve or strainer, or both, conducts the drilling fluid from the mud pit to the fluid circulation pump.

6.3.4.3 The fluid circulation pump must be able to lift the drilling fluid from the mud pit and move it through the system against variable pumping heads at a flow rate to provide an annular velocity that is adequate to transport drill cuttings out of the drill hole.

6.3.4.4 *Water-based Drilling Fluids*—The four main classes of water-based drilling fluids are: (*1*) clean, fresh water, (*2*) water with clay (bentonite) additives, (*3*) water with polymeric additives, and (*4*) water with both clay and polymer additives. For commonly used materials added to water-based fluid, see Section 7 on Materials.

(*1*) Clean fresh water alone is often not acceptable for core drilling due to poor bit lubrication, erosion due to high velocities required for lifting cuttings, and excessive water loss. In water-sensitive soils, it is desirable to use drill additives to form drill hole wall cakes and prevent moisture penetration. In some cases, water may be required for piezometer installations where other fluid additives are not acceptable, but often newer synthetic polymer materials are acceptable for piezometer and well installations.

(*2*) Bentonitic drill muds are often used in rotary drilling applications. The bentonite should be added to water with vigorous mixing and recirculation to ensure uniform properties and to reach a dispersed deflocculated state. For diamond core drilling, low viscosity is usually required due to small clearances. The viscosity of a fluid-mud mixture is related to the solids content and particle shapes and alignments of the additives. During the high speed rotary drilling process, solids have a tendency to spin out and collect inside drill rods. For diamond drilling, low solids content is desirable. If mass is required to balance high hydrostatic pressures, additives such as barite or ilmenite (see 7.1.8) can be added to keep solids contents low.

(*3*) The need for low solids contents and good lubrication properties point to the use of polymer drill fluids. Natural or synthetic polymer fluids are the best additives for diamond core drilling. Polymer chains such as those from guar gum exhibit flow thinning characteristics in high velocity and shear conditions. Polymer fluids can be weighted with salts to balance hydrostatic pressures. Detergents or deflocculating agents can be added to discharge lines to assist in dropping cuttings to maintain fluid properties.

(*4*) Fluid management requires considerable experience for successful drilling and sampling. Important fluid parameters include viscosity and density, and these parameters can be tested to improve fluid properties. Test Method D 4380 and American Petroleum Institute (API) test procedures are available for testing drill fluids. Fluid design can be improved by consultation with manufacturers, suppliers, and by review of literature **(2-8)**. Because of a large number of suppliers, varying grades of drill fluid products, and varying requirements of each project, providing an exact procedure for design and mixing of drill fluids, is impossible.

6.3.5 *Rotary Drilling Using Air As the Circulation Medium*:

6.3.5.1 The air compressor should provide an adequate volume of air, without significant contamination, for removal of cuttings. Air requirements depend upon the drill rod and bit type, character of the material penetrated, depth of drilling below ground water level, and total depth of drilling. Airflow rate requirements are usually based on an annulus upflow (or outflow) air velocity of about 3000 to 4000 ft/min (1000 to 1300 m/min) although air upflow (or outflow) rates of less than 3000 ft/min (1000 m/min) are often adequate for cuttings transport. Special reaming shells may be required to maintain air circulation between the annulus of the hole wall and large diameter drill rods **(9)**. For some geologic conditions, air-blast erosion may increase the borehole diameter in easily eroded materials such that the 1000 m/min (3000 ft/min) circulation rate may not be appropriate for cuttings transport.

6.3.5.2 Compressed air alone often can transport cuttings from the borehole and cool the bit. Pure air alone does not work well in very moist soils. In moist, clayey matrices, mud rings and bit balling may occur. For some geologic conditions, water injected into the air stream will help control dust or break down "mud rings" that can form on the drill rods. If water is injected, the depth(s) of water injection should be documented. In these cases, adding water and a foaming agent to make a misting mixture is desirable **(3)**. Under other circumstances, for example if the borehole starts to produce water, injection of a foaming agent may be required. The depth at which a foaming agent is added should also be recorded. If water infiltration into the borehole impedes circulation, the use of stiffer foams or slurries may be needed **(3)**. Air drilling may not be satisfactory in unconsolidated or cohesionless soils under the ground water table, and fluid drilling systems may be required.

6.3.5.3 The dust collector conducts air and cuttings from the borehole annulus past the drill rod column to an air cleaning device (cyclone separator).

6.3.5.4 The air cleaning device (cyclone separator) separates cuttings from the air returning from the borehole via the dust collector. A properly sized cyclone separator can remove practically all of the cuttings from the return air. A small quantity of fine particles is usually discharged to the atmosphere with the "cleaned" air. Some air cleaning devices consist of a cyclone separator alone and others use a cyclone separator combined with a power blower and sample collection filters. When foaming agents are used, a cyclone-type cuttings separator is not used and foam discharge is accumulated near the top of the borehole.

6.4 *Hole Diameters*— Selection of hole diameter and core size is the most important consideration when planning a coring program. Most rock coring operations are performed with casings and core barrels whose sizes have been standardized by the Diamond Core Drill Manufacturers Association (DCDMA) **(5,10)**. Table 1 provides a summary of nomenclature used for drill hole sizing. For each size of hole, there is a family of casings, core barrels, bits, casing bits, and drill rods with the same primary letter symbol (A through Z) whose design is compatible. Furthermore, the size steps are such that the next smaller size letter equipment can be used inside the next larger group. This nesting of casings, barrels, and rods allows for tapering or telescoping of a drill hole through difficult formations. Since the core barrel must pass through the casings selected, anticipating the necessity for telescoping the hole is important so a large enough diameter is selected at the start.

NOTE 2—Inclusion of the following tables and use of letter symbols in the foregoing text is not intended to limit the practice to use of DCDMA tools. The table and the text references are included as a convenience to the user since the majority of tools in use do meet the DCDMA dimensional standards. Similar equipment of approximately equal size on the metric standard system is acceptable unless otherwise stipulated by the engineer or geologist.

6.4.1 Core diameter, barrel design, bit design, and drilling method have a direct influence on sample quality. Usually when drilling in delicate formations,larger diameter samples provide higher quality samples. Often, obtaining samples of the weaker seams or joints in the rock is critical to design. A larger diameter core barrel can often reduce shearing stresses imparted to a seam or joint in the core and thus reduce mechanical breakage. For core operations related to most surface drilling project investigations, the minimum core size would correspond to "N" sized borings.

6.4.2 In concrete coring operations, the primary consideration for selecting a core diameter is the maximum size aggregate. For interface shear strength determinations on lift lines, the core diameter should be 2½ to 3 times the maximum size aggregate **(11)**.

6.4.3 In underground hard rock drilling, smaller cores may be used for ease of operation.

6.5 *Casing*—For most coring operations, setting casings in overburden materials will be necessary, especially near the surface to control drill fluid circulation. Typically, water-sensitive soils and loose overburden soils are protected by casings that are set in competent bedrock or to firm seating at an elevation below the water-sensitive formation. The casing used should allow for unobstructed passage of the largest core barrel to be used, and should be free of upsets in inside diameter. A listing of DCDMA casing sizes is shown in Table 1. For rock coring operations, the flush inside diameter "W" series casing is used to allow for use of the matching core barrel. In some cases, flush coupled drive pipe can be used to support the hole. Drive pipe is available in thickness schedules 40, 80, and 160.

6.5.1 Casing and drill rod selection should be based on uphole (or outflow) velocity of the circulation system selected. Uphole (or outflow) velocity should be sufficient to bring up all drill cuttings.

6.5.2 Casing or temporary drill hole support can be accomplished through several methods. One casing advancement technique is to drill incrementally ahead of the casing and then drive the casing to the previous depth. Driven casings should be equipped with a hardened shoe to protect end threads. The inside diameter of the shoe should be flush with the casing inside diameter to avoid hang-ups of the core barrel. In some cases, water-sensitive zones may require cementing for stabilization. Casing can be equipped with diamond casing shoes that allow the casing to be advanced with rotary drilling. The casing shoe should have the same inside diameter as the casing. Casing "shoes" should not be confused with casing "bits" **(10)**. Casing bits are only acceptable for temporary, rotary installation of casing where coring operations are not required, such as temporary installation of a large diameter telescoped casing. Casing "bits" have an inside diameter that is not large enough to pass a core barrel of the same nominal hole size. Hollow-stem augers may be used as casing through overburden soils. Liners may be used inside large diameter casings or augers to increase fluid circulation velocity and optimize cuttings return. If liners are used, they should not be driven and care should be taken to maintain true hole alignment.

6.6 *Drill Rods*—Drill rod selection should be based on consideration of the uphole (or outflow) velocity of the circulating fluids for the circulation system selected. Uphole

TABLE 1 Diamond Core Drill Manufacturers Association Casing Specifications (10)

NOTE 1—W series casing is known as "flush-coupled casing". W series casing has flush inside diameter throughout, while X series casing has upset diameter with coupling inside diameter equal to flush wall inside diameter.

DCDMA Casing Design										
Size	Outside Diameter		Inside Diameter W Series		Inside Diameter X Series		Gallons Per 100 ft	Mass Per ft	Threads Per Inch	
	in.	mm	in.	mm	in.	mm			W series	X series
RW, RX	1.44	36.5	1.20	30.5	1.20	302.0	5.7	1.8	5	8
EW, EX	1.81	46.0	1.50	38.1	1.63	41.3	9.2	2.8	4	8
AW, AX	2.25	57.2	1.91	48.1	2.00	50.8	14.8	3.8	4	8
BW, BX	2.88	73.0	2.38	60.3	2.56	65.1	23.9	7.0	4	8
NW, NX	3.50	88.9	3.00	76.2	3.19	81.0	36.7	8.6	4	8
HW, HX	4.50	114.3	4.00	100.0	4.13	104.8	65.3	11.3	4	5
PW, PX	5.50	139.7	5.00	127.0	5.13	130.2		14.0	3	5
SW, SX	6.63	168.3	6.00	152.4	6.25	158.8		16.0	3	5
UW, UX	7.63	193.7	7.00	177.8	7.19	182.6			2	4
ZW, ZX	8.63	219.1	8.00	203.2	8.19	208.0			2	4

velocity should be sufficient to bring up all drill cuttings. Most drilling operations are done with DCDMA drilling rods conforming to the dimensions given in Table 2. Drill rods are normally constructed of tubular steel and have a flush outside wall diameter. Drill rod sections usually have threaded female connections machined in each end. The rods are connected by either removable or welded pins (in one end) strengthened by addition of material at the inside walls. Some drill rod pins are constructed of high strength steel because the joints are a weak link and are subject to failure. Some larger rods are composed of composite materials to reduce weight. Nonmagnetic rods are available for drill holes requiring use of magnetic surveying equipment.

6.6.1 Tables 3 and 4 lists dimensions of wireline and API drill rods that also can be used. Wireline drill rod dimensions are not standardized and are specific to individual manufacturers. The API internal flush joint rods have upset walls on the outside joint and should not be used in air drilling, as air erosion of the formation could occur at the joints.

6.7 *Conventional Core Barrels*—Many types of core barrels are available. A conventional core barrel is attached to the drilling rods (see 6.6) and the complete set of connected rods and barrel must be removed from the hole at the end of each core run. Torque is applied to the drill rods while the circulating fluid is pumped through the center of the drill rods to the bit. Fluid returns along the annulus between the borehole wall and barrel and drill rods. Conventional barrels are used in smaller drilling operations, such as short underground holes, or when intermittent sampling is to be performed. Most continuous high production coring today is performed with wireline equipment.

6.7.1 Several series of conventional core barrels have standardized dimensions set by the DCDMA **(10)** in North America. Other organizations such as the British Standards Institute have adopted DCDMA size conventions, while others have different standard dimensions such as metric or Swedish (Craelius) **(4)**. The DCDMA WG, WM, WT series of barrels have standard dimensions as shown in Table 5. Most manufacturers make core barrels fitting the dimensional requirements of one of these series, but there may be variation of other design features such as inner liners, bearings, fluid routing, or

TABLE 2 Diamond Core Drill Manufacturers Association Drill Rod Specifications (10)

Drill Rods, W Series Drill Rod									
Rod Type	Outside Diameter		Inside Diameter		Coupling Identification		Mass Per Foot, lbm	Threads Per Inch	Thread Type
	in.	mm	in.	mm	in.	mm			
RW	1.094	27.8	0.719	18.3	0.406	10.3	1.4	4	Regular
EW	1.375	34.9	0.938	22.2	0.437	12.7	2.7	3	Regular
AW	1.750	44.4	1.250	31.0	0.625	15.9	4.2	3	Regular
BW	2.125	54.0	1.500	44.5	0.750	19.0	6.1	3	Regular
NW	2.625	66.7	2.000	57.4	1.38	34.9	7.8	3	Regular
HW	3.500	88.9	3.062	77.8	2.375	60.3	9.5	3	Regular
WJ Series Drill Rod									
AWJ	1.75	44.5	1.43	36.4	0.63	16.1	3.6	5	Taper
BWJ	2.13	54.0	1.81	46.0	0.75	19.3	5.0	5	Taper
NWJ	2.63	66.7	2.25	57.0	1.13	28.8	6.0	4	Taper
KWJ	2.88	73.0	2.44	61.9	1.38	34.9	...	4	Taper
HWJ	3.50	88.9	2.88	73.1	1.75	44.5	...	4	Taper
Old Standard									
E	1.313	33.3	0.844	21.4	0.438	11.1	...	3	Regular
A	1.625	41.3	1.266	28.6	0.563	14.3	...	3	Regular
B	1.906	48.4	1.406	35.7	0.625	15.9	...	5	Regular
N	2.375	60.3	2.000	50.8	1.000	25.4	...	4	Regular

TABLE 3 Wireline Drill Rod Dimensions

Rod Type	Outside Diameter in.	Outside Diameter mm	Inside Diameter in.	Inside Diameter mm	Gallons Per 100 ft	Weight Per lbm	Threads Per Inch	Thread Type
AQWL[A]	1.750	44.5	1.375	34.9	7.7	3.3	4	Taper
AXWL[B]	1.813	46.0	1.500	38.1	9.18	2.8	4	Regular
BQWL[A]	2.188	55.6	1.812	46.0	13.4	4.0	3	Taper
BXWL[B]	2.250	57.2	1.906	48.4	14.82	3.8	4	Regular
NQWL[A]	2.750	69.9	2.375	60.3	23.0	5.2	3	Taper
NXWL[B]	2.875	73.0	2.391	60.7	23.30	6.8	3	Regular
HQWL[A]	3.500	88.9	3.062	77.8	38.2	7.7	3	Taper
HXWL[B]	3.500	88.9	3.000	76.2	36.72	8.7	3	Regular
PQWL[A]	4.625	117.5	4.062	103.2	...	...	. . .	. . .
CPWL[B]	4.625	117.5	4.000	101.6	...	...	. . .	. . .

[A]Q Series rods are specific manufacturer's design.
[B]X Series rods are specific manufacturer's design.

TABLE 4 American Petroleum Institute Drill Rod Dimensions (12)

API Tool Joints—Regular External Flush (in.-lb System)

Type/size	Rod o.d. (in.)	Rod o.d. (mm)	Rod i.d. (in.)	Rod i.d. (mm)
API 2-3⁄8	3.125	79.4	1	25.4
API 2-7⁄8	3.75	95.3	1.25	31.8
API 3-1⁄2	4.25	108.0	1.5	38.1
API 4	5.25	133.4	1.75	44.5
API 4-1⁄2	5.75	146.1	2.25	57.2
API 5 1⁄2	6.75	171.5	2.75	69.9
API 6 5⁄8	7.75	196.9	3.5	88.9
API 7 5⁄8	8.88	225.6	4.0	101.6.
API 8 5⁄8	10.0	25.4	4.75	120.7

API Tool Joints—Regular Internal Flush

Type/size	Rod o.d. (in.)	Rod o.d. (mm)	Rod i.d. (in.)	Rod i.d. (mm)
API 2-3⁄8	3.375	85.7	1.75	44.5
API 2-7⁄8	4.125	104.8	2.125	54.0
API 3-1⁄2	4.75	120.7	2.687	68.3
API 4	5.75	146.1	3.25	82.6
API 4-1⁄2	6.125	155.6	3.75	95.3

core extrusion methods. Some manufacturers make core barrels that do not fit dimensional DCDMA standards for core diameters. An example is the" D_3 and D_4" series core barrels shown in Table 5. Use of other nonstandardized core barrels is acceptable if the type of barrel is appropriate for the drilling conditions and the type of barrel used is reported.

6.7.2 For most investigations and when rock types are unknown, it is desirable to specify a swivel type, double tube core barrel with a split inner barrel, or solid inner barrel with split liners (also know as "triple tube"). The barrel should be equivalent to, or better than, "M" series design to reduce fluid exposure. If the formation is poorly lithified, and contains soil-like layers such as shales with interbedded clay seams, a large diameter core barrel may be specified to aid in recovery. These desired components are discussed below.

6.7.3 Core barrels generally come in 5- or 10-ft core run lengths. Ten-foot core runs can be performed with good rock conditions. If soft, friable, or highly fractured formations are encountered, it may be necessary to select barrels with 5-ft core runs to reduce the possibility of blockages and improve core recovery.

6.7.4 Important design components of a conventional core barrel are tube type (triple, double, or single), inner tube rotation (rigid or swivel), core bit type, including fluid discharge locations (internal discharge - contacting core, or face discharge and waterway design), core lifter, and reaming shell.

6.7.5 *Single Tube Core Barrel*—The single tube core barrel

TABLE 5 Approximated Core and Hole Diameters for Core Barrels

[A]Core barrel type/group	Set bit dimension inside diameter = core diameter in.	Set bit dimension inside diameter = core diameter mm	Set reaming shell = hole diameter in.	Set reaming shell = hole diameter mm
Conventional Core Barrels[B]				
RWT (d)	0.735	18.7	1.175	29.8
EWD_3	0.835	21.2	1.485	37.7
EWG (s.d.), EWM (d)	0.845	21.5	1.485	37.7
EWT (d)	0.905	23.0	1.485	37.7
AWD_3, AWD_4	1.136	28.9	1.890	48.0
AWG (s.d.), AWM (d)	1.185	30.1	1.890	48.0
AWT (d)	1.281	32.5	1.890	48.0
BWD_3, BWD_4	1.615	41.0	2.360	59.9
BWG (s.d.), BWM (d)	1.655	42.0	2.360	59.9
BWT (s.d.)	1.750	44.4	2.360	59.9
NWD_3, NWD_4	2.060	52.3	2.980	75.7
NWG (s.d.), NWM (d)	2.155	54.7	2.980	75.7
NWT (s.d.)	2.313	58.8	2.980	75.7
HWD_3, HWD_4	2.400	61.1	3.650	92.7
HWG (s.d.)	3.000	76.2	3.907	99.2
HWT (s.d.)	3.187	80.9	3.907	99.2
DCDMA Large Diameter—Double-Tube Swivel—Core Barrels				
2¾ × 3⅞	2.690	68.3	3.875	98.4
4 × 5½	3.970	100.8	5.495	139.3
6 × 7¾	5.970	151.6	7.750	196.8
Wireline Core Barrel Systems[C]				
AXWL (joy)	1.016	25.8	1.859	47.2
AQWL	1.065	27.1	1.890	48.0
BXWL	1.437	36.5	2.375	60.3
BQWL	1.432	36.4	2.360	60.0
BQ_3WL	1.313	33.4	2.360	60.0
NXWL	2.000	50.8	2.984	75.8
NQWL	1.875	47.6	2.980	75.7
NQ_3WL	1.75	44.4	2.980	75.7
HXWL	2.400	61.0	3.650	92.7
HQWL	2.500	63.5	3.790	96.3
HQ_3WL	2.375	60.3	3.790	96.3
CPWL	3.345	85.0	4.827	122.6
PQWL	3.345	85.0	4.827	122.6
PQ_3WL	3.25	82.6	4.827	122.6

[A]s = single tube; d = double tube.
[B]Conventional double-tube core barrels are available in either rigid or swivel designs. The swivel design inner barrel is preferred for sampling because it aids in preventing core rotation. In general, smallest core for given hole size results in best recovery in difficult conditions, that is, triple-tube core barrels. Use of double-tube-swivel type barrels with split liners is recommended in geotechnical investigations for best recovery and least sample damage.
[C]Wireline dimensions and designations may vary according to manufacturer.

is the simplest in design (see Fig. 2). The core is subjected to drill fluid circulation over its entire length. Once the core in the barrel is broken from parent material, it will rotate with the assembly. These effects break up all but the most competent core **(4, 12)**. Because of fluid exposure and rotational effects, this barrel should not be used to sample weak, friable, and water-sensitive materials. Additional disadvantages of this core barrel include: poor diamond performance of the cutting bit in fractured or friable formations, frequent core blocking, and severe diamond erosion due to re-drilling of broken fragments. This system is only suitable for sampling massive, hard, competent, homogeneous rock or concrete. Due to these disadvantages, this core barrel type is not recommended for routine investigations.

6.7.5.1 In shallow applications, generally less than 5 ft (2 m) competent concrete or soil cement is cored with single tube masonry core barrels with portable drill rigs **(11)**. If there is evidence of excessive core erosion, breakage, or blocking, use of double tube swivel type barrels should be considered.

6.7.6 *Double Tube Core Barrel*—Double tube core barrels contain an inner barrel that protects the core from contact with drill fluid and from erosion or washing from the circulating

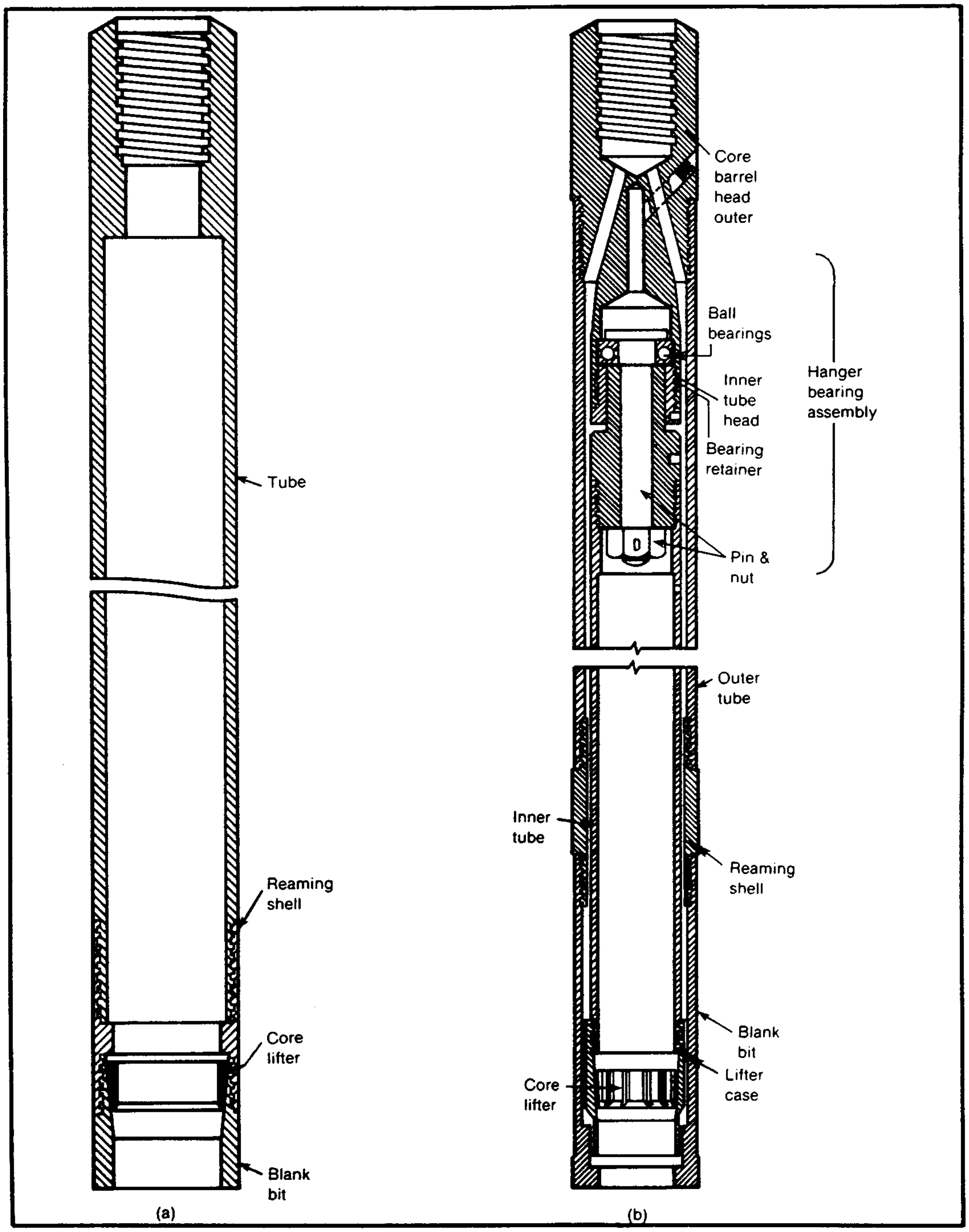


FIG. 2 Diagram of Two Types of Core Barrels: (a) Single Tube and (b) Double Tube

fluid. The bottom of the core may be subjected to fluid exposure depending on the locations of fluid discharge. Some barrel designs have fluid discharge near the lifter, near the bit, or on the bit face (see 6.7.7). The advantage of double tube design is greater protection of the core. Washing erosion is reduced and weaker zones can be recovered.

6.7.6.1 The inner barrel of double tube core barrels may be either solid or split. The barrel may be designed to accept split liners. Barrels accepting liners require a special inside diameter bit gage. Use of a split barrel or inner liners is preferred for easier handling of cores. Sections of the cores containing weak seams are more likely to remain intact. The cores may be rolled onto PVC half rounds. The use of split liners or PVC half rounds aids in placement of core in core boxes and handling of cores that require sealing for moisture preservation. In certain materials, such as expansive shales or blocked high fractured materials, the split liner may spring apart even though it is taped before sampling. In these cases, removing the inner barrel may be difficult. Remedies include use of a shorter core barrel, triple tube design with extruder (see 6.7.7.1), or the solid liner.

6.7.6.2 Double tube core barrels come in two designs, either rigid or swivel type.

(*1*) *Rigid Double Tube Barrel*—This barrel is rarely used in practice today due to limitations listed below. In the rigid barrel design, the inner barrel is fixed and it spins at the same rate as the outer barrel. Rigid tube barrels have fewer working parts, but suffer from similar disadvantages as single tube barrels. Core recovery is poor and diamond wear in friable and fractured formations is excessive. In softer deposits, there will be rotation of broken core, core blockage, and resulting crushing and grinding, which causes excessive bit wear. This type of design is not preferred for routine investigations where rock conditions are not known, as the equipment is only acceptable in hard competent formations.

(*2*) *Swivel Type Double Tube Barrels*—In the swivel type barrel (Fig. 3and Fig. 4show typical barrels) the inner barrel is connected to the drill string through a bearing that allows the inner barrel to remain stationary during coring. The core is completely protected once it enters the liner. This design reduces rock crushing and grinding and resulting blockages. Depending on the fluid discharge point, the core may be exposed to fluids near the bottom of the barrel and there could be erosion of soft or fractured formations.

(*3*) Double tube swivel type core barrels are the best selection for drilling rock of varying hardness and fracture. This type of barrel is typically the minimum requirement when drilling investigations are for engineering structures where varying conditions would be encountered.

6.7.7 *Triple Tube Core Barrels*—The triple tube barrel is essentially a double tube barrel with a liner inside the inner tube. The inner liner is made from either split metal half rounds or tubular acrylic. The use of split liners increases efficiency in handling and logging. If the purpose of the investigation is solely for logging of cores, the use of solid acrylic liners may be acceptable.

6.7.7.1 Many manufacturers offer the triple tube option and barrels are available that also have hydraulic core extrusion systems. These systems help with removing the inner liners by use of a piston in the top of the inner barrel. This feature is especially helpful if split liners are bowed apart by lateral expansion of the core. The extrusion systems allow for simple loading and unloading of liners.

6.7.8 *Conventional Barrel Standardized Designs*—DCDMA standardized barrels come in three designs, WG, WM, and WT series.

6.7.8.1 The "G" series barrels are the most simple in design and have a simple pin threaded bit into which the core lifter is inserted. Due to the simplicity of design, these barrels are the most rugged, with fewer parts and less maintenance. The only disadvantage is that the fluid exits above the lifter and the bottom of the core is exposed to fluids during drilling.

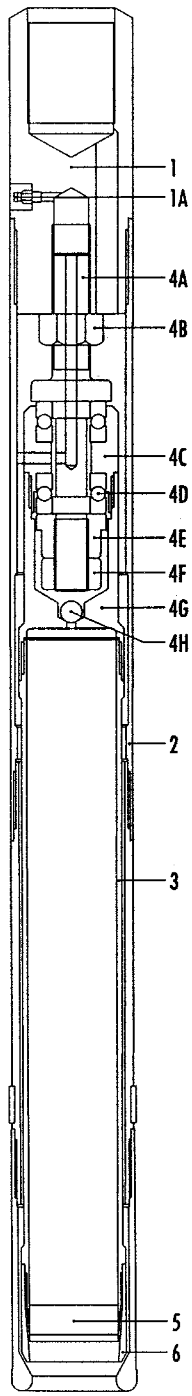
6.7.8.2 The "M" design core barrel is the best available tool for recovering of rock cores even in the most friable and caving stratums. The inner barrel is equipped with a lifter case that extends into the bit shank and therefore reduces exposure of the core to fluid during drilling. The fluid only contacts the core near the crown of the bit, and washing or eroding of the core is minimized. Face discharge bits are also available for almost no core exposure to fluids. The DCDMA "M" designs have been modified by individual manufacturers. Barrels such as the D_4 type barrels are equivalent to "M" design barrels.

6.7.8.3 The "T" series design stands for thin walled or thin kerf. This design provides larger core-to-hole size ratio. This barrel style has a thin kerf and requires fewer diamonds and less torque for drilling. It gives good performance in hard, dense, and friable shattered rock formations **(4)**. This type of core barrel is thin and lightweight and must be handled with care.

6.7.9 *Large Diameter, Double Tube, Swivel Design*—The large diameter conventional core barrel is similar in design to the double tube, swivel type, "WM" design, but with the addition of a ball valve in all the three sizes to control fluid flow. A sludge barrel to catch heavy cuttings is also incorporated on the two larger sizes (Fig. 5). The three sizes standardized by DCDMA are 2¾-in. (69.8 mm) by 3⅞-in. (98.4 mm), 4-in. (101.6 mm) by 5½-in. (139.7 mm), and 6-in. (152.4 mm) by 7¾-in. (196.8 mm). Other sizes such as 4⅝-in. (117.5 mm) by 3-in. (76.2 mm), 5¾-in. (146 mm) by 4-in. (101.6 mm), and 8-in. (203.2 mm) by 5⅞-in. (149.2 mm) have been designed by individual manufacturers. The larger barrels with increased annulus are suitable for larger rotary rig mud pumps and air compressors. Options include either conventional or face discharge bits with either conventional core lifter or spring finger basket retainers. Some core barrel systems can be converted to soil coring operations, but require carbide bit and a projecting cutting shoe. Some large diameter barrels are convertible from conventional to wireline coring operation.

6.8 *Wireline Core Barrels*—Wireline drilling for investigation in rock is a principal drilling system used for deep rock coring applications using surface mounted drill rigs (Fig. 6andFig. 7). In the wireline system, the drill rods are only removed from the hole to replace the coring bit, to free a stuck inner barrel, or to adjust the headspace of the inner barrel. The inner core barrel can be removed and replaced without removing the drill rods, allowing for continuous coring. The drill rods

NWD4-SERIES D4 CORE BARREL



NWD4 SERIES D4 CORE BARREL					
HOLE SIZE	CORE SIZE	OUTER TUBE O.D.	OUTER TUBE I.D.	INNER TUBE O.D.	INNER TUBE I.D.
2.980 in	2.060 in	2.906 in	2.562 in	2.375 in	2.135 in
75.7 mm	51.3 mm	73.8 mm	65.1 mm	60.3 mm	54.2 mm

NWD4 SERIES D4 CORE BARREL ASSEMBLIES
PART DESCRIPTION
Core Barrel Assembly - 5 ft (1.5 m)
Core Barrel Assembly - 10 ft (3.0 m)
Core Barrel Assembly - 5 ft (1.5 m) Split
Core Barrel Assembly - 10 ft (3.0 m) Split
SPARE PARTS FOR NWD4 SERIES D4 CORE E
1. Core Barrel Head, NW Rod
A. Grease Fitting
2. Outer Tube, 5 ft (1.5 m), C.P. Ends
Outer Tube, 10 ft (3.0 m), C.P. Ends
3. Inner Tube, 5 ft (1.5 m), C.P. ID
Inner Tube, 10 ft (3.0 m), C.P. ID
Inner Tube, Split, 5 ft (1.5 m) C.P. ID
Inner Tube, Split, 10 ft (3.0 m) C.P. ID
4. Bearing Assembly
A. Bearing Shaft
B. Lock Nut
C. Bearing Retainer
D. Bearing, Thrust Ball (2 Required)
E. Hex Nut, Flanged
F. Hex Nut, Regular
G. Inner Tube Connector
H. Ball
5. Core Lifter, Skirtless
6. Inner Tube Shoe/Case, C.P. ID
7. Thread Protector Sub

FIG. 3 Typical Double Tube Swivel Type-Conventional Core Barrel

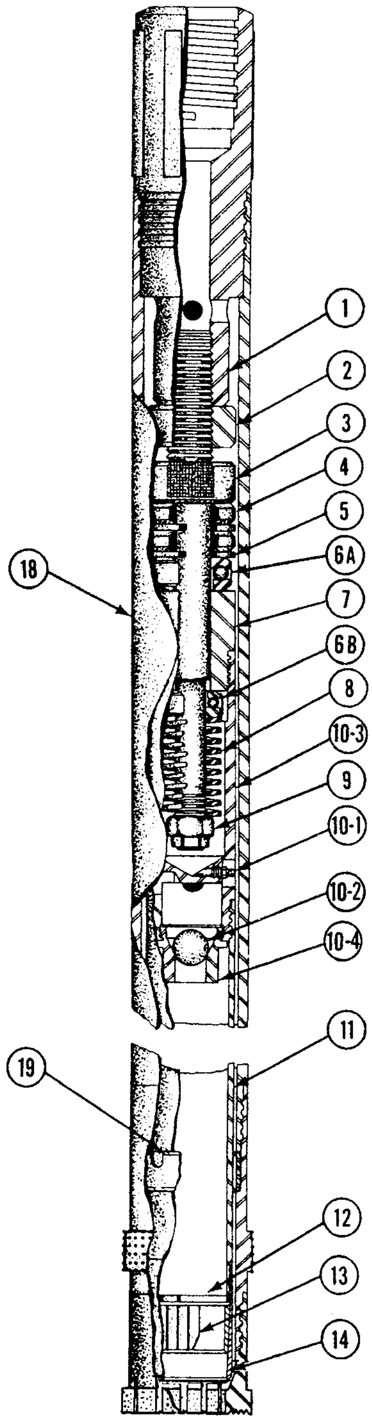
also act as a casing, and fluid is circulated from the bit through the annulus between the drill hole wall and drill rod. Wireline drill rod dimensions are not standardized. Table 3 lists the typical wireline rod sizes and Table 5 lists core barrel sizes of predominant types of wireline equipment available. Other systems such as heavy duty systems with differing dimensions may be available and are acceptable for use if dimensions are reported.

6.8.1 The inner barrel assembly is locked into the lead section of wireline drill rod by means of a retrievable overshot latching mechanism. A latching device locks into a complementary recess in the wall of the leading outer tube such that the outer tube could be rotated without causing the rotation of the inner tube. After the core run, the overshot mechanism is lowered through the rods and latches onto a spearhead on the top of the core barrel assembly and is hoisted to the surface

Double-Tube Swivel Type — Parts List

STANDARD CONVENTIONAL SYSTEM

NV2" Core Barrel



Item No.	Description	No. Req'd	Unit Weight lbs	kg
1-20	Core Barrel Assy 5 ft	—	76.0	34,5
1-20	Core Barrel Assy10 ft	—	126.0	57,2
-	Core Barrel Assy15 ft **	—	178.0	80,8
1-10	Head Assy	—	19.0	8,6
1	Outer Tube Head	1	8.7	3,9
2	Lock Nut	1	*	*
3	Spindle	1	3.1	1,4
4	Shut Off Valve	2	*	*
5	Valve Adjusting Washer	2	*	*
6A	Ball Thrust Bearing	1	*	*
6B	Hanger Bearing	1	*	*
7	Spindle Bearing	1	1.6	0,7
8	Compression Spring	1	*	*
9	Self Locking Nut	1	*	*
10	Inner Tube Cap Assy	—	3.6	1,6
10-1	Hydraulic Grease Fitting	1	*	*
10-2	Stainless Steel Ball	1	*	*
10-3	Inner Tube Cap	1	3.2	1,5
10-4	Check Valve Body	1	*	*
11	Inner Tube, 5 ft	1	12.3	5,6
11	Inner Tube, 10 ft	1	24.5	11,1
11	Inner Tube, 15 ft	1	38.0	17,2
12	Stop Ring	1	*	*
13	Fluted Core Lifter	1	*	*
14	Core Lifter Case	1	*	*
18	Outer Tube, 5 ft	1	44.0	20,0
18	Outer Tube, 10 ft	1	77.6	35,2
19	Inner Tube Stabilizer	1	*	*
20	Thread Protector (not shown)	1	2.5	1,1

Weighs less than one pound (0,45 kg)

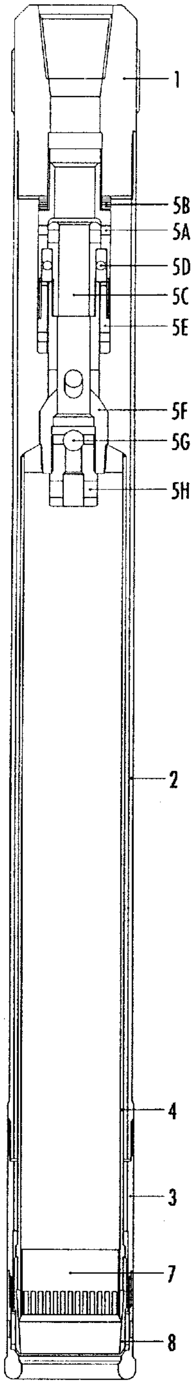
The Core Barrel Assembly 15 foot, consists of one Head Assembly, one each inner Tube 15 foot, Stop Ring, Core Lifter, Core Lifter Case, Outer Tube 5 foot, Outer Tube 10 foot, Thread Protector and two Inner Tube Stabilizers.

FIG. 4 Typical Double Tube Swivel Type-Core Barrel

with cable and wireline winch. The inner tube assembly consists of an inner tube with removable core lifter case and core lifter at one end, and a removable inner tube head swivel bearing, suspension adjustment, and a latching device with a release mechanism at the opposite end. If continuous coring is not required, the retrievable inner core barrel assembly can be replaced with a pilot bit for hole advancement.

6.8.2 Wireline coring systems are designed for long life bits with wide kerf and impregnated or surface set diamonds. Both internal discharge and face discharge bits are available. The

7-3/4 in X 5-7/8 in CORE BARREL



7-3/4 in X 5-7/8 in CORE BARREL					
HOLE SIZE	CORE SIZE	OUTER TUBE O.D.	OUTER TUBE I.D.	INNER TUBE O.D.	INNER TUBE I.D.
8.000 in	5.875 in	7.500 in	7.000 in	6.500 in	6.125 in
203.2 mm	149.2 mm	190.5 mm	177.8 mm	165.1 mm	155.6 mm

7-3/4 in X 5-7/8 in CORE BARREL ASSEMBLIES
PART DESCRIPTION
Core Barrel Assembly - 5 ft (1.5 m)
Core Barrel Assembly - 10 ft (3.0 m)
Core Barrell Assembly - 5 ft (1.5 m) Split
Core Barrell Assembly - 10 ft (3.0 m) Split
SPARE PARTS FOR 7-3/4 in X 5-7/8 in CORE
1. Core Barrel Head (4-1/2" A.P.I. Reg.)
2. Outer Tube, 5 ft (1.5 m)
Outer Tube 10 ft (3.0 m)
3. Outer Tube Sub
4. Inner Tube 5 ft (1.5 m), CP, ID
Inner Tube 10 ft (3.0 m), CP, ID
Inner Tube 5 ft (1.5 m) Split
Inenr Tube 10 ft (3.0 m) Split
5. Bearing Assembly
A. Cartridge Cap
B. Shim, Set
C. Bearing Retainer
D. Bearing, Thrust, Ball
E. Cartridge Plug
F. Inner Tube Plug
G. Ball
H. Pressure Relief Plug
6. Inner Tube Connector, Split
7. Core Lifter, HF
8. Inner Tube Shoe, BW
9. Thread Protector Sub
10. Tube Clamp, 7-1/2 in (190.5 mm) (outer)
OPTIONAL EQUIPME
11. Core Lifter, Skirtless, HF

Note: If you do not see the item or size you are looking for, please contact you for additional product information.

FIG. 5 Typical Large Diameter Series —Conventional Core Barrel

inner core barrel has a dual shut-off valve that stops fluid circulation to alert the driller of a core blockage.

6.8.3 The advantages of wireline drilling are:

6.8.3.1 Significant reduction in rod handling time compared with conventional core barrels.

6.8.3.2 Increased coring bit life with decreased diamond loss.

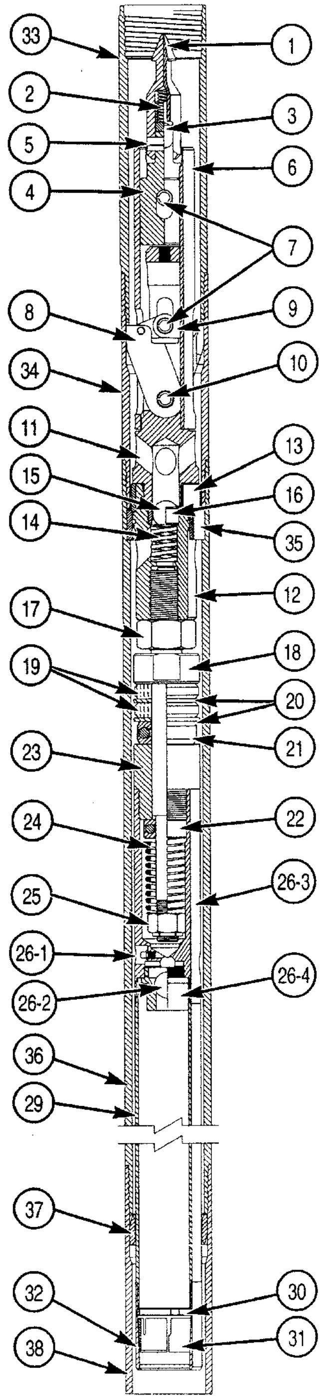
6.8.3.3 High core recovery.

6.8.3.4 Caving is reduced and rods aid to stabilize the drill hole walls.

6.8.3.5 Rods are flush or near flush both inside and outside and can be used as a temporary casing.

6.8.3.6 Various in-hole instrumentation packages can be sent through the end of the drill string to test the bottom of the hole. Wireline packer systems can be used for pressure water test (Test Method D 4630).

NQ Core Barrel



Item No.	Description	No. Req'd	Unit Weight lbs	kg
1-38	Core Barrel Assy 5 ft	—	-	-
1-38	Core Barrel Assy 10 ft	—	-	-
1-32	Inner Tube Assy 5 ft	—	-	-
1-32	Inner Tube Assy 10 ft	—	-	-
1-28	Head Assy	—	-	-
1	Spearhead Point	1	*	*
2	Compression Spring	1	*	*
3	Detent Plunger	1	*	*
4	Spearhead Base	1	1.3	0,6
5	Spirol Pin, 7/16" x 1"	1	*	*
6	Retracting Case	1	-	-
7	Spring Pin, 1/2" x 2"	2	*	*
8	Latch	2	*	*
9	Link	2	*	*
10	Spring Pin, 1/2" x 1-1/2"	1	*	*
11	Upper Latch Body	1	2.9	1,3
12	Lower Latch Body	1	3.1	1,4
13	Landing Shoulder	1	-	-
14	Dry Hole Spring, Light (not installed)			
15	Stainless Steel Ball, 22 mm (not installed)			
16	Bushing (not installed)			
17	Hex Nut	1	*	*
18	Spindle	1	3.1	1,4
19	Shut Off Valve, Hard	2	*	*
20	Valve Adjusting Washer	2	*	*
21	Thrust Bearing	1	*	*
22	Hanger Bearing	1	*	*
23	Spindle Bearing	1	1.6	0,7
24	Compression Spring	1	*	*
25	Self Locking Nut	1	*	*
26	Inner Tube Cap Assy (consists of 26-1, -2, -3, -4)	—	3.3	1,5
26-1	Hydraulic Grease Fitting	1	*	*
26-2	Stainless Steel Ball, 22 mm	1	*	*
26-3	Inner Tube Cap	1	2.9	1,3
26-4	Check Valve Body	1	*	*
27	Landing Indicator Bushing (not installed)			
28	Dry Hole Spring, Medium (not installed)			
29	Inner Tube, 5 ft	1	12.3	5,6
29	Inner Tube, 10 ft	1	24.5	11,1
30	Stop Ring	1	*	*
31	Core Lifter	1	*	*
32	Core Lifter Case	1	1.6	0,7
33	Full-Hole H/T Tanged Locking Coupling**	1	5.9	2,7
34	Adapter Coupling	1	3.2	1,5
35	Landing Ring	1	*	*
36	Outer Tube, 5 ft	1	44.0	20,0
36	Outer Tube, 10 ft	1	77.6	35,2
37	Inner Tube Stabilizer	1	*	*
38	Thread Protector	1	2.5	1,1

Weighs less than 1.0 lb (0,45 kg)
"H/T" means "Heat-Treated"

FIG. 6 Typical Wireline Rock Coring System

6.8.3.7 Two inner barrel assemblies can be used for maximum productivity in continuous coring operations.

6.8.4 The disadvantages of wireline drilling are:

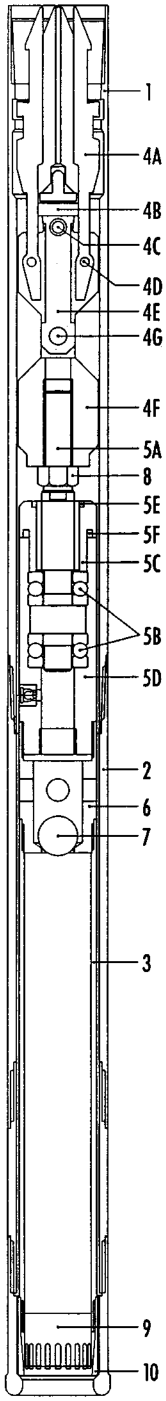
6.8.4.1 Equipment is more expensive than conventional equipment, and

6.8.4.2 Wireline systems are complicated and operations require additional training.

6.8.5 Table 5 lists common wireline core barrel sizes. They are available in "A" through "P" size. When rock samples are to be obtained for testing of engineering properties," H" size is recommended, "N" is minimum, and "P" size will result in better recovery of difficult formations.

6.8.6 The wireline core barrel is essentially a double tube swivel type core barrel. Since the core lifter is part of the inner barrel assembly, exposure of the core to drill fluid is minimized similar to "M" style conventional core barrels. Most systems can be adjusted for front discharge (inside above bit gage) or face discharge.

NXB WIRELINE CORE BARREL



NXB WIRELINE CORE BARREL					
HOLE SIZE	CORE SIZE	OUTER TUBE O.D.	OUTER TUBE I.D.	INNER TUBE O.D.	INNER TUBE I.D.
2.980 in	1.875 in	2.875 in	2.391 in	2.200 in	1.969 in
75.7 mm	47.6 mm	73.0 mm	60.7 mm	55.9 mm	50.0 mm

NXB WIRELINE CORE BARREL ASSEMBLIES
PART DESCRIPTION
Core Barrel Assembly - 5 ft Complete (1.5 m)
Core Barrel Assembly - 10 ft Complete (3.0 m)
Core Barrel Assembly 5 ft (1.5 m) Split
Core Barrel Assembly 10 ft (3.0 m) Split
SPARE PARTS FOR NXB WIRELINE CORE BA
1. Locking Coupling
Locking Coupling, NQ Box Thread
2. Outer Tube 5 ft (1.5 m)
Outer Tube 10 ft (3.0 m)
3. Inner Tube 5 ft (1.5 m)
Inner Tube 10 ft (3.0 m)
Inner Tube, Split, 5 ft (1.5 m)
Inner Tube, Split, 10 ft (3.0 m)
4. Quad-Latch Pivot Head Assembly
A. Quad latch (4 required)
B. Spring - Blue (Top)
C. Spring - Red (Bottom)
D. Pin (4 required)
E. Head Base (Top)
F. Head Base (Bottom)
G. Pin
5. Bearing Assembly
A. Bearing Shaft
B. Bearing (2 required)
C. Bearing Retainer
D. Housing w/Zerk & cap
E. O-Ring
F. O-Ring
6. Inner Tube Connector
InnerTube Connection, Split
7. Ball
8. Nut
9. Core Lifter, Skirtless, Buttress
10. Inner Tube Shoe/Case, CP

FIG. 7 Typical Wireline Rock Coring System

6.8.7 Most manufacturers offer a triple tube barrel, which is preferred for most operations. The third tube is a split inner liner that facilitates sample handling.

6.8.8 Some wireline barrels systems are convertible from soil sampling to rock sampling operation. These barrels are equipped with soil barrels that can lead in front of the core bit. Some systems are equipped with spring loaded soil core barrels. These systems are advantageous when soils or soft rock are encountered.

6.9 *Core Barrel Bits*— One of the most important equipment decisions in rock core drilling is the bit selection. Both the bit and reaming shell act together to cut the hole. There are many bit design factors involved when selecting the proper bit for good core recovery. Factors included in selection are:

6.9.1 Diamond type—source,

6.9.2 Diamond matrix (surface set or impregnated),

6.9.3 Rock hardness, grain size, and formation,

6.9.4 Drill power, and

6.9.5 Barrel type.

6.9.6 Bit selection is a trial and error process that may require several iterations. After a bit is selected, it is tried with the drill to be used. Penetration rate and bit life should be evaluated and a different design selected if necessary.

6.9.7 Important features of diamond drilling bits include crown shape, diamonds, and waterways. The crown is the end of the bit that contains a kerf equipped with cutting media. A round or semi-round kerf is frequently used with conventional core barrels. Flat, stepped, or v-ring designs are often used with wireline drilling with impregnated bits.

6.9.8 Important features of the diamonds themselves are the size, quality, quantity, setting, and matrix quality **(4)**. Surface set bits are used in most conventional coring operations. The size of diamonds is expressed in equivalent stones per carat (SPC). The typical SPC range is from 20 to 100 for surface set bits, with the finer stones being used for harder rock matrixes. Larger diamonds are used for softer, more friable formations. Impregnated bits are fragments mixed with metal and pressed and sintered into the bit. The diamond fragments are throughout the crown and the bit is, in a sense, self-sharpening. Impregnated bits are used in more severe drilling conditions and in wireline drilling where long life is essential.

6.9.9 Waterway design is also an important aspect of bit selection. Surface channel routing of the fluids from inside gage to outside is typical in conventional and wireline drilling for most crystalline rocks that are not sensitive to fluid erosion. Face discharge bits should be used for soft friable formations where fluid erosion is detrimental. Step-face discharge configurations further inhibit core erosion. Special flush discharge air ports are used with air and air-foam drilling operations. The softer the matrix, the larger the waterways must be to avoid blocking and plugging.

6.9.10 For very soft materials, it is not necessary to use diamonds as the cutting media. Diamonds can often be replaced with tungsten carbide or polycrystalline inserts for coring soft materials. Carbide and polycrystalline bits often have cutting teeth arranged in a sawtooth fashion. Polycrystalline bits (diamond grown to tungsten carbide substrates that are soldered or furnaced onto the crown) have replaced natural diamonds for coring in some softer sedimentary formations. Some core barrels, such as the large diameter series, can readily be changed from diamond rock coring to carbide soil sampling modes.

6.9.11 Manufacturers are an excellent resource to assist in selecting the matrix and style of bit, depending on rock conditions, drill power, and barrel type. Most manufacturers have a method for rating diamond matrices and bits into different series and groups **(3)**. DCDMA has selection codes for impregnated bits **(10)**. Manufacturers should be consulted for initial recommendations for your specific drilling conditions, and as the project progresses, they can work with the driller to refine designs and drilling technique. Based on wear patterns, it may be possible to switch series or design to optimize results. In hard competent formations, bit selection may be drill rig-dependent (rotation rate and advance forces). It is beyond the scope of this practice to address drill bit selection. In addition to manufacturers' advice, there are several useful references to provide information in evaluating causes for wear **(3, 4, 10)**.

6.9.12 Most diamond bits have salvage value and should be returned to manufacturers for credit toward future purchases.

6.10 *Reaming Shells*— The reaming shell is a subassembly of a row or strip of material placed on the outside of the core barrel for some distance behind the core bit. It is designed to ream and enlarge the hole to a final diameter and must allow for adequate fluid circulation to the surface. The shell also acts as a collar or centralizer for the barrel. Manufacturers should be consulted for appropriate reaming shell designs for the formations to be drilled. They may be surface set with diamond bits, impregnated with diamond particles, inserted with tungsten carbide strips or slugs, hard faced with various types of hard surfacing materials, or furnished blank, as appropriate to the formation being cored.

6.11 *Core Lifters*— Core lifters are used to break the core from parent material at the end of a core run. As coring progresses, the lifter floats up in its beveled recessed slot in the shoe. After an increment of core has been drilled that corresponds to core barrel length, the rotation is stopped. Fluid is circulated until cuttings are cleared, and then the drill pipe is steadily retracted. The lifter will slide down the beveled shoe and impart an increasing grip on the core. The core frequently breaks near the base of the hole, and often a snap can be felt in the drill pipe as the core breaks from parent material.

6.11.1 Core lifters of the split ring type, either plain or hard surfaced, are recommended and must be maintained in good condition, along with core lifter cases or inner tubes extensions or inner tube shoes. Basket or finger type lifters with any necessary adapters may be used with core barrels if directed by the engineer or the geologist.

6.12 *Core Boxes*—These are durable waxed cardboard or wooden boxes with partitioned compartments for storing the core samples (see Practice D 5079).

6.13 *Auxiliary Equipment*—The following auxiliary equipment is typically used for the rock core drilling project:

6.13.1 *Drilling bits*— roller rock bits, drag bits, chopping bits, boulder busters, and fishtail bits;

6.13.2 *Tools*—pipe wrenches, core barrel wrenches, chain tong, strap wrench, watch, RPM counter, lubrication equipment, core splitters, rod wicking, extruders, hand sieves or strainers, and marking and packaging tools;

6.13.3 *Rod holding equipment*—closed pulling ring, open iron ring, knife edge holding dog, holding iron, chucking rods, safety foot clamp, manila rope, bolt, and clevis pins;

6.13.4 *Fluid circulation equipment*—hoses, positive displacement pump along with packing and seals, water swivel, pressure gages, flow meters, water-level meters, and mud pit; and

6.13.5 *Drill area, platform, and leveling*—cribbing, planking, lumber, saw horses, metal saw horses with chain vise.

7. Reagents and Materials

7.1 *Water-Based Drill Fluid Additives*—Listed below are commonly used additives for water-based drilling fluids. Drilling additives in contact with drinking water aquifers should meet the requirements of NSF 60-1988.

NOTE 3—In some areas, certain types of drill fluid products are not allowed by state and local environmental authorities. Before using any drill fluid product, check with the authorities to determine its acceptability.

7.1.1 Beneficiated bentonite, a primary viscosifier and drill hole sealer, consists of montmorillonite with other naturally occurring minerals and various additives such as guar gum, sodium carbonate, or polyacrylates, or a combination thereof.

7.1.2 Unbeneficiated bentonite, a primary viscosifier and drill hole sealer, consists of montmorillonite with other naturally occurring minerals, but without additives such as guar gum, sodium carbonate, or polyacrylates.

7.1.3 Sodium carbonate powder (soda ash) is used to precipitate calcium carbonate from the drilling fluid water-base before adding other components. An increase in pH will occur with the addition of sodium carbonates. Sodium hydroxides (caustic soda) generally should not be used for this application.

7.1.4 Carboxylmethylcellulose powder (CMC) is sometimes used in a water-based fluid as a viscosifier and as an inhibitor to clay hydration. Some additives to water-based drilling-fluid systems retard clay hydration, thus inhibiting swelling of clays on the drill hole wall and "balling" or "smearing" of the bit.

7.1.5 Potassium chloride (muriated potash) or diammonium phosphate can be used as an inhibitor to clay hydration.

7.1.6 Polyacrylamide, a primary viscosifier and clay hydration inhibitor, is a polymer mixed with water to create a drilling fluid.

7.1.7 Guar gum, a primary viscosifier, drill-hole sealer, and hydration inhibitor, is a starch mixed with a water base. The water must be neutral to slightly acidic and hydrochloric acid is sometimes used to pre-treat the water base. Guar gum will degrade with time, but various chemicals can be used to accelerate decomposition.

7.1.8 Barium sulfate increases the density of water-based drilling fluids to help support the borehole wall. It is a naturally occurring high-specific gravity mineral processed to a powder for rotary drilling fluid applications.

7.1.9 Lost-circulation materials are added to the drilling fluid to seal the drill-hole wall when fluids are being lost through large pores, cracks, or joints. These additives usually consist of various coarse textured materials such as shredded paper or plastic, bentonite chips, wood fibers, or mica.

7.1.10 Attapulgite, a primary viscosifier for rotary drilling in high-salinity environments, is a clay mineral drilling-fluid additive.

8. Precautions

8.1 The drilling and sampling equipment shall be complete and in good order. A sufficient amount of drill rods, casings, drill bits, core barrels, core barrel liners, water meters, pumps, and pressure gages shall be in hand before the start of drilling. Measurement devices such as pressure gages and RPM counters shall be functioning in conformance with the manufacturer's specifications.

8.2 The use of fluid or air under high pressure may cause damage to formation materials by fracturing or excessive erosion if drilling conditions are not carefully maintained and monitored. If formation damage is evident and undesirable, other drilling method(s) should be considered.

8.2.1 Fluid pressure should be monitored during drilling. Fluid pressure at the bit should be as low as possible to maintain circulation and to reduce possibility of hydraulic fracturing or excessive erosion of surrounding materials. Normally, injection fluid pressures are fully monitored. Changes in fluid return and circulation pressure may indicate occurrence of excessive erosion, formation fluid loss, core blockage, or formation fracturing. Any abrupt changes or anomalies in the fluid pressure should be noted and documented, including the depth(s) of occurrence(s).

9. Procedure

9.1 Perform site inspections to determine locations of boreholes, and to select disposal sites for waste products during drilling.

9.1.1 Evaluate applicable methods for environmental protection and traffic regulation during core drilling.

9.1.2 Determine site accessibility and availability of water for core drilling operation. Check around the drill site for overhead obstructions or hazards, such as power lines, before raising the mast. A survey of underground and all other utilities is required before drilling to evaluate hazards.

9.2 Fabricate and assemble the drill mounting platform. The platform can take a variety of forms. The type of platform will depend on the terrain encountered, the stipulated depth of the borehole, and the accessibility of the drill site. Specialized mountings such as a barge or stilts or specially constructed towers are necessary to mount platforms for drilling over water.

9.3 For water-based fluid drilling operation, a mud pit is positioned to collect and filter fluid return flow. An initial quantity of drilling fluid is mixed, usually using the mud pit as the primary mixing reservoir.

9.3.1 For air-based circulation systems, the dust collector or cyclone separator is positioned and "sealed" to the ground surface.

9.4 Case any interval of the borehole that penetrates the overburden. This will prevent collapsing of loose materials into the borehole or loss of drill fluid. The casing should extend through the overburden and extend at least 5 ft (1.5 m) into the rock. Casing may be omitted if the borehole will stand open without caving. Deeper casing(s) or nested casing(s) may be required to facilitate adequate drill hole fluid circulation and hole control. Records of casing(s) lengths and depth intervals installed should be maintained and documented.

9.4.1 Surface casings can be installed using a variety of drilling methods. Hollow-stem auder drilling (D 6151) has been used successfully for surface casing and has an added benefit of obtaining samples of the overburden soils.The surface casing is normally backfilled, pressed, or sealed in place wit bentonite or cement, or both.

9.4.2 A datum for measuring drill hole depth should be established and documented. This datum normally consists of a stake driven into stable ground surface, the top of the surface casing, or the drilling deck. If there is possibility for movement of the surface casing, it should not be used as a datum. If the hole is to be later surveyed for elevation, record and report the height of the datum to the ground surface.

9.5 The core barrel is assembled following manufacturers' instructions. Keep core barrels cleaned and lubricated and free from damage, dents, or other defects that might affect core quality. Inspect barrels for wear, clearances, dents, or galls. Check condition of core lifters, fluid passages, relief holes, ball checks, valve rubbers, and inner barrel stabilizers, if present. Assemble and disassemble core barrels with the correct tools for the job.

9.5.1 The inner tube of double tube core barrels must be positioned correctly for proper operation. For both conventional and wireline systems where fluid circulates between the bit and lifter case, check that the proper clearance is maintained for circulation. For wireline systems, this will require engaging the inner barrel while the outer barrel is held vertically. If clearances are not correct, they should be adjusted using the adjustment screw on top of the barrel assembly.

9.5.2 For swivel type inner barrels, inspect the bearing assemblies and confirm the inner barrel is free to rotate smoothly when assembled.

9.6 An initial assembly of lead drill rod and core barrel is attached to the drill mechanism through a spindle or below the drill head, and placed within the top of the surface casing. Hole depth is determined by keeping track of the length of the rod-bit assemblies and comparing its position relative to the established surface datum. Hole depth for increments of drilling, coring, and sampling is recorded on the drill log.

9.7 The drilling-fluid circulation pump or air compressor is activated, causing drilling fluid or air to circulate through the system.

9.8 Drilling fluid or air circulation is initiated and rotation and axial force are applied to the drill rod and bit until drilling progresses to a depth where: (*1*) when the core sample has fully entered the core barrel or blockage is apparent, (*2*) sampling or in-situ testing will be performed, or (*3*) the length of the drill-rod column limits further penetration.

9.8.1 Maintain fluid circulation at a rate suitable for the formation to be drilled. Fluid should be circulated at a rate sufficient to circulate cuttings and cool the bit. Fluid pressures should be monitored during drilling. Avoid drilling at excessive advance rate, which could cause plugging of the bit and core blockage and damage. Changes in fluid return and circulation pressures may indicate occurrence of excessive erosion, formation fluid loss, or formation fracturing. Any abrupt changes or anomalies in fluid pressure should be noted and documented, including depth(s) of occurrence(s).

9.8.2 Maintain air circulation at a rate suitable for the formation, and avoid circulation losses. Add water or foam as necessary to maintain circulation. Zones of low air return or no air return should be documented. Should air-blast erosion occur, depth(s) of the occurrence(s) should be noted and documented. Air is particularly susceptible to blocking off circulation and causing uplift to occur very quickly.

9.8.3 Samples of drill cuttings can be collected for analysis of materials penetrated. If cuttings samples are obtained, the depth(s) and interval(s) should be documented.

9.8.4 The selection of proper rotation rate and down feed (advance) or hold-back pressure depends on many factors. The drilling process is iterative in nature. Diamond drilling in a harder matrix usually requires higher rotation rates and down force pressures. With the correct material and equipment configurations, diamond bit performance is generally optimum at rotation rates of at least 400 rpm or greater. Rates of up to 1000 rpm can be used, depending on the material. However, too high a rate can cause tearing of the formation and core recovery problems. Softer materials with other bits such as polycrystalline, require slower rotation rates. Vibration is extremely important to the drill hole and core quality and must be minimized. Sufficient thrust needs to be transmitted to the bit so that bit elements can cut the rock. The goal is to find the rotation rate and thrust that will result in high quality core and acceptable bit life.

9.8.4.1 Monitor advance or down force pressure, or hold-back pressures, and rotation rates of drill rods during drilling. Observe the penetration rate and drill cuttings as they relate to the geologic strata being penetrated. Document occurrences of any significant abrupt changes and anomalies during drilling.

9.9 Rotation is stopped, the advance or down force pressure is released, and circulation is continued for a short time until the drill cuttings are removed from the borehole annulus. Circulation is stopped and the barrel is rested on the hole bottom to determine hole depth.

9.10 Remove the core barrel and the core from the borehole. Disassemble the core barrel and remove the core.

9.10.1 With double tube barrels, when the barrel is retracted, the core lifter grips the core and the core is normally broken from the base material at the base of the hole. The core lifter is located inside the barrel above the bit typically about 0.1ft. When the core is broken there will be a small pedestal of core left in the hole. As long as the lifter is not slipping, and core is og goods quality, successive recoveries will be close to 100%. If for some reason, the lifter case slips, there will be low recovery recorded and there will be a longer pedestal on the subsequent sampling event. If there appears to be excessive core on the subsequent run, or there is visible evidence of the lifter slipping, these occurrences should be noted. If it is obvious the pedestal was present, the length can be accounted for in determination of recovery (see 10.1) of the previous ren. These occurrences and corrections should be appropriately noted in the drill report.

9.10.2 With single tube core barrels in shallow drilling operations, the core can be broken with a wedge and lifted by wire hoop to the surface.

9.11 Reassemble the core barrel and return it to the borehole. Check for proper barrel conditions as noted in 9.7. The use of two barrels can greatly speed coring operations; as one barrel is cleaned and reassembled the other is in use in coring.

9.12 Drilling depth is increased by attaching an additional drill-rod section(s) to the top of the previously advanced drill-rod column and resuming drilling operations in accordance with 9.8-9.12.

9.13 *Rock Core Handling*—Use of split inner barrel liners greatly increases the efficiency of handling of cores, especially in broken formations. Cores can be transferred into plastic half rounds for logging and sealing. Log, preserve, and place core samples in core boxes in accordance with Practice D 5079.

9.14 *Rock Core Recovery*—Rock core shall be recovered continuously in the borehole. If recovery drops below 100 % (see Section 10), modify the drilling procedure, that is, adjust the drilling RPM, down feed pressure, the drilling fluid type and flow, or change the type and the size of core barrel or bit used, until core recovery is improved to a level acceptable to the project geologist or project engineer. Minimize mechanical breaks in the core during core drilling as much as possible.

9.14.1 *Poor Recovery*— Stop core drilling when recovery equals or falls below 50 %. If recovering samples is important, select a better core barrel or bit design. In some cases, it may be necessary to attempt soil sampling techniques **(11)**.

9.15 If conditions prevent advance of the drill hole to the stipulated depth, the borehole shall be cemented and redrilled, or reamed and cased, cased and advanced with a smaller size drill bit and core barrel, or abandoned, as directed by the engineer or geologist.

9.16 Prepare boring logs and place the rock sample in core boxes, and mark and pack them in accordance with Practice D 5079.

10. Calculation

10.1 *Calculate Percent Core Recovery*—Determine the rock core recovery as the ratio of length of core recovered to the length drilled, and express as a percent.

$$\text{Percent core recovery} = \frac{\text{Length of the recovered core}}{\text{Total length of the core run}} \times 100 \quad (1)$$

10.2 Calculate Rock Quality Designation (RQD) in accordance with D 6032.

11. Report

11.1 Report the following information:

11.1.1 *Site Conditions*— Site description: description of the site and any unusual circumstances.

11.1.2 *Personnel*—document all personnel at the site during the drilling process, including the driller, helpers, geologist or logger, engineer, and other monitors or visitors.

11.1.3 Weather conditions during drilling.

11.1.4 Working hours, operating times, break-down times, and sampling times. Report any long-term delays in the drilling and installation process.

11.1.5 Report any unusual occurrences that may have happened during the investigation.

11.1.6 *Drilling Methods*:

11.1.6.1 Description of the coring system including type, sizes, core barrels, fluid pump, fluid circulation, and discharge systems. Note intervals of equipment change or drilling method changes and reasons for change.

11.1.6.2 Type, quantities, and drill hole locations of use of additives added to the circulation media. If changes to the circulating medium are made, such as addition of water or conversion to foam, the depth(s) or interval(s) of these changes should be documented.

11.1.6.3 Descriptions of circulation rates, cuttings returns, including quantities, over intervals used. Note the quantity and locations of loss of circulation and probable cause.

11.1.6.4 Descriptions of drilling conditions related to drilling pressures, rotation rates, and general ease of drilling related to subsurface materials encountered. These descriptions can be very general, and should report how the sampling of different materials progressed.

11.1.6.5 *Records of casing installed*—Report type, amount and times of installation. Record water levels (dates and elevation) observed during drilling.

11.1.7 *Sampling*—When core sampling or undisturbed sampling at the base of the boring separate from coring operations, report condition of the base of the boring before sampling and any slough or cuttings present in the recovered sample. Samples of fluid circulation cuttings can be collected for analysis of materials being penetrated. If cuttings samples are taken, the depth(s) and interval(s) should be documented.

11.1.8 *In-situ Testing*:

11.1.8.1 For devices inserted below the base of the drill hole, report the depths below the base of the hole and any unusual conditions during testing.

11.1.8.2 For devices testing or seating at the drill hole wall, report any unusual conditions of the drill hole wall such as inability to seat pressure packers.

11.1.9 *Installations*— A description of completion materials and methods of placement, approximate volumes placed, intervals of placement, methods of confirming placement, and areas of difficulty or unusual occurrences.

11.2 *Boring Logs*— Boring logs should be completed in accordance with Guide D 5434. Some information that the boring log should include is:

11.2.1 Project identification, boring number, location, orientation, date boring began, date boring completed, and drillers' name(s).

11.2.2 Elevation coordinates of the top of the borehole.

11.2.3 Elevation of, or depth to, ground water surface, and any changes in water level, including the dates and times measured.

11.2.4 Elevations or depths at which the drilling fluid returns were lost and amount of return with depth. Report advance or down feed and hold-back pressures, rotation rates of drill rods, fluid/gas pressure, and circulations return during drilling. Report the penetration rate and drill cuttings as they relate to the geologic strata being penetrated. Document any significant abrupt changes and anomalies that occur during drilling.

11.2.5 Size, type, and design of core barrels used. Size, type, and set of core bits and reaming shells used. Size, type, and design and lengths of all casing used, and locations or elevations of casings used. Records of casing(s) lengths and depth intervals installed should be maintained and documented.

11.2.6 Length of each core run and the percentage of core recovery.

11.2.7 Driller's description of the core in each run, if no engineer or geologist was present.

11.2.8 Geologist's or engineer's description of the core recovered in each run. Subsurface description, including dip of strata, jointing, cavities, fissures, core loss, and any other observations made by the geologist, engineer, or the driller that could yield information about the formation encountered during drilling. Depth, thickness, and apparent nature of the filling of each soft seam or cavity encountered. Report the calculated RQD and D 6032.

11.2.9 Any change in the character of the drilling fluid or drilling fluid return.

11.2.10 Reservoir, tidal, or current information, if the drilling is near or over a body of water.

11.2.11 Drilling time in minutes per foot and down feed gage pressure, when applicable, and the RPM of the drill rods.

11.2.12 Notations of character of drilling, that is, soft, slow, easy, smooth, and others.

12. Precision and Bias

12.1 This practice does not produce numerical data; therefore, a precision and bias statement is not applicable.

12.2 The boring log reflects the subjective opinions of the engineer, the geologist, or the driller. Therefore, the designer must exercise proper prudence when interpreting the boring logs.

12.3 This procedure produces data on rock type and rock quality and recovery factors such as RQD (D 6032) that may reflect the biases of the persons collecting the data. Precision for determination of RQD will be addressed inD 6032.

13. Keywords

13.1 diamond drilling; exploration; rock; rock coring; rock investigations; site characterization

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(**1**) *Drilling Safety Guide*, National Drilling Association, 3008 Millwood Ave., Columbia, SC, 29205.

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(**3**) *Australian Drilling Manual*, Australian Drilling Industry Training Committee Limited, PO Box 1545, Macquarie Centre, NSW 2113, Australia, 3rd Ed., 1992.

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(**5**) *Drillers Handbook*, T.C. Ruda, and P.J. Bosscher, Eds, National Drilling Contractors Association, 3008 Millwood Avenue, Columbia, SC, June 1990.

(**6**) Shuter, E., and Teasdale, W., "Application of Drilling, Coring, and Sampling Techniques to Test Holes and Wells," Chapter F1, Book 2, Collection of Environmental Data, Techniques of Water-Resource Investigations of the United States Geological Survey, United States Government Printing Office, Washington, DC, 1989.

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(**9**) Teasdale, W.E., and Pemberton, R.R., "Wireline-Rotary Air Coring of the Bandelier Tuff, Los Alamos, New Mexico," Water Resources Investigations Report 84-4176, U.S. Geological Surey, Denver, CO, 1984.

(**10**) *DCDMA Technical Manual*, Diamond Drill Core Manufacturers Association, 3008 Millwood Avenue, Columbia, SC, 1991.

(**11**) "Guidelines for Drilling and Testing Core Samples at Concrete Gravity Dams," GS-6365, Research Project 2917-5, Final Report, Report by Stone and Webster Inc. for Electric Power Research Institute, Palo Alto, CA, May 1989.

(**12**) Specifications for Drill Pipe and Drill String, Number 5D-92 and 7G-90, American Petroleum Institute.

(**13**) Core Recovery Techniques for Soft or Poorly Consolidated Materials, prepared for U.S. Bureau of Mines by Woodward Clyde Consultants, Contract J0275003, pp. 136. APL, 1978.

(**14**) API RP 13B "Recommended Practice Standard Procedure for Testing Drilling Fluids," American Petroleum Institute, 2101 L. St., N.W., Washington, DC.

SUMMARY OF CHANGES

This section identifies the principal changes to thispractice that have been incorporated since the last issue. There have been significant changes to the standard. The previous standard was develped in the 1970's. Since that time wireline systmens have gained preference in industry.

(*1*) Expanded Section 1 to add reference to other drilling standards and safety standards.

(*2*) Added logging and transport an storage standards to Section 2.

(*3*) Added a Terminology section and defined drilling-related terms.

(*4*) Added Section 4, Summary of Practice, to describe drilling, coring, and sampling processes.

(*5*) Expanded Apparatus section to discuss the advantages and disadvantages of selecting specific designs. Added sections on fluid and air drilling. Changed and expanded section on wireline drilling methods.

(*6*) Added section on materials and presented major drill fluid materials and additives.

(*7*) Removed section on transportation and storage of rock core and referred to Practice D 5079.

(*8*) Added new Section 8, Precautions, to warn against fracturing and drill hole disturbance.

(*9*) Added section on Calculations and added recovery and RQD. Referred to RQD as a separate D 6032.

(*10*) Changed section Boring Log to Report and referred to Guide D 5434.

INTERNATIONAL

Designation: D 6032 – ~~96~~02

Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core[1]

This standard is issued under the fixed designation D 6032; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method covers the determination of the rock quality designation (RQD) as a standard parameter in drill core logging.

1.2 ~~Th~~All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026.

1.2.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.3 The values stated in SI units are to be regarded as the standard. The values stated in inch-pound units are approximate.

1.~~3~~4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water and Vadose Zone Investigations.

Current edition approved ~~Oct.~~ Nov. 10, ~~1996.~~ 2002. Published ~~M~~ January 2003. Originally approved in 199~~7~~6. Last previous edition approved in 1996 as D 6032–96.

***A Summary of Changes section appears at the end of this standard.**

D ~~2113 Practice for Diamond Core Drilling for Site Investigation~~ 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]
D ~~5079 Practices~~ 2113 Practice for Diamond Core Drilling for Site Investigation[2]
D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[2]
D 5079 Practices for Preserving and Transporting Rock Core Samples[2]
D 6026 Practice for Using Significant Digits in Geotechnical Data[3]
E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[4]

3. Terminology

3.1 For terminology used in this test method, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *core run*—in the most basic usage, the length of the interval measured from the depth each core sample was started to the depth at which drilling stopped and the sample was recovered from the core barrel. If required, the core run can also be defined to cover a specific length or lithology in the core samples.

3.2.2 *drill break*—any mechanical or man-made break in the core that is not natural occurring.

3.2.3 *intact core*—any segment of core between two open, natural discontinuities.

3.2.4 *rock quality designation (RQD)*—a modified core recovery percentage in which all pieces of sound core over 100 mm are counted as recovery.

3.2.5 *sound core*—any core which is fresh to moderately weather and which has sufficient strength to resist hand breakage.

4. Summary of Test Method

~~3~~4.1 The RQD denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run, as shown in Fig. 1. ~~Engineering~~ Rock mechanics judgement may be necessary to determine if a piece of core qualifies as being ~~intact.~~

~~4. Significance~~ intact and ~~Use~~

~~4.1 The RQD was first introduced in the mid 1960's to provide a simple and inexpensive general indication of rock mass quality to predict tunneling conditions and support requirements. The recording of RQD has since become virtually standard practice in drill core logging for a wide variety of geotechnical investigations.~~

~~4.2 The RQD values provide a basis for making preliminary design decisions involving estimation of required depths of excavation for foundations of structures. The RQD values also can serve to identify potential problems related to bearing capacity, settlement, erosion, or sliding in rock foundations. The RQD can provide an indication of rock quality in quarries for concrete aggregate, rockfill, or large riprap.~~

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[2] *Annual Book of ASTM Standards*, Vol 04.08.
[3] *Annual Book of ASTM Standards*, Vol 04.09.
[4] *Annual Book of ASTM Standards*, Vol 14.02.

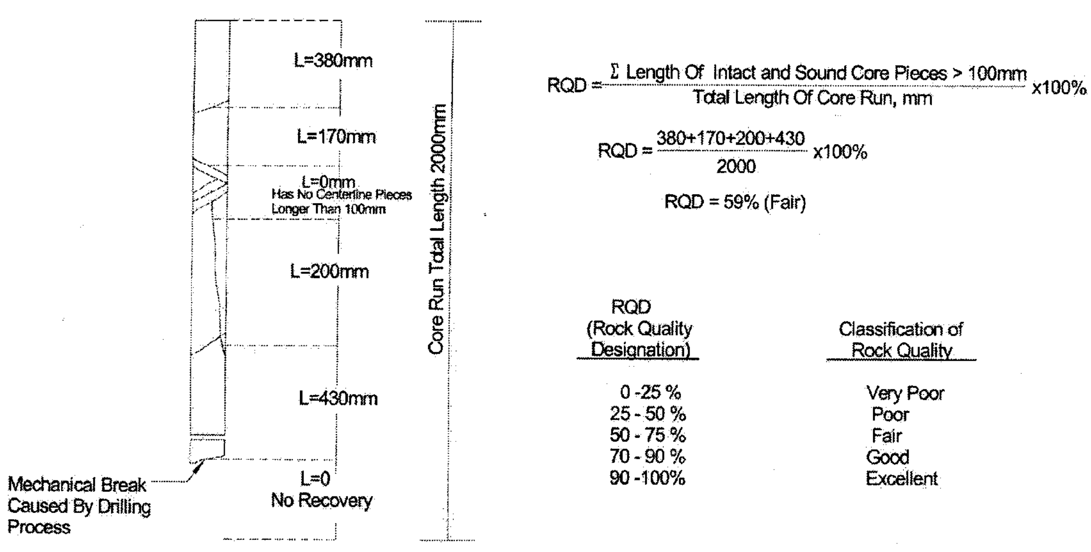

FIG. 1 RQD Logging Center Line Method[5]

~~4.3 The RQD has been widely used as a warning indicator of low-quality rock zones that may need greater scrutiny or require additional borings or other investigational work.~~

~~4.4 The RQD is a basic component of many rock mass classification systems for engineering purposes.~~

~~4.5 Used alone, The RQD is not sufficient to provide an adequate description of rock mass quality. The RQD does not account for joint orientation, tightness, continuity, and gouge material. The RQD must be used in combination with other geological and geotechnical input.~~

~~4.6 The RQD is sensitive to the orientation of joint sets with respect to the orientation of the core. That is, a joint set parallel to the core axis will not intersect the core, unless the drill hole happens to run along the joint. A joint set perpendicular to the core axis will intersect the core axis at intervals equal to the joint spacing. For intermediate orientations, the spacing of joint intersections with the core will be a cosine function of angle between joints and the core axis.~~

~~4.7 Core sizes from BQ to PQ with core diameters of 36.5 mm (1.44 in.) and 85 mm (3.35 in.), respectively, are normally acceptable for measuring RQD as long as proper drilling techniques are used that do not cause excess core breakage or poor recovery, or both. The NX-size (54.7 mm [2.16 in.]) and NQ-size (47.5 mm [1.87 in.]) are the optimal core sizes for measuring RQD. The RQD is also useful for large core diameters provided the core diameter is clearly stated. The RQD calculated for core smaller than BQ may not be representative of the true quality of the rock mass.~~ sound.

5. Significance and Use

5.1 The RQD was first introduced in the mid 1960's to provide a simple and inexpensive general indication of rock mass quality to predict tunneling conditions and support requirements. The recording of RQD has since become virtually standard practice in drill core logging for a wide variety of geotechnical investigations.

5.2 The RQD values provide a basis for making preliminary design decisions involving estimation of required depths of excavation for foundations of structures. The RQD values also can serve to identify potential problems related to bearing capacity, settlement, erosion, or sliding in rock foundations. The RQD can provide an indication of rock quality in quarries for concrete aggregate, rockfill, or large riprap.

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NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Procedure

~~5~~6.1 Drilling of the rock core should be done in accordance with Practice D 2113. It is important that proper drilling techniques and equipment are used to minimize core breakage or poor core recovery, or both.

~~5~~6.2 There are several ways to define a core run for calculating RQD. Three of these are: (*1*) a core run is equal to a drill run; (*2*) a change in formation or rock type could constitute an end of a core run; and (*3*) a core run can be a selected zone of concern. In determining a core run it is important to be consistent throughout a drill hole and to document how the core run was defined.

~~5~~6.3 Retrieval, preservation, transportation, storage, and cataloging of the rock core should be done in accordance with Practices D 5079. The RQD should be logged on site when the core is retrieved because some rocks can disintegrate, due to poor curatorial handling, slaking, desiccation, stress relief, or swelling, with time. For these rocks it is recommended that the RQD be measured again after 24 h to assist in determining durability.

~~5~~6.4 Close visual examination of core pieces is required for assessing the type of fracture (that is, natural or drill break). Pieces of core that are moderately or intensely weathered, contain numerous pores, or are friable, or combination thereof, should not be included in the summation of pieces greater than 100 mm (4 in.) for the determination of the RQD. Any rejected piece of core is still included as part of the total length of core run and should be noted in the report.

~~5~~6.5 Measure all core piece lengths that are intact and greater than 100 mm (4 in.) to the nearest 1 mm (0.04 in.) and record on a RQD data sheet (Fig. 2). Measure such pieces along the centerline of the core as illustrated in Fig. 1[5]

NOTE ~~1~~2—Centerline measurements ensure that the RQD value resulting from the measurements is not dependent on the core diameter. Centerline measurements also avoid unduly penalizing resulting RQD values for cases where fractures parallel the core axis ~~(~~. Any other method used for accounting for fractures parallel to the core axis, while not advoca~~te~~d by thi~~e~~s test method and in the l~~i~~iter~~a~~ature, mus~~)~~t be clearly stated.[6,7]

~~5~~6.6 Only those pieces of rock formed by natural fractures (that is, joints, shear zones, bedding planes, or cleavage planes that result in surfaces of separation) shall be considered for RQD purposes. The core pieces on either side of core breaks caused by the drilling process shall be fitted together and counted as one piece. Drilling breaks are usually evident by rough fresh surfaces. In some cases it may be difficult to differentiate between natural fractures and drilling breaks. When in doubt, count a fracture as a natural fracture. If for some reason there is not 100 % core recovery for a drill run, the length of core left in the borehole should be taken into account by adding it to the run in which it was cored rather than the run in which it was retrieved.

~~5~~6.7 Record the top and bottom depths of each core run.

~~5~~6.8 Sketch core features such as natural fractures, drilling breaks, lost core, highly weathered pieces, and so forth (see Fig. 1).

~~5~~6.9 Include remarks concerning judgement decisions such as whether a break in a core is a natural fracture or a drilling break or why a piece of core longer than 100 mm (4 in.) was not considered to be intact.

~~5~~6.10 Record the sum of intact core pieces longer than 100 mm (4 in.) long, and calculate the RQD value for the core run being evaluated.

~~5~~6.11 Indicate the rock quality description for the core run using the rock quality table in Fig. 1.

~~6~~7. Calculation

~~6~~7.1 Calculate as a percentage, the RQD of a core run as follows:

$$\cancel{RQD = \frac{[\Sigma \text{length of intact core pieces} > 100 \text{ mm (4 in.)}] \times 100\,\%}{\text{total core run length}}} \quad (1)$$

$$RQD = \frac{[\Sigma \text{length of intact and sound pieces} > 100 \text{ mm (4 in.)}] \times 100\,\%}{\text{total core run length, mm}} \quad (1)$$

In accordance with Practice D 6026, record the result to the nearest one percent.

8. Report

8.1 A typical report may include the following:

8.1.1 Source of sample including project name, location, and, if known, storage environment. The location may be specified in terms of borehole number and depth of core runs from the collar of the hole.

8.1.2 Description of drilling equipment, method, personnel, and hole orientation.

8.1.3 Physical description of core runs including diameter, rock type and location and orientation of discontinuities, such as, apparent weakness planes, bedding planes, schistosity, and large inclusions or inhomogeneities, if any.

8.1.4 Date of RQD calculations and sketches and/or photographs of core runs.

8.1.5 General indication of any conditions, observations, and assumptions relevant to the RQD values or calculations.

8.1.6 Include a table of RQD values and/or copies of any RQD data forms or sketches.

8.1.7 Report the rock quality classification for the core run using the table in Fig. 1.

9. Precision and Bias

~~7~~9.1 *Precision*—A round-robin study of the RQD index of cores of four selected types of sedimentary rock (anhydrite/calcite, calcareous shale, limestone, and anhydrite) with four replications per rock type was conducted in accordance with Practice E 691 by eight experienced participants.[8] The repeatability and reproducibility statistics reported in Table 1 refer to within-participant and between-participant precision, respectively. The probability is approximately 95 % that two results obtained by the same participant on the same material will not differ by more than the repeatability limit r. Likewise, the probability is approximately 95 % that two results obtained by different participants on the same material will not differ by more than the reproducibility limit R. The precision statistics are calculated from the following equation:

$$r = 2(\sqrt{2})s_r \quad (2)$$

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[5] Deere, D. U., and Deere, D. W., "The Rock Quality Designation (RQD) ~~Index in Practice,"~~ After Twenty Years," *Rock Classification Systems for Engineering Purposes, ASTM STP 984*, 1988, pp. 91–101.

~~[6] Pincus, H. J.,~~

[6] Deere, D. U., and ~~Clift, S. J., *Interlaboratory Testing Program for*~~ Deere, D. W., " *Rock ~~Properties: Repeatability and Reproducibility of RQD Values for Selected Sedimentary Rocks~~ Quality Designation (RQD) Index in Practice," Contract Report G1–89–1* , ~~*PCN: 33-000011-38, ASTM Institute*~~ Department of ~~Standards Research, 1994.~~ *the Army Corps of Engineers, 1989.*

[7] Bieniawski, Z.T., "Exploration for Rock Engineering" *Proceeding of the Symposium on Exploration for Rock Engineering,* November 1976, Johannesburg, A.A., Balkema, Rotterdam.

[8] Pincus, H. J., and Clift, S. J., *Interlaboratory Testing Program for Rock Properties: Repeatability and Reproducibility of RQD Values for Selected Sedimentary Rocks,* PCN: 33-000011-38, ASTM Institute of Standards Research, 1994.

<table>
<tr><td colspan="4">RQD DATA SHEET</td></tr>
<tr><td colspan="3">Project:</td><td>Date:</td></tr>
<tr><td colspan="2">Core Box I.D. no.:</td><td colspan="2">Recorder(s):</td></tr>
<tr><td colspan="2">Total Length of Core Run, mm (in):</td><td colspan="2">Checker(s):</td></tr>
<tr><td colspan="2">Core Diameter, mm (in):</td><td colspan="2">Date Checked:</td></tr>
<tr><td>Depth, m (ft)</td><td>Sketch or Photographic Image of Core</td><td>Length of Each Sound Piece of Core > 100 mm (4-inch)</td><td>Remarks</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">• Lengths of Sound Pieces of Core > 100 mm (4-in):</td></tr>
<tr><td colspan="4">• Lengths of Sound Pieces of Core > 100 mm (4-in) * 100%
RQD (%) = ---
Total Length of Core Run, mm (in)</td></tr>
<tr><td colspan="2">RQD (%) =</td><td colspan="2">Rock Classification:</td></tr>
<tr><td colspan="4">Page ____ of ____</td></tr>
</table>

FIG. 2 RQD Data Sheet

TABLE 1 RQD Index of Cores of Sedimentary Rock

Material (Rock Type)	Mean RQD, $\bar{x}$, %	Repeatability, r, % [A]	Reproducibility, R, % [A]
Anhydrite/calcite	86	28	28
Calcareous shale	60	32	40
Limestone	92	14	14
Anhydrite	86	20	20

[A] The numbers in the r and R columns are not to be taken as percentages of the means, but are applied as plus or minus terms to the respective means.

where s_r = repeatability standard deviation, and

$$R = 2(\sqrt{2})s_R \quad (3)$$

where s_R = reproducibility standard deviation.

NOTE ~~2~~3—Some combinations of the means and r and K can result in KQD limits that exceed 100 % because the RQD values have been assumed to be normally distributed which may not reflect the actual underlying distribution of the RQD values.

~~7~~9.2 *Bias*—There is no accepted reference value for this test method; therefore, bias cannot be determined.

~~8~~10. Keywords

~~8~~10.1 classification; index; logging; quality; rock; rock core

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (1996) that may impact the use of this standard.

(1) Added to Section 1 required statement about significant figures and Practice D 6026.
(2) Added Terminology D 653, Practices D 3740, and D 6026
(3) Added Terminology Section , and renumbered subsequent sections.
(4) Added Note 1 in Significance and Use Section, referencing Practice D 3740, and renumbered subsequent notes.
(5) In Section 4.1 defined method as applicable to drill holes in any orientation and added the word “sound” between “intact rock”. Changed “Engineering judgement” to Rock mechanics judgement” so that both the engineering and geological considerations were included.
(6) In Calculation Section, added the sentence: “In accordance with Practice D 6026, record the result to the nearest one percent.
(7) In Calculation Section, Note 2, corrected typographical error in a symbol and the abbreviation for RQD. Took out confusing discussion of vertical fractures since it pertains to any fracture that parallels the core axis and added references used to support this section.
(8) In Section 6.1 added words “and equipment” with “proper drilling techniques.”
(9) In Section 6.3 added the influence of curatorial handling.
(10) Added Report Section and renumbered accordingly.
(11) Figure 1 — Added “Centerline Method” to title, added “intact and sound” to the formula and changed “Description of Rock Quality” to “Rock Quality Classification.”
(12) Figure 2 — Fixed heading to include more relevant background data, added the words “intact and sound” to the formula, changed meters to millimeters, and added place to put the rock quality classification.

Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling[1]

This standard is issued under the fixed designation D 6151; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers how to obtain soil samples using hollow-stem sampling systems and use of hollow-stem auger drilling methods for geotechnical exploration. This practice addresses how to obtain soil samples suitable for engineering properties testing.

1.2 In most geotechnical explorations, hollow-stem auger drilling is combined with other sampling methods. Split barrel penetration tests (Test Method D 1586) are often performed to provide estimates of engineering properties of soils. Thin-wall tube (Practice D 1587) and ring-lined barrel samples (Practice D 3550) are also frequently taken. This practice discusses hole preparation for these sampling events. For information on the sampling process, consult the related standards. Other in situ tests, such as the vane shear Test Method D 2573, can be performed below the base of the boring by access through the drill string.

1.3 This practice does not include considerations for geoenvironmental site characterizations and installation of monitoring wells which are addressed in Guide D 5784.

1.4 This practice may not reflect all aspects of operations. It offers guidance on current practice but does not recommend a specific course of action. It should not be used as the sole criterion or basis of comparison, and does not replace or relieve professional judgment.

1.5 *Hollow-stem auger drilling for geotechnical exploration often involves safety planning, administration, and documentation. This standard does not purport to specifically address exploration and site safety. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to its use.* Performance of the test usually involves use of a drill rig, therefore, safety requirements as outlined in applicable safety standards, for example OSHA (Occupational Health and Safety Administration) regulations, DCDMA safety manual (**1**),[2] drilling safety manuals, and other applicable state and local regulations must be observed.

2. Referenced Documents

2.1 *ASTM Standards:*
- D 420 Guide to Site Characterization for Engineering, Design, and Construction Purposes[3]
- D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]
- D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[3]
- D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock[3]

2.2 *Standards for Sampling of Soil and Rock:*
- D 1452 Practice for Soil Investigation and Sampling by Auger Borings[3]
- D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[3]
- D 1587 Practice for Thin-Walled Tube Geotechnical Sampling of Soils[3]
- D 2113 Practice for Diamond Core Drilling for Site Investigation[3]
- D 3550 Practice for Ring-Lined Barrel Sampling of Soils[3]
- D 4220 Practice for Preserving and Transporting Soil Samples[3]
- D 4700 Guide for Soil Sampling from the Vadose Zone[3]
- D 5079 Practices for Preserving and Transporting Rock Core Samples[3]

2.3 *In situ Testing:*
- D 2573 Test Method for Field Vane Shear Test in Cohesive Soils[3]
- D 3441 Test Method for Deep, Quasi Static, Cone and Friction-Cone Penetration Tests of Soil[3]
- D 4719 Test Method for Pressuremeter Testing in Soils[3]

2.4 *Instrument Installation and Monitoring:*
- D 4428 Test Methods for Crosshole Seismic Testing[3]
- D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[3]
- D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers[3]

2.5 *Drilling Methods:*
- D 5784 Guide for the Use of Hollow-Stem Augers for

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved August 10, 1997, Published December 1997.

[2] The boldface numbers in parentheses refer to the references at the end of this practice.

[3] *Annual Book of ASTM Standards,* Vol 04.08.

Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices[4]

D 5876 Guide for the Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices[4]

3. Terminology

3.1 *Definitions:* Terminology used within this practice is in accordance with Terminology D 653 with the addition of the following (see Figs. 1-5 for typical system components):

3.1.1 *auger cutter head*—the terminal section of the lead auger equipped with a hollow cutting head for cutting soil. The cutter head is connected to the lead auger. The cutter head is equipped with abrasion-resistant cutting devices, normally with carbide surfaces. The cutter can be teeth (usually square or conical), or blades (rectangular or spade design). Cutter head designs may utilize one style cutter or a combination of cutters.

3.1.2 *bit clearance ratio*—a ratio, expressed as a percentage of the difference between the inside diameter of the sampling tube and the inside diameter of the cutting bit divided by the inside diameter of the sampling tube.

3.1.3 *blow-in*—(Practice D 5092)—the inflow of groundwater and unconsolidated material into the borehole or casing caused by differential hydraulic heads; that is, caused by the presence of a greater hydraulic head outside the borehole/casing than inside. Also known as *sanding in* or *soil heave*.

3.1.4 *clean out depth*—the depth to which the end of the drill string (bit or core barrel cutting end) has reached after an interval of drilling. The clean out depth (or drilled depth as it is referred to after cleaning out of any sloughed material or cuttings in the bottom of the drill hole) is normally recorded to the nearest 0.1 ft. (0.03 m).

3.1.5 *continuous sampling devices*—sampling systems which continuously sample as the drilling progresses. Hollow-stem sampling systems are often referred to as continuous samplers because they can be operated in that mode. Hollow-stem sampling systems are double-tube augers where barrel-type samplers fit within the lead auger of the hollow auger column. The double-tube auger operates as a soil coring system

[4] *Annual Book of ASTM Standards*, Vol 04.09.

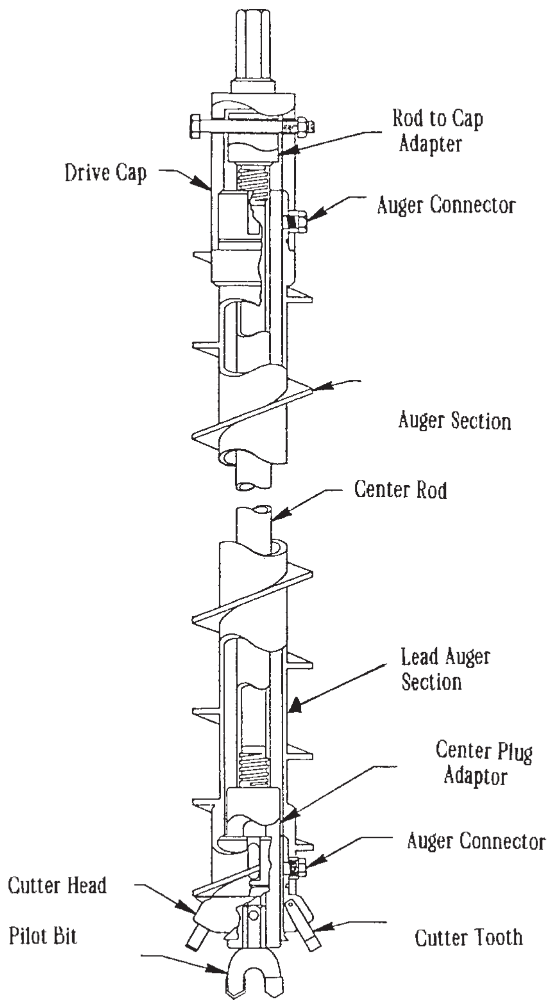

FIG. 1 Rod-Type Auger System With Pilot Bit[6]

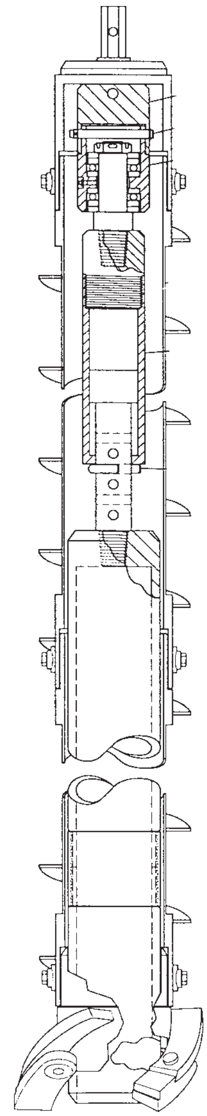

FIG. 2 Example of Rod-Type Sampling System[5]

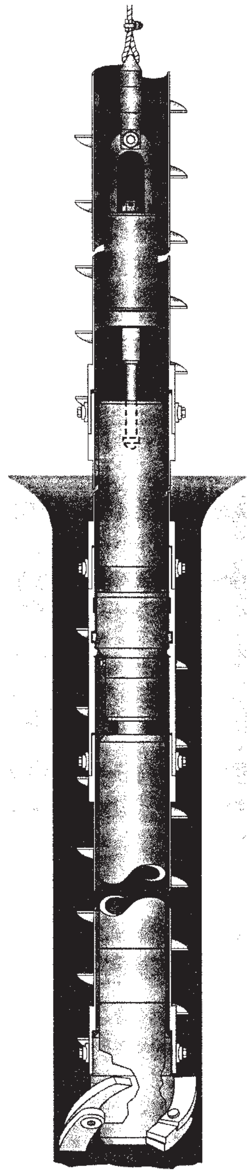

FIG. 3 Example of Wireline Sampling System[5]

in certain subsurface conditions where the sampler barrel fills with material as the augers advance. The barrel can be removed and replaced during pauses in drilling for continuous coring.

3.1.6 *double-tube auger*—an auger equipped with an inner barrel for soil sampling (soil coring). If equipped with an inner barrel and liner, the auger system can be described as a triple-tube auger.

3.1.7 *drill hole*—a cylindrical hole advanced into the subsurface by mechanical means. Also known as borehole or boring.

3.1.8 *drill string*—the complete drilling assembly under rotation including augers, core barrel or pilot bit, drill rods, and connector subassemblies. Drilling depth is determined by knowledge of the total length of the drill string, and by subtracting the string length above a ground surface datum.

3.1.9 *fluid injection devices*—pumps, fittings, hose and pipe components, or drill rig attachments that may be used to inject a fluid within a hollow auger column during drilling.

3.1.10 *HSA*—Hollow stem auger(s). See 3.1.11.

3.1.11 *hollow stem auger*—a cylindrical hollow tube with a continuous helical fluting/fighting on the outside, which acts as a screw conveyor to lift cuttings produced by an auger drill head or cutter head bit to the surface.

3.1.12 *in-hole-hammer*—a drop hammer for driving a soil sampling device. The in-hole hammer is designed to run down-hole within the HSA column. It is usually operated with

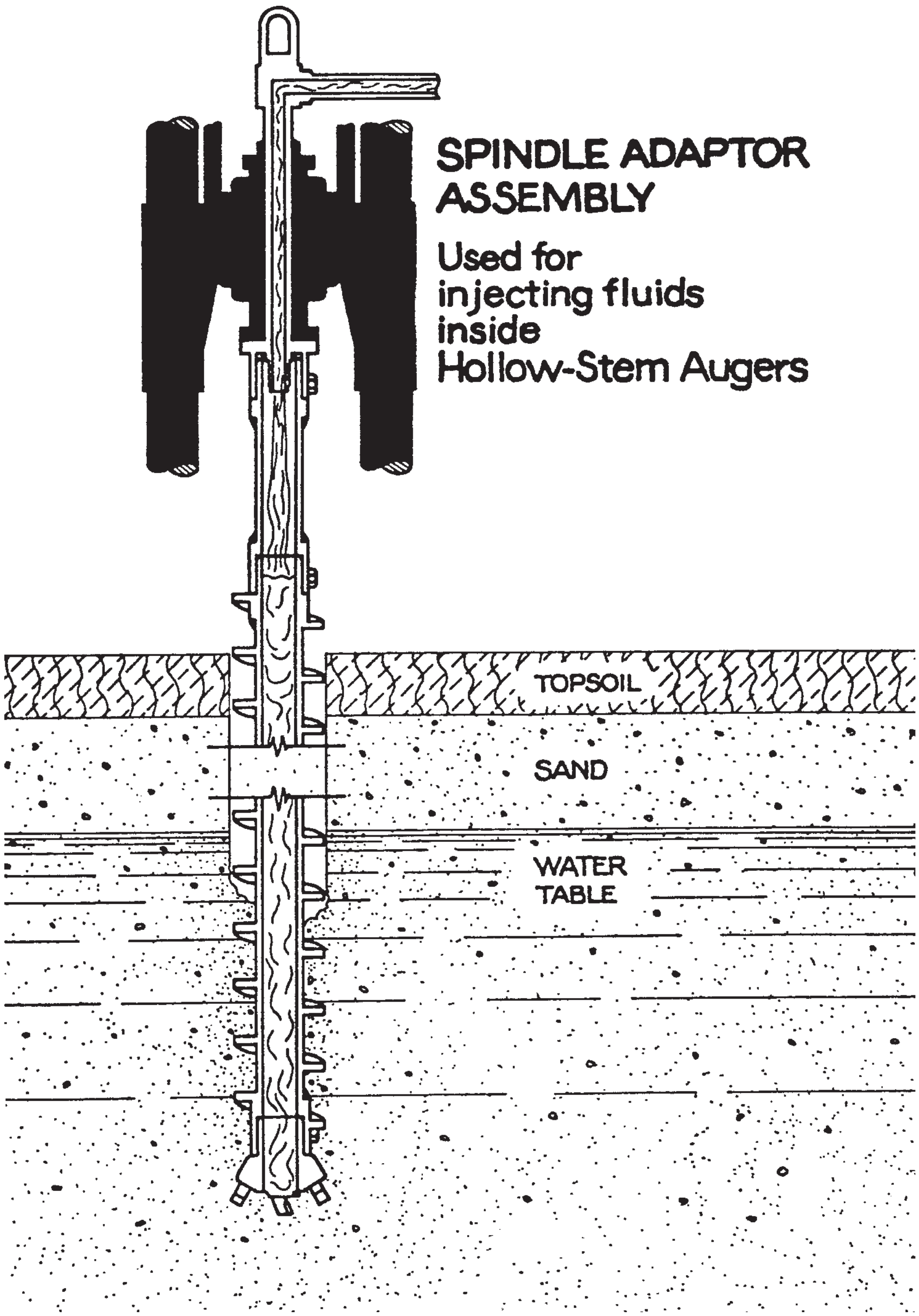

FIG. 4 Spindle Adaptor Assembly

a free-fall wireline hoist capable of lifting and dropping the hammer weight to drive the sampler below the HSA column and retrieve the hammer and sampler to the surface. See Fig. 6[5]

3.1.13 *in situ testing devices*—sensors or probes, used for obtaining test data for estimation of engineering properties, that are typically pushed, rotated, or driven in advance of the hollow auger column assembly at a designated depth or advanced simultaneously with advancement of the auger column (see 2.3).

3.1.14 *intermittent sampling devices*—barrel-type samplers that may be rotated, driven, or pushed below the auger head at a designated depth prior to advancement of the auger column (see 2.2).

3.1.15 *lead auger assembly*—the first hollow stem auger to be advanced into the subsurface. The end of the lead auger assembly is equipped with a cutter head for cutting. The lead auger may also contain a pilot bit assembly or sample barrel assembly housed within the hollow portion of the auger. If a wireline system is used, the lead auger assembly will have an adapter housing on top of the first auger containing a latching

[5] Foremost Mobile, Mobile Drilling Company Inc., 3807 Madison Avenue, Indianapolis, IN.

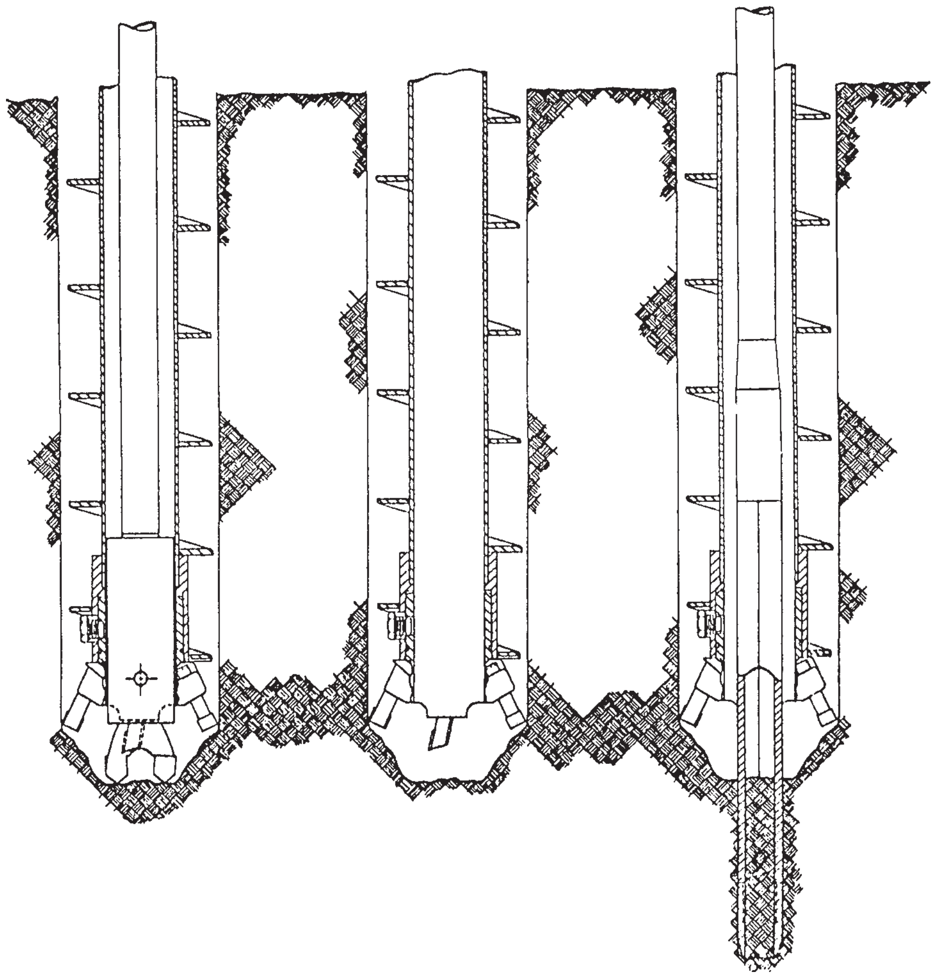

FIG. 5 Example of Drive Case Sampling Through HSA

device for locking the pilot bit assembly or sampling core barrel into the lead auger assembly.

3.1.16 *lead distance*—the mechanically adjusted length or distance that the inner core barrel cutting shoe is set to extend beyond the lead auger assembly cutting head.

3.1.17 *overshot*—a latching mechanism located at the end of the hoisting line (wireline). It is specially designed to latch onto or release the pilot bit or core barrel assemblies. It serves as a lifting device for removing the pilot bit or sampler assembly.

3.1.18 *O-ring*—a rubber ring for preventing leakage between joining metal connections, such as hollow-stem auger sections.

3.1.19 *percent recovery*—percentage which indicates the success of sample retrieval, calculated by dividing the length of sample recovered by the length of sampler advancement.

3.1.20 *pilot bit assembly*—an assembly designed to attach to a drill rod or lock into the lead auger assembly for drilling without sampling. The pilot bit can have various configurations (drag bit, roller cone, tooth bit, or combination of designs) to aid in more efficient or rapid hole advancement.

3.1.21 *recovery length*—the length of sample actually retrieved during the sampling operation.

3.1.22 *sanding in*—a condition that occurs when sand or silt enters the auger after removal of the pilot bit or sampling barrel. See *blow-in*. Sanding in can occur from hydrostatic imbalance or by suction forces caused by removal of the pilot bit or sampling barrel.

3.1.23 *slough*—the disturbed material left in the bottom of the borehole, usually from falling off the side of the borehole, or falling out of the sampler, or off of the auger.

3.1.24 *soil coring, hollow-stem*—The drilling process of using a double-tube HSA system to intermittently or continuously sample the subsurface material (soil).

3.1.25 *wireline drilling, hollow-stem*—a rotary drilling process using a lead auger which holds a pilot bit or sampling barrel delivered and removed by wireline hoisting. Latching assemblies are used to lock or unlock the pilot bit or sampler barrel. The pilot bit or core barrel is raised or lowered on a wireline cable with an overshot latching device.

4. Significance and Use

4.1 Hollow-stem augers are frequently used for geotechnical exploration. Often, hollow-stem augers are used with other sampling systems, such as split barrel penetration resistance testing, Test Method D 1586, or thin-wall tube sampling, Practice D 1587 (see 2.5). Hollow-stem augers may be used to advance a drill hole without sampling using a pilot bit assembly, or they may be equipped with a sampling system for obtaining soil cores. In some subsurface conditions that contain

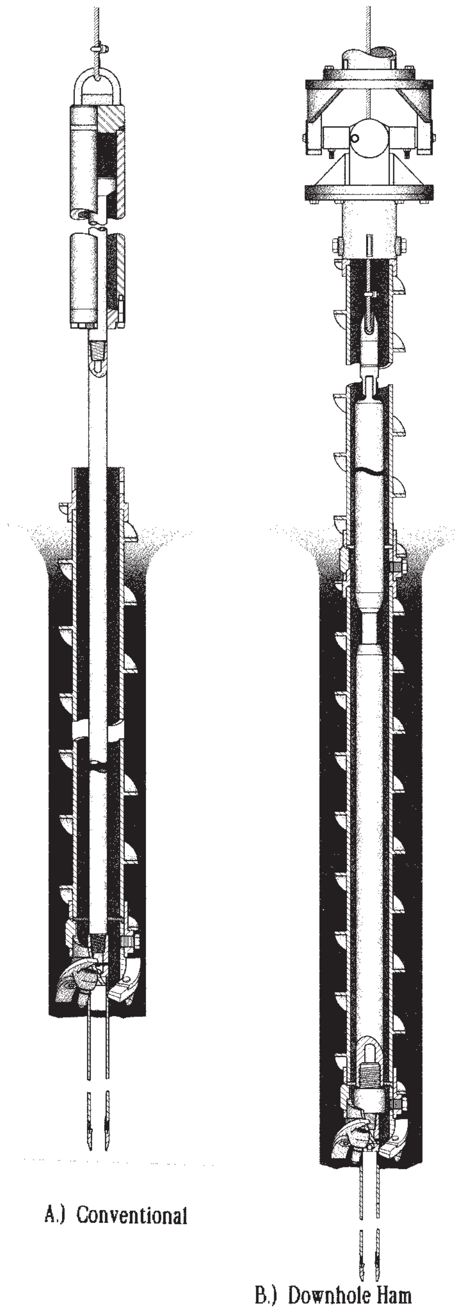

FIG. 6 In-Hole-Hammer and Conventional Drive Hammer[5]

cohesive soils, the drillhole can be successfully advanced without the use of a pilot bit assembly. Intermittent drilling (advancing of the HSA column with or without a pilot bit) and sampling can be performed depending on the intervals to be sampled, or continuous sampling can be performed. During pauses in the drilling and sampling process, in situ testing or other soil sampling methods can be performed through the hollow auger column below the lead auger assembly. At completion of the boring to the depth of interest, the hole may be abandoned or testing or monitoring devices can be installed. Hollow-stem auger drilling allows for drilling and casing the hole simultaneously, thereby eliminating hole caving problems and contamination of soil samples (**2**). The hollow-stem auger drilling and sampling method can be a satisfactory means for collecting samples of shallow unconsolidated subsurface materials (**2**). Additional guidance on use can be found in Refs. **2, 3, 4, 5, 6**.

4.2 Soil sampling with a double-tube hollow-stem sampling system provides a method for obtaining continuous or intermittent samples of soils for accurate logging of subsurface materials to support geotechnical testing and exploration. A wide variety of soils from clays to sands can be sampled. The sampling systems can be particularly effective in dry soft to stiff clayey or silty deposits but also can work well under saturated conditions. Saturated cohesionless soils such as clean sands may flow and cave during drilling (see Note 1). In many cases, the HSA soil core sampling system can produce very little disturbance to the sample and can provide samples for laboratory tests for measurement of selected engineering properties. Large-diameter soil cores, if taken carefully, can provide Class C and D samples as described in Practice D 4220. The HSA systems can also provide disturbed samples of unsaturated sands and gravels with some structure preserved. Full 5-ft (1.5-m) long cores usually cannot be obtained in unsaturated sands due to increasing side wall friction between the dry sands and inside surface of the sample core barrel. Sample length of 2 to 2.5 ft. (0.60 to 0.75 m) is generally the limit of amount of sample that can be recovered in unsaturated sands before the friction between the sampler and the sand becomes too high and causes blocking or plugging of the sampler. Shorter large diameter core runs of 2.5 ft with the 5-ft sample barrel system, or with a 2.5-ft sample barrel system, have generally proven to result in the best samples.

NOTE 1—Research on thin-wall piston sampling in clean sands indicates that in general it is impossible to obtain truly undisturbed samples of saturated clean sands. These soils can dilate or collapse upon insertion of a sampling tube. The hollow-stem auger double-tube system can only obtain partitially disturbed samples of sands below the water table.

4.3 Hollow-stem auger drilling is considered a shallow drilling method with maximum depth of drilling of 200 to 300 ft (60 to 90 m) depending on torque and pull down/retract capacity of the drilling equipment and subsurface conditions of the formation(s) encountered. Saturated loose unconsolidated deposits further limit maximum depth that can be attained. Hollow-stem augers can act as casings set through unconsolidated surficial soils and drilling can be converted to other methods (see 2.5) for deeper drilling.

4.4 Drilling and soil sampling can be accomplished with a variety of hollow-stem auger systems. Types of systems can be chosen depending on the advantages of handling, sampling requirements, and subsurface conditions. There are two basic types of systems. One type of system uses inner drill rods or hex rods connecting the sampler or pilot bit assembly to the surface for advancing and retrieving the sampler barrel or pilot bit assembly (Fig. 1[6] and Fig. 2[5]). Another system uses a wireline latching system in the HSA column to lower, latch, and retrieve a core barrel or pilot bit assembly (Fig. 3[5]).

4.5 Double tube hollow-stem auger sampling systems can be particularly advantageous for sampling water-sensitive soils, such as collapsible soils, since fluid is not used in the drilling process. Since no pressurized circulation medium is used during the drilling process, the possibility for hydraulic fracturing of formation materials and core contamination from drill fluids is reduced.

4.6 Difficulties in drilling may occur if cohesionless soils are drilled below the water table. Possibilities for sand lock or wedging of cuttings may occur (**2**). In cases where sands enter the HSA, water or drilling fluid may be added to the HSA column to provide hydrostatic balance or special pilot bit assemblies can be used (see 5.6). Problems may occur in getting the soil core barrel or pilot bit assembly back to the bottom of the HSA column. Highly saturated sands or liquefiable material may be drawn into the HSA by vacuum created when the sampler barrel or pilot bit assembly is initially pulled back through the cutter head of the lead auger assembly from the bottom of the borehole.

4.7 Consideration should be given to proper decontamination and cleaning of drilling equipment, hollow-stem augers, samplers, and soil coring components.

5. Apparatus

5.1 Fig. 1 illustrates the components of a hollow-stem auger used with a pilot bit for hole advancement using a center-inner rod system. Figs. 2 and 3 illustrate hollow-stem augers equipped for soil sampling in either a rod-type or wireline system. Hollow-stem auger systems consist of rotating outer hollow-stem augers and a cutter head assembly, with either a center pilot bit or a nonrotating inner sample barrel with a smooth cutting shoe.

5.2 *Hollow-stem Augers*—Each auger section of the hollow-stem auger assembly consists of a cylindrical steel tube with continuous helical steel flights rigidly attached to the outer surface of the tube (see Fig. 1). Each hollow auger section has a coupling at each end for attaching additional auger sections at the top end to make up the articulated hollow-stem auger column. The bottom of the lead auger has a coupling attachment for the cutter head. Typical hollow-stem auger inside diameters are 2¼ , 3¼ , 3⅜ , 4¼ , 4⅝ , 6¼ , 6⅝ , and range up to 12¼ in. (57, 83, 86, 108, 117, 159, 168, and 311 mm). Outside diameters of the auger flights range from 5 to 18 in. (127 to 457 mm). Typical HSA double-tube sample inside diameters range from 2.25 to 6.85 (57 to 174 mm). Hollow-stem augers are normally supplied in 5-ft (1.5-m) lengths. The helical auger flights are often hard surfaced for better wearing characteristics.

5.2.1 *Diameter Requirements*—The inside diameter of the hollow-stem auger system is selected by considering sample size requirements, intermittent sampling and in situ testing tool size, and completion requirements. For undisturbed sampling, larger-diameter systems generally produce less disturbance (**6**). For logging purposes, where a disturbed sample is sufficient, smaller diameters are selected. The inside diameter of the hollow stem must be large enough to insert intermittent sampling or in situ testing devices if used (sec 2.2 and 2.3). When using sampling methods such as split barrel, Method D 1586, or thin-wall tube Test Method D 1587, the inside diameter of the hollow-stem should be at least 0.25 in. (6 mm) larger than the sampler outside diameter or rod diameter, which ever is largest. If other drilling methods (see 2.5) are to be used, the inside diameter of the HSA drill string should be selected to accommodate those tools. If special completion is required, such as piezometer or well casing installation, the diameter should be large enough for placing completion materials. For example, if a 2–in. (50 mm) riser pipe is to be completed for shear wave velocity testing in accordance with Test Methods D 4428, consideration of clearance for tremie pipes may also increase diameter requirements. If the lead auger section contains a stabilizer ring, this clearance may govern available diameter for sampling, testing, or completion (see 5.4.1).

[6] Modified from Central Mine Equipment Company, 4215 Rider Trail North, Earth City, MO.

5.2.2 *Auger Connections*—Augers are connected using either locking bolts, drive pins, locking collars, or threaded connections. In some cases when drilling saturated soils, water entering the augers may cause difficulty with drilling or sampling. Hollow-stem augers may be used with O-ring seals or other sealing designs at the HSA connections to prevent leakage. Some HSA connection designs have compression seals and bolt caps to facilitate sealing between auger connections. This can prevent soil or water ingress through the auger connecting joints (in certain drilling conditions) and the accumulation of a high solids slurry in the bottom of the HSA column that may interfere with the latching system for retrieval and placement of sample barrel assembly by means of the wireline/overshot system

5.3 *Drive Cap*—The drive cap assembly (see Fig. 1) attaches to the uppermost hollow-stem auger section and transfers rotary power and axial force from the drill rig to the auger drill string assembly.

5.4 *Lead Auger Section*—The lead auger has a hollow cutter head. The cutter head is attached to the lead auger of the hollow auger column and usually contains replaceable, abrasion-resistant cutters or teeth (see Fig. 1). As the hollow auger head is rotated, it cuts and directs the cuttings to the auger flights which convey the cuttings to the surface. The cutters can be made of hardened steel or carbide and in several designs. Cutter head types should be selected to effectively remove cuttings and minimize soil disturbance when sampling. The cutter head or cutter teeth, or both, should be replaced if worn or damaged.

5.4.1 If a wireline system is used, there can be an adapter coupling on top of the lead auger and may contain inside barrel grooves or recesses for latching systems for wireline tooling.

5.4.2 A stabilizer ring may be used (usually made of brass) in the end of the HSA cutter head opening. The stabilizer ring is machined to a close tolerance to be slightly larger than the outside diameter of the sample barrel or pilot bit. The actual opening of the end of the HSA column at the cutter head is smaller with this stabilizer ring than the normal designated inside diameter of the HSA being used. The stabilizer ring keeps the sample barrel centered in the middle of the HSA cutter head and prevents material that may interfere with the sample barrel remaining stationary from lodging around the barrel and shoe and between the full opening of the HSA cutter head. In some cases, in unstable soils the vacuum created during removal of the pilot bit through a stabilizer ring may produce sanding in. In these cases, provisions for venting may be required.

5.5 *Sampler or bit retrieval system*:

5.5.1 *Rod-type System* (Fig. 1 and Fig. 2)—The sampler or pilot bit can be inserted into the lead auger using a system of inner rods. The inner rods are typically AW, or NW size (**7**) or hex rods. Rods are supplied in the same lengths as the hollow-stem augers.

5.5.2 *Wireline system, In-hole-hammer*—The sampler or pilot bit can be inserted into the lead auger by using a free-fall wireline cable hoist capable of lifting and dropping the hammer weight down the hole within the HSA column to drive the sampler below the HSA column. This wireline method can also be used in conjunction with a drilling rig with an open spindle rotary head to allow the wireline and in-hole-hammer with the proper bit to act as a pilot bit assembly while advancing the HSA column. The weight of the hammer and pilot bit is allowed to float within the HSA column and advance with the cutter head and lead auger section to deter material from entering the HSA column.

5.5.3 *Wireline System, Double-tube HSA* (Fig. 3)—The sampler or pilot bit is raised and lowered using a wireline and latching mechanism. A wireline system may consist of a latching lead auger section, a locking or latching head assembly above the sample barrel or pilot bit, and an overshot (retrieving tool) that locks into the locking head assembly to hoist and lower the sample barrel or pilot bit assembly through the HSA column.

5.6 *Pilot Bit Assembly*—The pilot bit assembly can be a machined plug with a bit attached to the bottom to enhance cutting when used with the cutter head of the HSA and to keep material from entering the hollow-stem auger. Another version is a center auger with left-handed flighting to provide a downward spiral rotation in the middle of the HSA drill string. This left hand flighting keeps material from entering the HSA drill string forcing the parent material down and to the outside of the main auger. While the HSA drill string is rotating and drilling, the material displaced by the left hand flighting is conveying up along the outer flighting away from the cutter head to the surface.

5.7 *Hollow-stem Double-tube Auger Sample Barrel Systems*—The sampler is suspended in the HSA column and is retained in a stationary position. The head may be made with connections to a latching assembly including a bearing assembly. A bearing assembly helps prevent rotation of the sampler barrel and is especially important for undisturbed sampling. In the wireline system the barrel is connected to a latching and hanger bearing assembly that locks into the HSA column (Fig. 3). In the rod-type system (Fig. 2) the bearing is located either down hole or at the top of the auger column and is connected to drill rods or hex rods extending to the top of the HSA column. The drill rod or hex rod string is connected through the auger drive adapter to the drill rig to provide a means of controlling rotation of the sampler.

5.7.1 The sample barrel may be of various sizes and lengths. The barrel may be used with or without liners. A split barrel without a liner is most often used for easy examination of disturbed soil cores while a barrel with a liner is most often used for preserving specimens for laboratory testing. The liners fit in the inside of the barrel to facilitate sample collection. The sample barrel and HSA are matched with respect to size. The actual sample diameter varies with different manufacturers. The sample diameter is controlled by the inside diameter of the cutting shoe. With some manufacturer's designs, the inside diameter of the cutting shoe varies depending upon the liners used in the sample barrel. To obtain samples with minimal disturbance, care must be taken to ensure a smooth transition from the insider diameter of the cutting shoe to the barrel or liners. There should be no gaps or upset surfaces in the inside clearance. A smaller inside diameter shoe can be used when coring swelling materials, such as stiff clays, to allow for the sample to swell inside the barrel without blocking. Core swelling may affect engineering properties determinations.

5.7.2 Sample barrels may be 5-ft (1.5-m) long, solid or split, 5-ft long one piece, or two 30-in. (0.75-m) barrels (solid or split), with a coupling to make a 5-ft barrel. The 5-ft barrel length matches the length of the lead HSA section. The shorter 2.5-ft (0.75-m) barrel may be used in place of the 5-ft barrel for shorter sampling runs to reduce disturbance and to facilitate handling.

5.7.3 *Retainers*—Basket retainers are used, if necessary, to prevent the sample from falling out of the barrel during retrieval. They are generally used when sampling some wet clays and wet or dry sands and gravels. The retainers may affect the sample quality.

5.7.4 *Cutting Shoe and Lead Distance*—The sample barrel with cutting shoe is extended beyond the cutter head in varying increments. The shoe is set at or beyond the bottom of the cutter bits, or teeth. The extent of the distance the shoe is set beyond the cutter head is dictated by the stiffness of the material to be sampled (cored). When the sampler cutting shoe is extended beyond the cutter head, the cutting edge of the shoe is being forced down in front of the cutter head before the HSA cutter head cuts the soil away. The HSA column and cutter head is rotating around the double-tube HSA soil coring barrel as the drill rig applies down force and rotation to the HSA soil coring column. The softer the material, the greater the lead distance. The harder the soil, the shorter the lead distance. Adjusting the lead distance for the sample barrel shoe may be done by various methods. Some systems require adjusting the lead distance directly above the sample barrel assembly, some can be adjusted at the top of the HSA column. Examples of adjusting methods include the following: rod subs, adjustable hex extension with U-pins, threaded adjustment with locking nut, special HSA drive adapter with adjusting slots, or different shoe lengths. The length of extension may vary from the shoe being flush (even) with the cutter bits to as much as 6 in. (150 mm) or more.

5.7.5 *Liners*—The sample barrel may be fitted with liners. Liners are nomially one 5-ft (1.5-m) length or two 2½-ft (0.75-m) sections. The liners can be metal, stainless steel, or acrylic. Acrylic tubing provides for visual inspection of the material sampled. Clear liners can sometimes show detailed soil layering, but, in many cases, the core could be smeared or masked by the disturbance. If the purpose of the exploration program is detailed, logging the complete core should be inspected. Liners should be checked for roundness and wall thickness. Acrylic tubing is reusable but should be checked for cracks before reuse.

5.8 Auxiliary components of a HSA system are various devices such as auger connector wrenches, auger forks, hoisting hooks, hoisting assemblies, pipe vices, strap wrenches or chain wrenches, and fluid injection swivels or adapters (Fig. 4).

5.9 A drill rig is used to rotate and advance the auger column. The drill rig must be capable of producing controlled rotation, feed pressure, and feed rate. The drill rig should be capable of applying sufficient power and torque at a rotary velocity of 50 to 100 r/min. The drill rig should have a feed stroke of at least the effective length of the auger sections plus the effective length of the auger couplings plus about 4 in. (100 mm). As the HSA soil coring systems diameters increase, more torque and pulldown/retract capacities of the drill rig will be required. The subsurface conditions to be explored will also affect the torque and pulldown/retract capabilities required of the drill rig. Conditions such as depth to ground water, cemented or very dense formations, loose sands and gravels, cobbles, cohesiveness of soil, and potential for saturated flowing conditions and heaving sands will affect the depth that can be explored with a drill of any given torque and pulldown/retract capability.

6. Drilling and Sampling Procedures

6.1 *General*—Several drilling approaches are discussed in the following sections. Hollow-stem auger drilling can be performed with a pilot bit to advance a boring. During pauses in drilling, sampling and field testing can be performed at the base of the augers. A section is also devoted to taking continuous or intermittent cores with the double tube auger soil coring method. Any combination of these drilling and sampling methods may be performed in a single boring.

6.2 *General Drilling and Sampling Considerations*:

6.2.1 *Site Setup*—Stabilize the drill rig, erect the drill rig mast, and attach an initial assembly of hollow-stem auger components (Fig. 1) to the rotary drive of the drill rig. When erecting the mast, check above the drilling rig for overhead obstructions or hazards, such as power lines, prior to lifting the mast. Perform a survey of underground and all other utilities prior to drilling to evaluate possible hazards. Establish and document a datum for measuring hole depth. This datum normally consists of the ground surface, or a stake driven into stable ground surface, or a drilling deck if used. If the hole is to be surveyed later for elevation, record and report the height of the datum to the ground surface.

6.2.2 *Hole Starting*—Push the auger column assembly below the ground surface and initiate rotation at a low velocity. Good practice for starting a straight hole normally requires minimum rotation speed while maintaining firm downward pressure to avoid whipping and widening of the top of the hole (**1**). An auger guide may be used (if available) to aid in starting the first auger to maintain a straight hole.

6.2.3 *Hole Advancement and Cuttings Return*—As the augers are rotating, apply down feed pressure to the HSA column to clean the hole and bring cuttings to the surface. Use rotation and penetration rates compatible with efficient cuttings returns. The use of excessive penetration rates faster than cuttings can be returned to the surface may result in the following: (1) cuttings which are packed into the auger flights, prohibiting newly penetrated materials from moving up the auger or, (2) forcing materials into the hole wall and increasing the chances of locking or binding of the HSA drill string. After advance of the auger string to the desired incremental depth in a hole advancement mode with pilot bits, rotation is normally continued without penetration for a time period long enough to ensure circulation of the cuttings up the flights.

6.2.4 *Pauses in Drilling*—Sampling or in situ testing can be performed at any depth by interrupting the advance of the augers and stopping rotation. During pauses in drilling the

HSA drill string can be held in place with an auger fork inserted at the surface. The fork will suspend the augers and prevent settling.

6.2.5 *Drill Hole Advancement*—Drilling at greater depths is accomplished by attaching additional hollow-stem auger sections to the top of the previously advanced HSA column assembly. If drilling with the pilot bit assembly in the HSA column using a wireline/overshot system; HSA sections can be added to the top of the HSA column without pulling the pilot bit assembly or adding any drill rods to advance the hole to a predetermined depth. When using the rod-type system, add a new inner rod along with an additional hollow-stem section.

6.2.6 *Cuttings Removal and Classification*—Periodically remove cuttings from around the top of the auger column, typically with a shovel. Soil cuttings above the ground water may be representative of deposits being penetrated if proper conveyance up the auger flight is maintained. Cuttings from below the ground water surface are likely to be mixed from varying formations in the hole and are usually not representative of deposits at the end of the auger. If cuttings are sampled for classification (Practice D 2488) and relation to lithology, report and document the intervals sampled.

6.2.7 *Recording of Drilling Information*—Record depths, progress, and location of samples or testing as drilling progresses. Monitor down feed pressures, rotation rates, and cuttings return during drilling. Note any indications of binding or locking of the augers during drilling. Observe the ease or difficulty of advancing the HSA drill string during drilling as it relates to the geologic strata being penetrated. Document occurrences of any significant abrupt changes and anomalies which occur during drilling. As drilling progresses, note and document drilling procedures such as water or drilling fluid added and losses, and intervals where equipment is changed or drilling method is changed.

6.3 *Hole Advancement with Pilot Bit*:

6.3.1 *General Considerations*—Following an increment of drilling, removal of the pilot bit assembly should be performed slowly so that the entrance of material into the bottom of the HSA column is minimized prior to sampling or installation of testing devices. The success of pilot assembly removal without disturbance will depend upon the following several principal factors: (1) the character of the soil at the auger head, (2) the water levels inside and outside the HSA column prior to removal of the pilot assembly, (3) the type of pilot assembly used, and (4) the speed of removal. As drilling progresses in saturated, granular materials, it usually becomes progressively more difficult to maintain the stability of the material below the auger column because of unbalanced hydraulic heads between outside ground water and inside the hollow stem. The stability of the material below the auger head may be enhanced by using special pilot assemblies, or maintaining fluid level in the HSA column during auger advancement and during retrieval of the pilot bit assembly (Fig. 4). Under some circumstances it may be effective to drill without using a pilot assembly. If a pilot assembly is not used, however, and water or drilling fluid is not injected into the auger column simultaneously with advancement, material often will enter the hollow stem of the auger column. In some cases when drilling in saturated granular materials, a screened lead auger section may be used to help deter blow-in. The screened auger allows formation water to flow into the HSA column to help prevent water level differences and maintain a hydrostatic balance.

6.3.2 *Knock Out Plugs*—If sampling or in situ testing is not required during drilling for installation of an instrumentation device, the boring can be advanced (for some geologic conditions) using an expendable, knock-out plate or plug, or flexible center plus instead of a pilot assembly. Knock-out plates or plugs usually remain in the ground close to the instrumentation device. It may be necessary to fill or partially fill the auger stem with water or drilling fluid to prevent blow-in, or sanding in at the time of plate or plug removal. An auger head with an integral, hinged aperture cover or flexible center plug can be used to deter entrance of materials into the auger stem.

6.3.2.1 *Flexible Plug*—The flexible center plug system uses a plastic basket with flexible finger, inverted in the HSA column at the cutter head. The flexible center plug allows split spoon sampling through the flexible fingers and helps prevent water-bearing sands from entering the HSA column while advancing the augers.

6.3.3 *Locking Problems, Blow-in*—There may be instances, during insertion of the pilot bit, when difficulties are encountered in locking of the bit and getting it back to the bottom of the HSA column. If material is present in the hollow-stem auger, it may be necessary to lift the HSA column to engage the locking mechanism. The action of lifting the hollow-stem augers can cause subsurface disturbance. Blow-in can be minimized by venting or the use of fluids in the hollow-stem auger.

6.4 *Intermittent Sampling or Field Testing*—Sampling or field testing can be performed at any depth by interrupting the advance of the augers and stopping rotation. Solid sampling is usually accomplished by either of the following two methods: (1) drive, push, or core sampling or (2) soil coring using hollow-stem augers (see 6.5)

6.4.1 Soil sampling and in situ testing methods, some of which are listed in 2.2 and 2.3, are often used to obtain samples or perform tests at the base of the boring. Slowly remove the pilot assembly, if being used, and insert a sampler or testing device through the hollow stem of the auger column. The sampled or tested depth should be compared to the clean-out depth if the sampler is attached to the rods. This comparison is accomplished by resting the sampler or testing device at the bottom of the hole and comparing the apparent depth with the clean-out depth. If cuttings, cave in material, or sanding in is apparent, these conditions should be noted. Sampler barrels which drop past the cutting teeth of the augers may indicate excessive disturbance at the base of the drill hole. If there is material in the HSA column that does not allow for the sampler to rest at the augured depth below the end of the HSA bit, it may be necessary to allow the material to fall out of the HSA column. Actual depth of the sampler in relation to the bottom of the hole should be considered, not where the bottom of HSA string is setting. If in situ testing is performed below the base of the borehole, check for disturbance below the base of the borehole, and advance the testing instrument well in advance of any disturbance at the base of the boring.

6.5 *Continuous or Intermittent Soil Sampling with the Double-Tube HSA Soil Coring System*:

6.5.1 *Intermittent Sampling*—The pilot bit can be replaced at any time with the double-tube HSA core barrel assembly and samples taken at desired depths. Samples can be taken at selected intervals of concern and based on change of soils encountered.

6.5.2 *Continuous Sampling*—In the continuous soil sampling process a sampler barrel is used during hole advancement. Remove and replace barrels as drilling progresses. Detailed stratigraphic logging and sampling for geotechnical exploration may be obtained.

6.5.3 *Hole Advancement and Cuttings Return*—When using the double-tube HSA soil coring system, typically perform drilling at a rotary velocity of about 50 to 100 r/min. Advance the system to a depth equal to the length of the sample barrel, or where intermittent sampling or in situ testing is required, or until the cutter head assembly is advanced to the desired depth. When using the HSA double-tube soil sampling system, rotational speeds and rate of down feed may vary with the degree of resistance of the material being sampled. As the augers are rotating, apply down feed pressure to the HSA column. Cut away the material from around the inner barrel by the cutter head. The rotating action of the cutter head around the sampler barrel cutting shoe allows the inner sample barrel to push/core down over the column of material filling the inner barrel. Cuttings are directed to the HSA flights and conveyed to the surface by the rotating HSA column. Rotation to clean cuttings from the hole should be limited in the HSA double-tube soil sampling mode to prevent sample from being vibrated (loosen) out of the sample barrel. Rotation for borehole cleaning can be accomplished after removal of the HSA sample barrel prior to the beginning of the next sampling increment.

6.5.4 *Selection of HSA Sampling Barrel*—Depending on the exploration needs, different types of sample barrels may be used. Split barrels are often used for lithologic logging and soil classification. Split barrel samples are often taken in 5-ft (1.5-m) lengths. Sample length can be reduced to reduce disturbance. Undisturbed samples consistent with Practice D 4220, Class c and d are often taken in liners. For undisturbed sampling, it is important to adjust the clearance ratio and the lead distance to reduce disturbance. In general, satisfactory undisturbed samples are usually at least 3 in. (75 mm) in diameter and larger and sampling length is reduced to 2.5 ft (0.75 m).

6.5.4.1 *Considerations for Undisturbed Sampling*:

6.5.4.1.1 *Undisturbed Sampling*—If the goal of the investigation program is to obtain samples with minimal disturbance, lead distance and cutting shoe clearance ratio must be adjusted for optimum sample recovery. This will be a trial-and-error process. The ultimate goal in undisturbed sampling is to achieve core recovery as close to 100 % as possible with a sample that just fills the liner.

6.5.4.1.2 *Lead Distance Optimization*—The lead distance of the core barrel cutting shoe should be adjusted to obtain optimum sample recovery (see 5.7.4). With wireline systems, the lead distance can be checked by vertically suspending the entire lead auger so that the inner barrel assembly can hang freely and then latch inside the lead auger.

6.5.4.1.3 *Clearance Ratio Optimization*—The clearance ratio of the cutting shoe should be optimized for the soil formations to be sampled (see 5.7.4). For undisturbed sampling, hold the liners in place in the sample barrel assembly by the cutting shoe which threads onto the end of the barrel. Cutting shoes are machined with different bit clearance ratios (see 3.1.2). Cutting shoe bit clearance ratios should be checked prior to use. Guidelines for bit clearance ratios for different soil types are as follows:

Bit clearance ratio %	Material
0 to ½	sands with little or no fines
½ to 1	silty sand, clay, silt
1 to 1½	expansive clay, shales, claystones

6.5.5 *General HSA Sampling Considerations*—When the bit or sample barrel assembly is removed and replaced, check the depth to the base of the boring where the end of the string rests and compare to the clean-out depth to evaluate hole quality. Hole depth is recorded by knowing the length of the auger assemblies and the actual amount of extension of the end of the sample barrel beyond the end of the HSA cutter head. This will facilitate accurate depth calculation of the sample taken and comparison of its position relative to the established surface datum. Excessive slough or cuttings within the hollow stem are undesirable and should be corrected by changes in technique, changes in equipment, or repair of equipment. Carefully record the start and stop depths of the sampling interval. Calculate the recovery. Sample recovery is the most important indicator of sample quality. To enhance sample recovery, the rate of penetration should be no greater than the speed at which the HSA cutter head is able to cut; that is, the downward force on the sampler barrel assembly should be a minimum. The speed of rotation should be limited to that which will not tear or break the soil during sampling (generally this varies from 40 to 125 r/min.) Important considerations for optimum sampling are lead distance and clearance ratio or head space of the cutting shoe and prevention of inner barrel rotation (**5**). Extension of the sample barrel shoe beyond the HSA cutter head depends on the soil type and should be the least amount which will result in a fully filled sample barrel (see 5.7.4).

6.5.6 *Sample Barrel Recovery and Reinsertion*

6.5.6.1 *Rod Systems*—After drilling the length of the sample barrel, stop, secure, and disconnect the HSA column from the drill rig drive connector. Disconnect the connecting rods inside the HSA column that may be attached to or extend through the rotary spindle of the drill rig. Remove the drill rotary head off the hole and hoist the rods connecting the sample barrel out of the HSA column. Replace the barrel by attachment of a new barrel to inner rods which are lowered back into the hollow-stem column and secured through the drive cap or rotary spindle attachment.

6.5.6.2 *Wireline Systems*—If a wireline/overshot system is used, after disconnecting the drill rig rotary drive connector from the top of the HSA column and removing the rotary head, lower the overshot retrieval tool down the HSA column to latch into the latching head on top of the sample barrel assembly. After the overshot is locked into the latching head assembly, hoist the sample barrel out of the HSA drill string on a wire cable attached to a hydraulic winch on the drill rig. Remove the sample barrel and connect another sample barrel assembly to the latching head and hoist and lower down the HSA column by means of the overshot and wireline assembly until the latching head locks into the latching connector box (part of the HSA column above the lead HSA and cutter head). Release the overshot from the locking head above the sample barrel and hoist to the surface.

6.5.6.3 *Reinsertion*—Add the next HSA section to the top of the HSA column and connect to the drill rig rotary spindle. Connect inner connecting rods (if not the wireline system) to or through the rotary spindle before the auger drive adapter is connected to the top of the HSA column. In special cases, such as in loose sand, lift the HSA drill string by the drill rig to remove the auger holding fork, and then lower to the bottom of the hole where the previous sample stopped. Rotate and push the HSA column to begin the soil coring procedure again.

6.5.6.4 There may be instances, during insertion of the sample barrel, when difficulties are encountered in locking of the barrel and returning it back to the bottom of the HSA column. If material is present in the hollow-stem auger it may be necessary to lift the HSA column to engage the locking mechanism. This will allow the sample barrel assembly to fall to the bottom of the HSA column, forcing out the slough and reach the locking position. When the sample barrel assembly is connected to drill rods or hex rods to the top of the HSA column, the rods may have to be pushed with the hydraulics of the drill rig to the bottom of the HSA column to reach the proper depth to begin the next soil coring interval. When drilling in 5-ft (1.5-m) intervals, a shorter HSA coring interval may have to be run to allow for slough material. If 2.5-ft (0.75-m) sample intervals are being used, use of a 5-ft barrel will allow for accommodation of slough. Note and record sample intervals, recovery, and any slough, cuttings, fluid exposure, or evidence of rotation contained in the samples recovered.

6.5.7 *Sample Testing and Handling*—First measure samples for recovery upon retrieval. Handle and transport samples in accordance with Practice D 4220. Classify soil samples in accordance with Practice D 2488. Samples from split liners can be classified and stored in jars or bags. Report the locations of specimens removed for testing. Collect material for classification of samples in liners to be stored for laboratory testing from the ends of the sample. Trim and seal the sample ends for preservation. The average soil in-place unit weight can be determined (**6**). Moisture specimens can be obtained from the cutting shoe or liner trimmings. Report results and locations of any tests performed on cores such as Torvane or pocket penetrometer.

7. Drill Hole Monitoring and Completion

7.1 *Monitoring*—It is advisable to monitor ground water levels, if present, in the drill hole during and after drilling. Ground water elevations should be measured and documented during drilling. If ground water is not encountered or if the level is of doubtful reliability, such information should also be documented.

7.2 *Installation of Instrumentation Devices*:

7.2.1 Instrumentation devices, such as piezometers or inclinometers (see 2.4) are installed using hollow-stem augers following a three-step procedure: (1) drilling, with or without sampling, (2) removal of the pilot assembly, if being used, and insertion of the instrumentation device, and (3) incremental removal of the hollow auger column as completion materials such as backfill or grout is installed as required.

7.2.1.1 If materials enter the bottom of the auger hollow stem during removal of the pilot assembly, they can be removed with a bailer, other device, or fluid rotary drilling (see 2.4) .

7.2.1.2 Completion materials such as bentonite pellets, granules and chips, and grouts should be selected and installed to specific subsurface instrumentation requirements.

7.3 *Other Completion Methods*—Depending on requirements of the investigation it may be necessary to perform special installations with protective casings or to the backfilling. An example of special completion is for the seismic crosshole test (Test Methods D 4428) which requires grouted PVC casings. These installations are also performed using the three-step method in 7.2.1. Several methods are available for grouting of casings. It is desirable to use injection grouting where injection is performed at the base of the boring, and grouts are pumped up the annulus until they reach the surface indicating a continuous seal.

7.4 *Drill hole Abandonment*—If there are no needs for special completion or instrument installations for the drill hole, it should be backfilled for completion. The method of backfilling for abandonment depends on the requirements of the exploration program and should be specified as part of the program. Certain state and local regulations may apply. At a minimum, the surface of the hole should be backfilled to reduce potential hazard to those at the surface. In cases where the hole is to be backfilled completely, the condition of the hole should be evaluated and documented. Any zones of caving or blocking which preclude complete backfilling should be documented. Backfilling can be performed by addition of backfill materials from the surface or through injection by tremie pipes. When backfilling from the surface, either cuttings spoil, (only if suitable for replacement) bentonite pellets or granules, or select materials may be added. If complete backfilling is desired using surface methods, use of uniform backfill materials such as bentonite pellets or granules will reduce the possibility of bridging. The hole can be probed to test for bridging. The tremie methods ensure the best backfilling and should be performed when exploration plans require assurance of complete backfilling. Tremie methods consist of placing a small-diameter grout pipe near the base of the drill hole and pumping either cement or bentonite grouts to the surface while displacing any drill hole fluid. The tremie pipe is withdrawn in increments, but the tip is maintained below the grout surface. Typical grout consistencies depend on equipment and the needs of the exploration program. Typical grout mixtures are given in Practice D 5092 and Test Methods D 4428.

8. Report

8.1 Report information in accordance with Guide D 5434 of "Subsurface Explorations of Soil" and identified as necessary and pertinent to the needs of the exploration program. Information is normally required for the project, exploration type and execution, drilling equipment and methods, subsurface conditions encountered, ground water conditions, sampling events, and installations.

8.2 Other information in addition to that mentioned in Guide D 5434 should be considered if deemed appropriate and necessary to the requirements of the exploration program. Additional information should be considered as follows:

8.2.1 *Drilling Methods*:

8.2.1.1 Report description of the hollow-stem auger system including the head, drive, and pilot assemblies. Provide information on drill hole and sample sizes. Note intervals of equipment change or drilling method changes and reasons for change.

8.2.1.2 Report type, quantities, and locations of use of additives such as water added to the hole. If changes to the circulating medium are made, such as addition of water, the depth(s) or interval(s) of these changes should be documented.

8.2.1.3 Report descriptions of down-feed pressures, rotation rates, and cuttings returns over intervals drilled. Note locations of loss of cuttings return and probable cause. Note any indications of binding or locking of the augers during drilling. Observe the ease of drilling during advancement as it relates to the geologic strata being penetrated. Document occurrences of any significant abrupt changes and anomalies in drilling conditions which occur during drilling.

8.2.1.4 If blow-in or sanding-in is evident in the HSA column, note occurrences and the amount. As the drilling progresses, note and document drilling procedures such as cuttings return, water added and losses, and intervals where equipment is changed or drilling method is changed.

8.2.2 *Sampling*:

8.2.2.1 Report depth interval sampled, recovery, classification, and any other tests performed, such as moisture or soil in-place unit weight determinations.

8.2.2.2 When core sampling or undisturbed sampling at the base of the boring, report condition of the base of the boring prior to sampling and report any slough or cuttings present in the recovered sample.

8.2.2.3 If cuttings are sampled for classification and relation to lithology, report and document the intervals sampled.

8.2.2.4 During insertion of the continuous sample barrel note any difficulties in locking of the barrel. Note any disturbances or evidence of rotation observed in the samples recovered.

8.2.3 *In situ Testing*:

8.2.3.1 For devices which were inserted below the base of the drill hole, report the depths below the base of the hole and any unusual conditions during testing.

8.2.3.2 For devices testing or seating at the drill hole wall, report any unusual conditions of the drill hole wall such as inability to seat pressure packers.

8.2.4 *Completion and Installations*—A description of completion materials and methods of placement, approximate volumes placed, intervals of placement, methods of confirming placement, and areas of difficulty or unusual occurrences.

9. Keywords

9.1 continuous sampling; double-tube auger; drilling; hollow-stem augers; soil coring; soil sampling; subsurface exploration

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1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) describes the procedures associated with the packaging and shipment of environmental samples. Two (2) general categories of samples exist: environmental samples consisting of water and soil submitted for routine environmental testing and waste material samples which include nonhazardous solid wastes and/or hazardous wastes as defined by 40 CFR Part 261 submitted for environmental testing or bench/pilot-scale treatability testing. Packaging and shipment procedures differ for the two sample categories.

This SOP is applicable to packaging and shipment of environmental samples submitted for routine environmental testing. Environmental samples are not considered a hazardous waste by definition; therefore, more stringent Department of Transportation (DOT) regulations regarding sample transportation do not apply. Environmental samples do, however, require fairly stringent packaging and shipment measures to ensure sample integrity as well as safety for those individuals handling and transporting the samples.

This SOP is designed to provide a high degree of certainty that environmental samples will arrive at their destination intact. This SOP assumes that samples will often require shipping overnight by a commercial courier/carrier service; therefore, the procedures are more stringent than may be necessary if a laboratory courier is used or if samples are transported directly to their destination by a sampling team member.

Respective state or federal agency (regional offices) protocols may require or recommend specific types of equipment for use in sample packaging or a specific method of shipment that may vary from the indicated procedures. Deviations from this SOP to accommodate other regulatory requirements should be reviewed in advance of the field program, should be explained in the project work plan, and must be documented in the field project notebook when they occur.

1.2 General Principles

Sample packaging and shipment generally involves the placement of individual sample containers into a cooler or other similar shipping container and placement of packing materials and coolant in such a manner as to isolate the samples, maintain the required temperature, and to limit the potential for damage to sample containers when the cooler is transported.

1.3 Quality Assurance Planning Considerations

Sampling personnel should follow specific quality assurance guidelines as outlined in the PDIWP or Quality Assurance Project Plan (QAPP). Proper quality assurance requirements should be provided that will specify sample packaging and shipment requirements if variations to the indicated procedures are necessary on a particular project.

1.4 Health and Safety Considerations

Sampling personnel should be aware that packaging and shipment of samples involves potential physical hazards primarily associated with handling of occasional broken sample containers and lifting of heavy objects. Adequate health and safety measures must be taken to protect sampling personnel from these potential hazards. The project Health and Safety Plan (HASP) generally addresses physical and other potential hazards. The HASP must be approved by the Site Safety Officer before work commences, must be distributed to all personnel performing work at the site, and must be adhered to as field activities are performed. In the absence of a HASP, work will be conducted according to the NRT's Health and Safety Policy and Procedures Manual and/or direction from NRT's Health and Safety Manager.

2.0 RESPONSIBILITIES

2.1 Sampling Technician

It is the responsibility of the sampling technician to be familiar with the procedures outlined within this SOP and with specific sampling, quality assurance, and health and safety requirements outlined within the site-specific plans. The sampling technician is responsible for proper packaging and shipment of environmental samples and for proper documentation of sampling activities for the duration of the sampling program.

2.2 Sampling Coordinator

Large sampling efforts may require additional support personnel such as a sampling coordinator. The sampling coordinator is responsible for providing management support such as maintaining an orderly sampling process, providing instructions to sampling technicians regarding sampling locations, and fulfilling sample documentation requirements to allow sampling technicians to collect samples in an efficient manner.

2.3 Project Manager

The Project Manager (PM) will be responsible for ensuring that site-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the activities in accordance with the PDIWP, this SOP and/or other related SOPs. The PM will be responsible for ensuring that proper arrangements have been made with the designated analytical laboratory. These arrangements include, but are not limited to, subcontractor agreements, analytical scheduling, and bottle/cooler orders. The PM may delegate some of these responsibilities to other project staff.

3.0 REQUIRED MATERIALS

- Sample coolers
- Sample containers
- Shipping labels
- Chain-of-custody records, custody seals
- Bubble wrap or styrofoam pellets
- "Blue Ice" refreezable ice packs or ice cubes

- Transparent tape
- Fiber tape
- Duct tape
- Zip-loc bags
- Trash bags
- Health and Safety supplies
- Equipment decontamination materials
- Field project notebook/pen

4.0 METHOD

4.1 General Information

4.1.1 Regulatory Information

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. The EPA regulations (40 CFR Section 261.4(d)) specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under the Resource Conservation and Recovery Act (RCRA) when any of the following conditions are applicable:

- Samples are to be transported to a laboratory for analysis;
- Samples are to be transported to the collector from the laboratory after analysis;
- Samples are to be stored by the collector prior to shipment for analyses, by the analytical laboratory prior to analyses, or by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

4.1.2 Sample Information

The following information must accompany each shipment of samples on a chain-of-custody form where each sample has an individual entry:

- Sample collector's name, mailing address and telephone number;
- Analytical laboratory's name, mailing address and telephone number;
- Cleardentification of each sample;
- Sample description (matrix);
- Number and type of sample containers;
- Container size;
- Preservative;
- Type and method of analysis requested;
- Date and time that the samples were collected and prepared for shipping; and,
- Special handling instructions, including notation of suspected highly impacted samples.

4.1.3 Laboratory Notifications

Prior to sample collection, the PM, or designated alternative must notify the laboratory manager of the number, type and approximate collection and shipment dates for the samples. If the number, type or date of sample shipment changes due to program changes which may occur in the field, the PM or alternate must notify the laboratory of the changes. Additional notification from the field is often necessary when shipments are scheduled for weekend delivery or expedited turnaround.

4.2 General Site Preparation

4.2.1 Small Sample Packages

Small sample packages of one or two days duration may require packaging and shipment of samples using the field vehicle as the sample preparation area. If sample coolers are sent via third party commercial carrier service, adequate sample packaging materials should be sent to the site sampling technician in advance of the sampling activity or will be purchased from stores located near the site.

4.2.2 Large Sample Packages

Multi-day or weekly sampling efforts may require a designated area to be selected for storage of unused sample containers/coolers and another area for sample handling, packaging, and shipment. Handling of environmental samples should preferably be conducted in a clean area and away from unused sample containers to minimize the potential for cross contamination. Large quantities of packaging materials may require advance special ordering. Shipping forms/labels may be preprinted to facilitate shipping.

4.2.3 Cooler Inspection and Decontamination

Laboratories will often re-use coolers. Every cooler received for site use will be inspected for condition and cleanliness. Any coolers that have cracked interior or exterior linings/panels or hinges should be discarded as their insulating properties are likely compromised. Any coolers missing one or both handles should also be discarded if replacement handles (i.e., knotted rope handles) can't be established in the field. Replacement coolers may be purchased in the field, if necessary.

The interior and exterior of each cooler should be inspected for cleanliness before using it at the site. Excess strapping tape and old shipping labels should be removed. If the cooler interior exhibits visible contamination or odors it should be decontaminated prior to use or returned to the laboratory. Drain plugs should be sealed on the inside with duct tape.

4.2.4 Other Considerations

VOC Samples - Sample containers used for VOC analysis may be grouped into a single cooler, with separate chain-of-custody record, to limit the number of trip blanks required for transportation and analysis. Individual VOC samples may also be placed into Zip-lock bags to further protect the samples.

Contaminated Samples - Sample containers with presumed high contaminant concentrations will be isolated within their own cooler with each sample container placed into a Zip-loc bag.

4.3 Sample Packaging Method

Sample packaging should be conducted in the following manner:

1. Place plastic bubble wrap matting over the base of each cooler or shipping container as needed.
2. Insert a clean trash bag into the cooler to serve as a liner.

3. Check that each sample container is sealed, labelled legibly, and is externally clean. Re-label and/or wipe bottles clean, if necessary. Clear tape should be placed over the labels to protect them. Wrap each sample bottle individually with bubble wrap secured with tape. Place bottles into the cooler in an upright single layer with approximately one inch of space between each bottle. Do not stack bottles or place them in the cooler lying on their side. If plastic and glass sample containers are used, alternate the placement of each type of container within the cooler so that glass bottles are not placed side by side.
4. Insert cooler temperature blanks, if required.
5. Place additional bubble wrap and/or styrofoam pellet packing material throughout the voids between sample containers within each cooler to the approximate top of the sample containers. Packing material may require tamping by hand to reduce the potential for settling.
6. Place cubed ice or cold packs in heavy duty Zip-loc bags, close the bags, and distribute the packages in a layer over the top of the samples. Cubed ice should be double-bagged to prevent leakage. Loose ice should never be used. Cold packs should be used only if the samples are chilled before being placed in the cooler.
7. Add additional bubble wrap/styrofoam pellets or other packing materials to fill the balance of the cooler or container.
8. Obtain two pieces of chain of custody tape and enter the custody tape numbers in the appropriate place on the chain-of-custody form. Sign and date the chain-of-custody tape.
9. Complete the chain-of-custody form. If shipping the samples involves use of a third party commercial carrier service, sign the chain-of-custody record thereby relinquishing custody of the samples. Shippers should not be asked to sign chain of custody records. If a laboratory courier is used, or if samples are transported to the laboratory, the receiving party should accept custody and sign the chain-of-custody records. Remove the last copy from the form and retain it with other field notes. Place the original (with remaining copies) in a Zip-loc bag and tape the bag to the inside lid of the cooler or shipping container.
10. Close the top or lid of the cooler or shipping container.
11. Place the chain of custody tape at two different locations (i.e., one tape on each side) on the cooler or container lid and overlap with transparent packaging tape.
12. Packaging tape should be placed entirely around the sample shipment containers. A minimum of two full wraps of packaging tape will be placed around the cooler lid and at least two places around the cooler.
13. Repeat the above steps for each cooler or shipping container.

4.4 Sample Shipping Method

Packaged sample coolers should be shipped using one of the following options:

4.4.1 Hand Delivery

When a project team member is transporting samples by automobile to the laboratory, the cooler should only be sealed with tape. In these cases, chain-of-custody will be maintained by the person transporting the sample and chain-of-custody tape need not be used. Chain-of-custody records should be relinquished upon delivery and a copy of the record retained in the site file.

4.4.2 Laboratory Courier

Laboratory couriers that receive the samples are usually employees of the analytical laboratory. As such, they will accept custody of the samples and must be asked to sign the chain-of-custody records. Chain-of-custody records do not need to be sealed in the cooler although it is recommended that the coolers be sealed with tape. All other packaging requirements generally apply unless otherwise specified in the QAPP.

If the laboratory courier is not authorized to accept custody of the samples, or if the requirements of the PDIWP preclude transfer to the laboratory courier, samples will be handled as described below in Section 4.4.3.

4.4.3 Third Party Courier

If overnight shipment is required, a third party package delivery service will be used. Transport of the cooler to the package delivery service office will be performed by a NRT Project Team member. The appropriate packaging shipment form or Airbill will be completed and affixed it to the cooler. The receipt will be retained for package tracking purposes. Please note that each cooler also requires a shipping label which indicates points of origin and destination. This will aid in recovery of a lost cooler if a shipping form gets misplaced. Coolers will never be left unattended. Airbills will be maintained as part of the custody documentation.

4.5 Sample Receipt

Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and will sign "received by laboratory" on each chain-of-custody form. The laboratory will verify that the chain-of-custody seal has not been broken previously and that the seal number corresponds with the number on the chain-of-custody record. The laboratory will note the condition of the samples upon receipt and will identify any discrepancies between the contents of the cooler and chain-of-custody. The analytical laboratory will then forward the back copy of the chain-of-custody record to the PM to indicate that sample transmittal is complete.

5.0 QUALITY CONTROL

The potential for samples to break during transport increases greatly if individual containers are not snugly packed into the cooler. Completed coolers may be lightly shake-tested to check for any loose bottles. The cooler should be repacked if loose bottles are detected.

Environmental samples are generally shipped so that the samples are maintained at a temperature of approximately 4°C. Temperature blanks may be required as a quality assurance check on shipment temperature conditions. These temperature blanks usually are supplied by the laboratory and consist of a 40-ml vial or plastic bottle filled with tap water. Temperature blanks should be placed near the center of the cooler.

6.0 DOCUMENTATION

Documentation supporting sample packaging and shipment generally consists of chain-of-custody records and shipping records. In addition, a description of sample packaging procedures will be provided in the field project notebook. All documentation will be retained in the project files following project completion.

7.0 TRAINING/QUALIFICATIONS

Sample packaging and shipment is a relatively simple procedure requiring minimal training and a minimal amount of equipment. It is, however, recommended that initial attempts be supervised by more experienced personnel. Sampling technicians should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

SOP – DECONTAMINATION OF FIELD EQUIPMENT

SUMMARY

Equipment, tools, materials, etc. used in the investigation and collection of samples at field investigation sites must be properly prepared and cleaned/decontaminated during and after each sampling event. The degree of cleaning/decontamination will be dependent upon site conditions and the nature and type of contamination, if present, the intent and goal(s) of the investigation, and data quality objectives, as well as other site-specific requirements.

Procedure

1. **Heavy Equipment Decontamination**

   All equipment, tools and materials associated with sampling events must be cleaned or decontaminated prior to usage. Items such as geoprobes, drill rigs, auger flights, and other heavy equipment pieces or parts may present potential sources of contamination to environmental samples. Therefore, all heavy equipment utilized at the site must undergo the following decontamination procedures:

   - the equipment will first be high pressure, hot washed or steam-cleaned with potable water; and,
   - the equipment will be rinsed thoroughly with potable water.

   Contain, collect, and dispose of all decontamination fluids in accordance with site/project-specific requirements.

2. **Cleaning of Field Sampling Equipment**

   All equipment and tools used to collect samples for geotechnical or chemical analyses, including spatulas, spoons, scoops, trowels, split-spoons, augers, etc. will be decontaminated using the following procedures:

   - non-phosphate detergent wash;
   - potable water or distilled/deionized water rinse; and
   - air or oven-dry.

   If the equipment is to be stored for future use, allow to dry and then store in a secure area. Collect or dispose of all decontamination fluids in accordance with site/project-specific requirements.

3. **Personal Clothing Decontamination**

   All footwear worn in and around the contamination area will be washed down using soap and water to remove soil or oily residue remnants. If disposable gloves, boots or suits (such as Tyvek® suits) are worn, such are to be removed and disposed in a designated 55-gallon drum on site for future disposal. Any other clothing that comes in contact with the potentially contaminated material should not be worn more than 24-hours and should be washed prior to wearing again.

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This SOP provides guidance for installing groundwater monitoring wells. Monitoring wells are installed to monitor the depth to groundwater, to measure aquifer properties, and to obtain samples of groundwater for chemical analysis. This SOP is applicable to installation of single observation/monitoring/pumping wells within a borehole. The construction and installation of nested, multilevel or other special well designs is not covered within this SOP as these types of wells are not frequently constructed. This SOP applies to both overburden and bedrock well construction. Some states and EPA Regions have promulgated comprehensive guidelines for monitoring well construction and for subsurface investigation procedures. Deviations from this SOP to accommodate other regulatory requirements must be documented in the field project notebook when they occur.

1.2 General Principles

Monitoring well construction and installation generally involves drilling a borehole using conventional drilling equipment, installing commercially available well construction and filter/sealing materials, and development of the well prior to sampling. This SOP covers well construction and installation methods only. Borehole drilling and well development methods are covered under separate SOPs.

1.3 Quality Assurance

Field personnel will follow specific quality assurance guidelines as outlined in the site-specific QAPP. The following aspects of monitoring well design and installation procedures depend on project-specific objectives, which will be addressed in the QAPP and in the PDIWP:

- Borehole drilling method and diameter;
- Type of construction for well screen, riser, filter pack and seals;
- Diameter of well materials;
- Length of well screen;
- Location of well screen;
- Location, thickness, and composition of annular seals; and,
- Well completion and surface protection requirements.

1.4 Health and Safety

Monitoring well installation may involve chemical hazards associated with materials in the soil or groundwater being investigated and always involves physical hazards associated with drilling equipment and well construction methods. When wells are to be installed in locations where the aquifer and/or overlying materials (vadose zone) may contain chemical hazards, a Health and Safety Plan (HASP) must be prepared and approved by the Health and Safety Manager before field work commences. The HASP must be distributed to all field personnel and must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary equipment for well construction and installation. Well construction materials will be consistent with project requirements.

2.2 Surveying Subcontractor

It is the responsibility of the surveying subcontractor to provide one or more of the following well measurements as specified in the PDIWP: ground surface elevation, horizontal well coordinates, top of well casing elevation (i.e., measuring point elevation), and/or top of protective casing elevation.

2.3 Project Geologist/Engineer

It is the responsibility of the Project Geologist/Engineer to directly oversee the construction and installation of the monitoring well by the drilling subcontractor to ensure that the well-installation specifications defined in thePDIWP are adhered to, and that all pertinent data are recorded on the appropriate forms.

2.4 Project Manager

It is the responsibility of the Project Manager (PM) to ensure that each project involving monitoring well installation is properly planned and executed.

3.0 REQUIRED MATERIAL

3.1 Well Construction Materials

Well completion materials include silica sand, bentonite, cement, protective casings, and locks. Completion materials will be provided by the drilling subcontractor.

3.2 Other Required Materials

Other required materials include the **following:**

- Potable water supply;
- Fiberglass or steel measuring tape;
- Water level indicator;

- Well construction diagrams;
- Waterproof marker or paint (to label wells);
- Health and Safety supplies;
- Equipment decontamination materials; and,
- Field project notebook/pen

4.0 METHOD

4.1 General Preparation

4.1.1 Borehole Preparation

Standard drilling methods will be used to achieve the desired drilling/well installation depths specified in the PDIWP. Soil sampling, if conducted, will be conducted in accordance with the subsurface soil sampling SOP. The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals. Bedrock wells may require reaming after coring in order to provide a large enough borehole diameter to enable well installation. Rotary drilling methods may require bentonite-based drilling fluids; if selected, will be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, potentially reducing the permeability of the material adjacent to the well screen. If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids will be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt will be made to recover the quantity of fluid or water that was introduced, either by flushing the borehole prior to well installation and/or by over pumping the well during development.

4.1.2 Well Material Decontamination

Although new well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, it is sometimes necessary to decontaminate the materials prior to their use. Well materials will be inspected by the project geologist/engineer upon delivery to check cleanliness. If the well materials appear dirty, or if local or regional regulatory guidance requires decontamination, then well material decontamination will be performed by the drilling subcontractor in accordance with the Equipment Decontamination SOP.

4.2 Well Construction Procedure

4.2.1 Depth Measurement

Once the target drilling depth has been reached, the drilling subcontractor will measure the total open depth of the borehole with a weighted, calibrated tape measure. Adjustments of borehole depth can be made at this time by drilling further or installing a small amount of sand filter material to achieve the desired depth. If drilling fluids were used during the drilling process, the borehole will be flushed at this time using potable water. The water table depth may also be checked with a water level indicator if a measurement cannot be obtained with the calibrated tape.

4.2.2 Centralizers

In order to install a well which is centered within the borehole, it is recommended that centralizers be used. Centralizers are especially helpful for deep well installations where it may be difficult to position the well by hand. Centralizers may not be necessary on shallow water table well installations where the well completion depth is within 25 feet of the ground surface.

4.2.3 Well Construction

The well screen and riser pipe generally are assembled by hand as they are lowered into the borehole. Before the well screen is inserted into the borehole, the full length of the slotted portion of the well screen as well as the unslotted portion of the bottom of the screen will be measured with the measuring tape. These measurements will be recorded on the well construction diagram. After the above measurement has been taken, the drilling subcontractor may begin assembling the well. As the assembled well is lowered, care will be taken to ensure that it is centered in the hole if centralizers are not used. The well will be temporarily capped before filter sand and other annular materials are installed.

4.2.4 Filter Sand Installation

The drilling subcontractor will fill the annular space surrounding the screened section of the monitoring well to at least 1 foot above the top of the screen with an appropriately graded, clean sand or fine gravel. In general, the filter pack will not extend more than 3 feet above the top of the screen to limit the thickness of the monitoring zone. If coarse filter materials are used, an additional 1-foot thick layer of fine sand will be placed immediately above the filter pack to prevent the infiltration of sealing components (bentonite or grout) into the filter pack. As the filter pack is placed, a weighted tape will be lowered in the annular space to verify the depth to the top of the layer. Depending upon depth, time may be required for these materials to settle; placement of the sand pack may require the use of a tremie pipe to eliminate possible bridging or creation of voids. Tremie pipe sandpack installations are generally suggested for deep water table wells and for wells which are screened some distance beneath the water table.

4.2.5 Bentonite Seal Installation

A minimum 3-foot thick layer of bentonite pellets or slurry seal will be installed by the drilling subcontractor immediately above the well screen filter pack in all monitoring wells. The purpose of the seal is to provide a barrier to vertical flow of water in the annular space between the borehole and the well casing. Bentonite is used because it swells significantly upon contact with water. Pellets generally can be installed in shallow boreholes by pouring them very slowly from the surface. If they are poured too quickly, they may bridge at some shallow, undesired depth. As an option, powdered bentonite may be mixed with water into a very thick slurry and injected through a tremie pipe to establish the seal at the desired depth.

4.2.6 Annular Grout Seal Installation

This grout seal will consist of a bentonite/cement mix with a ratio of bentonite to cement of between 1:5 and 1:20. The grout ratio will be chosen based on site conditions with a higher percentage of bentonite generally used for formations with higher porosity. A mud balance will be used if a specific mud density is required at a particular site. Grout slurry will be pumped into the annular space using a side-discharging tremie pipe located about 2 feet above the sand pack. Side discharge will help preserve the integrity of the sand pack. In situations where the monitoring well screen straddles the water table, the seal will be in the unsaturated zone and pure bentonites (pellets or powder) will not work effectively as seals without hydration. Dry bentonite may be used if sufficient time to hydrate the seal is allowed. Seal hydration requires the periodic addition of clean water. Optionally, seals in this situation may include a cement/bentonite mixture containing up to 10 percent bentonite by weight. This type of mixture shall be tremied to the desired depth in the borehole. The borehole annulus will be grouted with seal materials to within 3 feet of the ground surface. Drill cuttings, even those known not to be contaminated, will not be used as backfill material.

4.2.7 Well Completion

The drilling subcontractor will cut the top of the well to the desired height and install a vented (if possible), locking cap. The upper portion of the well casing can optionally be drilled to allow venting. Well casings are usually cut to be a certain height above ground surface (typically 2.5 to 3 feet) or are cut to be flush with the ground surface.

4.2.8 Protective Casing/Concrete Pad Installation

The drilling subcontractor will install a steel guard pipe on the well as a protective casing. The borehole around the guard pipe will be dug out to an approximate 2 to 3-foot radius to a minimum depth of 1 foot at the center and 6 inches at the edges. After installing the protective casing, the excavation will be filled with a concrete/sand mix. The surface of the concrete pad will be sloped so that drainage occurs away from the well. Flush-mount protective casings may not require an extensive concrete pad and will be completed such that they are slightly mounded above the surrounding surface to prevent surface water from running over or ponding on top of the casing. Above-ground protective casings will also be vented or will have non-air tight caps. Flush-mounted installations will not be vented. Installation of additional guard pipes may be necessary around aboveground well completions in high traffic areas. Protective casings will be lockable to prevent unauthorized access.

4.2.9 Well Numbering

The project geologist/engineer will number each well casing with an indelible marker or paint to identify the well. This is particularly important with nested or paired wells to distinguish between shallow and deep wells. The well will be labeled on both the outside of the protective casing and inside beneath the protective casing lid.

4.2.10 Measuring Point Identification

The project geologist/engineer will mark the measuring point from which water level measurements will be collected at a specific location along the upper edge of the well casing. PVC wells can easily be notched with a pocket knife or saw. Stainless steel wells (or PVC wells) can be marked with a waterproof marker on the outside of the well casing with an arrow pointing to the measuring point location. The measuring point is the point which will require surveying during the well elevation survey task.

4.2.11 Well Measurements

Upon completion, the following well measurements will be taken by the project geologist/engineer and recorded on the well construction diagram:

- Depth to static water level if water level has stabilized;
- Total length of well measured from top-of-well casing;
- Height of well casing above ground surface;
- Height of protective casing above ground surface; and,
- Depth of bottom of protective casing below ground surface (may be estimated).

Well screen filter pack, bentonite seal, and annular seal thicknesses and depths will also be recorded on the well construction diagram.

4.2.12 Disposal of Drill Cuttings/Drilling Wastes

Drill cuttings and other investigation-derived wastes (IDW) such as drilling mud or well development/purge water must be properly contained and disposed of in accordance with DER-10. Site-specific requirements for collection and removal of these waste materials are outlined in the PDIWP. Containment of these materials will be performed by the drilling subcontractor.

4.2.13 Well Development

At some point after installation of a well and prior to use of the well for water-level measurements or collection of water quality samples, development of the well shall be performed (see SOP for Monitoring Well Development). Well development may be performed by the drilling subcontractor if contracted to do so or by the project geologist/engineer or other project staff.

4.2.14 Well Elevation Survey

At the completion of the well installation program, all monitoring wells will be surveyed to provide, at a minimum, the measuring point elevation for water level monitoring purposes. Other surveyed points which may be required by the PDIWP include: ground surface elevation, top of protective casing elevation, and well coordinates. Well elevation surveys are to be conducted by a NYS-licensed professional land surveyor.

5.0 QUALITY CONTROL

Certain quality control measures will be taken to ensure proper well completion.

- The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, if necessary, before any well construction materials are to be placed.
- Water level and non-aqueous phase liquid (NAPL) presence will be checked during well installation to ensure that the positions of well screen, sand pack, and seal relative to water level conform to project requirements.
- The depth to the top of each layer of packing (i.e., sand, bentonite, grout, etc.) will be verified and adjusted, if necessary, to conform to project requirements before the next layer is placed.
- If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids may be required for analysis of chemical constituents of interest at the site.

6.0 DOCUMENTATION

All well construction data will be recorded on the Well Construction Detail form. All wells will be referenced onto the appropriate site map. A field notebook and/or boring log will be used as additional means of recording data. In no case will the notebook or boring log take the place of the well construction diagram.

7.0 TRAINING/QUALIFICATIONS

Well construction and installation requires a moderate degree of training and experience as numerous drilling situations may occur which will require field decisions to be made. It is recommended that inexperienced personnel be supervised for several well installations before working on their own. Experienced drillers are also of great assistance with problem resolution in the field. Field personnel will be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

DEFINITIONS

Annulus: The measured width between the borehole wall and the outside of the well screen or riser pipe.

Bentonite Seal: A granular, chip, or pellet-size bentonite material that is often used to provide an annular seal above the well screen filter pack. This seal is typically installed dry followed by in-place hydration with or without the addition of water. Hydrated bentonite is sometimes used as a grout seal.

Bottom Cap/Plug: Threaded or slip-on cap placed at the bottom of the well prior to installation. Often serves as a sump for accumulation of silt which settles within the well. The measured length from the lowermost well screen slot to the bottom of the bottom cap is known as the sump or tail pipe portion of the well.

Centralizers: Stainless steel expansion clamps which, when fitted to well screens or riser pipe, expand to contact the borehole walls positioning the well centrally within the open borehole. Centralizers assist with even positioning and distribution of filter pack and sealant materials and assist with maintaining well plumbness.

Expansion Cap/Well Ca/J-Plug: Cap used to cover the opening at the top of the well riser pipe. Expansion caps are equipped with a rubber gasket and threaded wing nut which, when turned, provides a watertight seal. Expansion caps may also be locked, and generally are recommended for use with flush-mounted wells. Other well caps may include slip-on or threaded caps made of the same material as the well casing (i.e., Schedule 40 PVC).

Filter Pack: A well-graded, clean sand or gravel placed around the well screen to act as a filter in preventing the entry of very fine soil particles into the well.

Grout Seal: A cement/bentonite mixture used to seal a borehole that has been drilled to a depth greater than the final well installation depth or to seal the remaining borehole annulus once the well has been installed. Occasionally, pure cement or pure bentonite is used as a grout seal.

Measuring Point: A selected point at the top of the well casing (riser pipe) used for obtaining periodic water-level measurements. The measuring point will consist of either a notch or indelibly marked point on the upper surface of the casing. Typically, the highest point on the casing (if not level) is used as the measuring point. The measuring point is also the point that is surveyed when well elevation data is obtained.

Protective Casing: A locking metal casing, placed around that portion of the well riser pipe that extends above the ground surface. The protective casing is generally cemented in-place when the concrete pad is built around the well.

Riser Pipe: The section of unperforated well casing material used to connect the well screen with the ground surface. Frequently, it is made of the same material and has the same diameter as the well screen. Riser pipe is typically available pre-cleaned and pre-threaded for immediate use.

Flush-Mount Box: A protective casing that is flush-mounted with the ground around a well installation. Flush mount or road boxes are used in areas where the monitoring well cannot extend above the ground surface for traffic or security reasons.

Tremie Pipe: A small diameter pipe which fits in the open borehole annulus and is used to inject filter sands or hydrated seal materials under pressure.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. Typically a well screen is purchased pre-slotted, pre-cleaned, and pre-threaded for immediate use.

Vent Hole: Small diameter hole drilled in the upper portion of the well riser pipe which provides atmospheric venting of the well. Allows for constant equilibration of the water level with changing atmospheric conditions. In flood-prone areas, or with flush-mount wells, vent holes will not be used.

SOP – MONITORING WELL DEVELOPMENT

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This SOP describes the methods used for developing newly installed monitoring wells and/or existing wells which may require redevelopment/rehabilitation. This SOP is applicable to monitoring wells and/or small diameter recovery wells and piezometers.

Monitoring well development and/or redevelopment is necessary for several reasons:

- To improve/restore hydraulic conductivity of the surrounding formations as they have likely been disturbed during the drilling process, or may have become partially plugged with silt;
- To remove drilling fluids (water, mud), when used, from the borehole and surrounding formations; and,
- To remove residual fines from well filter materials and reduce turbidity of groundwater, therefore, reducing the chance of chemical alteration of groundwater samples caused by suspended sediments.

Respective state or federal agency (regional offices) regulations may require specific types of equipment for use or variations in the indicated method of well development. Deviations from this SOP to accommodate other regulatory requirements will be reviewed in advance of the field program and must be documented in the field project notebook when they occur.

1.2 General Principles

Well development generally involves withdrawal of an un-specified volume of water from a well using a pump, surge block or other suitable method such that, when completed effectively, the well is in good or restored hydraulic connection with the surrounding water-bearing unit and is suitable for obtaining representative groundwater samples or for other testing purposes.

1.3 Quality Assurance

Field project personnel will follow specific quality assurance guidelines as outlined in the site-specific Quality Assurance Project Plan (QAPP). The QAPP will indicate the preferred method of well development at a particular site based on project objectives, aquifer conditions, and NYSDEC/RCDOH requirements. Specific well performance criteria such as low turbidity values to be achieved following well development will also be specified as well as any requirements for collection/containerization and disposal of well development water.

1.4 Health and Safety Considerations

Monitoring well development may involve chemical hazards associated with materials in the soil or aquifer being characterized and may involve physical hazards associated with use of well development equipment. When wells are to be installed and developed on hazardous waste investigation sites, a Health and Safety Plan (HASP) must be prepared and approved by the Health and Safety Manager, and distributed to all field project personnel before field work commences. The HASP must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Project Geologist/Engineer

Development or oversight of development of new monitoring wells is the responsibility of the project geologist/engineer involved in the original installation of the well. Records of well development methods and results will be retained in the project file.

2.2 Project Manager

The Project Manager (PM) is responsible for ensuring that the appropriate method of well development has been chosen that best meets project objectives, site hydrogeologic conditions, and/or relevant regulatory requirements.

3.0 REQUIRED MATERIALS

Well development can be performed using a variety of methods and equipment. The specific method chosen for development of any given well is governed by the purpose of the well, well diameter and materials, depth, accessibility, geologic conditions, static water level in the well, and type of contaminants present, if any. The following list of equipment, each with their own particular application, may be used to develop and/or purge monitoring wells.

3.1 Bailer Purging

A bailer is used to purge silt-laden water from wells after using other devices such as a surge block. In some situations, the bailer can be used to develop a well by bailing and surging, often accompanied with pumping. A bailer will be used for purging in situations where the depth to static water is greater than 25 feet and/or where insufficient hydraulic head is available for use of other development methods.

3.2 Surge Block Development

Surge blocks are commercially available for use with Waterra™-type pumping systems or may be manufactured using a rubber or teflon "plunger" attached to a rod or pipe of sufficient length to reach the bottom of the well. Well drillers usually can provide surge blocks if requested.

3.3 Pump Development

A pump is often necessary to remove large quantities of silt-laden ground water from a well after using the surge block. In some situations, the pump alone can be used to develop the well and remove the fines by over pumping. Since the purpose of well development is to remove suspended solids from a well and surrounding filter pack, the pump must be capable of removing solids without damage. The preferred pump is a submersible pump which can be used in both shallow and deep groundwater situations. A centrifugal pump may be used in shallow wells but will work only where the depth to static groundwater is less than approximately 25 feet. Pumping may not be successful in low-yielding aquifer materials or in wells with insufficient hydraulic head.

3.4 Compressed Gas Development

Compressed gas, generally nitrogen from a tank or compressed air through a compressor, can be used to both surge and develop a monitoring well. The method works by injection of compressed gas at the bottom of the water column, driving sediment-laden water to the surface. Compressed gas can also be used for "jetting" - a process by which the gas is directed at the slots in the well screen to cause turbulence (thereby disturbing fine materials in the adjacent filter pack). Compressed gas is not limited by any depth range. Since the compressed gas will be used to "lift" water from the monitoring well, provisions must be made for controlling the discharge from impacted wells. This is generally accomplished by attaching a "tee" discharge to the top of the casing and providing drums to contain the discharged water. Gas-lifting will never be done in contaminated wells without providing a means to control discharge.

3.5 Other Required Materials:

- Well development forms;
- Water quality instrumentation: turbidity, pH, temperature, specific conductance, ORP, as required;
- Health and Safety equipment;
- Equipment decontamination materials; and,
- Field project notebook/pen

4.0 METHOD

4.1 General Preparation

4.1.1 Well Records Review

Well completion forms will be reviewed to determine well construction characteristics. Formation characteristics will also be determined from review of available boring logs.

4.1.2 Site Preparation

Well development, similar to groundwater sampling, will be conducted in as clean an environment as possible. This usually requires, at a minimum, placing sheet plastic on the ground to provide a clean working area for development equipment.

4.1.3 IDW Containment

Provisions will be in place for collection and management of investigation-derived wastes (IDW), specifically well development water and miscellaneous expendable materials generated during the development process. The collection of IDW in drums or tanks may be required depending on project-specific requirements. The QAPP will specify the requirements for IDW containment.

4.1.4 Water Level/Well Depth Measurement

The water level and well depth will be measured with a water level indicator and written on the well development record. This information is used to calculate the volume of standing water (i.e., the well volume) within the well.

4.1.5 Equipment Decontamination

All downhole equipment will be decontaminated prior to use.

4.1.6 Removal of Drilling Fluids

Drilling fluids such as mud or water, if used during the drilling and well installation process, will be removed during the well development procedure. It is recommended that a minimum of 1.5 times the volume of added fluid be removed from the well during development. Drilling muds will initially have been flushed from the drilling casing during the well installation procedure with water added during the flushing process. If the quantity of added fluid is not known or could not be reasonably estimated, removal of a minimum of 10 well volumes of water is recommended during the development procedure.

4.2 Development Procedures

4.2.1 Development Method Selection

The construction details for each well shall be used to define the most suitable method of well development. Some consideration will be given to the potential degree of contamination in each well as this will impact IDW containment requirements. The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and level of contamination, and characteristics of the geologic formation adjacent to the screened interval. The limitations, if any, of a specific procedure are discussed within each of the following procedures.

4.2.2 General Water Quality Measurements

Measure and record water temperature, pH, specific conductance, and turbidity periodically during development using the available water quality instruments. These measurements will aid in determining whether well development is proceeding efficiently, will assist in identifying when well development is complete, will determine whether the development process is effective or not with any given well and, potentially, may identify well construction irregularities (i.e., grout in well, poor well screen slot-size selection). Water quality parameters will be checked a minimum of 3 to 5 times during the development process.

4.2.3 Bailer Procedure

As stated previously, bailers shall preferably not be used for well development but may be used in combination with a surge block to remove silt-laden water from the well.

- When using a bailer to purge well water; select the appropriate bailer, then tie a length of bailer cord onto the end of it.
- Lower the bailer into the screened interval of the monitoring well. Silt, if present, will generally accumulate within the lower portions of the well screen.
- The bailer may be raised and lowered repeatedly in the screened interval to further simulate the action of a surge block and pull silt through the well screen.
- Remove the bailer from the well and empty it into the appropriate storage container.
- Continue surging/bailing the well until sediment-free water is obtained. If moderate to heavy siltation is still present, the surge block procedure will be repeated and followed again with bailing.
- Check water quality parameters periodically.

4.2.4 Surge Block Procedure

A surge block effectively develops most monitoring wells. This device first forces water within the well through the well screen and out into the formation, and then pulls water back through the screen into the well along with fine soil particles. Surge blocks may be manufactured to meet the design criteria shown in the example or may be purchased as an adaptor to fit commercially available well purging systems such as the Waterra system.

- Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of approximately 3 feet, will allow material which is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, remove the surge block and purge the well using a pump or bailer. The returned water will be heavily laden with suspended silt and clay particles. Discharge the purged water into the appropriate storage container.
- Repeat the process. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging will be undertaken along the entire screen length in short intervals (2 to 3 feet) at a time. Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material.
- Check water quality parameters periodically.

4.2.5 Pump Procedure

Well development using only a pump is most effective in monitoring wells that will yield water continuously. Theoretically, pumping will increase the hydraulic gradient and velocity of groundwater near the well by drawing the water level down. The increased velocity will move residual fine soil particles into the well and clear the well screen of this material. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

- When using a submersible pump or surface pump, set the intake of the pump or intake line in the center of the screened interval of the monitoring well.
- Pump a minimum of three well volumes of water from the well and raise and lower the pump line through the screened interval to remove any silt/laden water.
- Continue pumping water from the well until sediment-free water is obtained. This method may be combined with the manual surge block method if well yield is not rapid enough to extract silt from the surrounding formations.
- Check water quality parameters periodically.

4.2.6 Compressed Gas Procedure

Although the equipment used to develop a well using this method is more difficult to obtain and use, well development using compressed gas is considered to be a very effective method. This method is also not limited by well depth, well diameter or depth to static water. Caution must be exercised, however, in highly permeable formations not to inject gas into the formation. Drilling subcontractors will often provide the necessary materials as well as perform this method, if requested. When using a compressor, an oil-free compressor will be used, or an oil trap/filter will be placed on the air discharge line which enters the well.

- Lower the gas line into the well, setting it near the bottom of the screened interval. Install the discharge control equipment (i.e., tee fitting) at the wellhead.
- Set the gas flow rate to allow continuous discharge of water from the well.
- At intervals during gas-lifting, especially when the discharge begins to contain less suspended material , shut off the air flow and allow the water in the well to backflush through the screened interval to disturb any bridging that may have occurred. Re-establish the gas flow when the water level in the well has returned to the pre-development level.
- Continue gas-lifting and/or jetting until the discharged water is free from suspended material.
- Check water quality parameters periodically.

5.0 QUALITY CONTROL

A well has been successfully developed when one or more of the following criteria are met:

- The sediment load in the well has been eliminated or greatly reduced. Regulatory requirements may be in-place which state that water turbidity values ranging from 5 to 50 NTU must be achieved at the end of the development procedure. Use of a turditimeter is required during the well development procedure to measure water turbidity if meeting a specific turbidity value is required by the regulations. Attaining low turbidity values in fine-grained formations may be difficult to achieve.
- Stable field parameters (pH, specific conductivity, temperature, and/or ORP)
- Permeability tests (i.e., Hydraulic Conductivity Testing) yield repeatable hydraulic conductivity values.

6.0 DOCUMENTATION

The Monitoring Well Development Form will be completed by the geologist or hydrogeologist conducting the development. In addition, a field project notebook will be maintained detailing any problems or unusual conditions which may have occurred during the development process.

7.0 TRAINING/QUALIFICATIONS

Well development procedures vary in complexity. It is recommended that initial development attempts be supervised by more experienced personnel. Field personnel will be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

DEFINITIONS

Bridging: A condition within the filter pack outside the well screen whereby the smaller particles are wedged together in a manner that causes blockage of pore spaces.

Hydraulic Conductivity: A characteristic property of aquifer materials which describes the permeability of the material with respect to flow of water.

Hydraulic Connection: A properly installed and developed monitoring well will have good hydraulic connection with the aquifer. The well screen and filter material will not provide any restriction to the flow of water from the aquifer into the well.

*Permeabilit*y Test: Used to determine the hydraulic conductivity of the aquifer formation near a well screen. Generally conducted by displacing the water level in a well and monitoring the rate of recovery of the water level as it returns to equilibrium. Various methods of analysis are available to calculate the hydraulic conductivity from these data.

Static Water Level: The water level in a well that represents an equilibrium or stabilized condition, usually with respect to atmospheric conditions in the case of monitoring wells.

Well Surging: That process of moving water in and out of a well screen to remove fine sand, silt and clay size particles from the adjacent formation.

Well Purging: The process of removing standing water from a well to allow surrounding formation water to enter the well.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. The perforated, or slotted, portion of a well is also known as the screened interval.

SOP – AQUIFER TESTING

1.0 PURPOSE

The purpose of this standard operating procedure is to establish standard methods by which NRT personnel should conduct aquifer tests.

2.0 SCOPE

This procedure shall serve as professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Client (O&R), Project Manager (PM), and the Pre-Design Investigation Lead.

3.0 DEFINITIONS

3.1 Hydraulic Conductivity

Hydraulic conductivity is the rate of flow through a unit area cross section under a unit hydraulic gradient, at the prevailing temperature. Hydraulic conductivity typically is reported as feet (ft) per day (reduced from cubic feet/day/square feet [ft^3/day/ft^2]). In the Systems International system, the units are typically cubic meters/day/square meters [m^3/day/m^2] or meters/day. The letter "k" is typically used to denote hydraulic conductivity.

3.2 Transmissivity

Transmissivity (T) is the product of the hydraulic conductivity (k) and saturated aquifer thickness (b), and is the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Transmissivity values are given in area per time units, typically gallons/day/ft or ft^2/day in the English system. In the Systems International system, transmissivity is given in m^3/day/m or m^2/day.

3.3 Storage Coefficient

Storage coefficient is the volume of water an aquifer releases or takes into storage per unit surface area of the aquifer per unit change in head. Storage coefficient (S) is unitless and is applied only to confined aquifers. Typical values of storage coefficients range from 10^{-3} to 10^{-5}.

3.4 Specific Yield

Specific yield is the ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass. Specific yield (Sy) is applied to unconfined aquifers only. Typical values of specific yield are 10^{-1} to 10^{-3}.

3.5 Confined Aquifer

A confined aquifer is an aquifer that is located between layers of impermeable materials, such as clay, which impede the movement of water into and out of the aquifer. The water level in a well in a confined aquifer usually rises above the top of the aquifer.

3.6 Unconfined Aquifer

An unconfined aquifer is also known as a water table aquifer and is an aquifer in which the water table forms the upper boundary. The water level in an unconfined aquifer lies at the water table.

3.7 Skin Effects

Skin effects are described as an increase or decrease in measured hydraulic conductivity caused by drill cuttings or fluids accumulating along the wall of the boring.

3.8 Hydraulic Boundaries

Hydraulic boundaries are a geologic or hydrologic feature that affects the movement or distribution of groundwater.

3.9 Delayed Yield

Delayed yield is water that drains vertically downward from the newly created unsaturated zone during an unconfined aquifer test, after the water table has been lowered from its initial level.

3.10 Observation Well

An observation well is a well drilled in a select location for the purpose of observing aquifer parameters, such as water levels and water quality.

3.11 Pumping Well

A pumping well is a well from which water is withdrawn by pumping in order to evaluate aquifer characteristics by monitoring the response to the pumping action in the pumping or observation wells.

3.12 Well-Bore Storage Effects (Casing Effects)

Well-bore storage effects are the delayed drawdown responses observed in the initial phases of a pump test due to removal of water from storage in the well casing and filter pack.

4.0 RESPONSIBILITIES

The PDI Lead is responsible for selecting the appropriate aquifer test procedures based on the objectives of the test. The PDI Lead is also responsible for ensuring that the PDIWP defines test methods clearly. The PDI Lead is responsible for ensuring that all personnel involved in aquifer tests shall have the appropriate education, experience, and training to perform their assigned tasks. The Technical Director is responsible for ensuring overall compliance with this procedure. The Field Manager (FM) is responsible for supervising the test in the field. Aquifer testing qualifications for the FM include a degree in geology, hydrogeology, hydrology, or civil/environmental engineering with 2 years of experience in conducting aquifer tests and interpreting the results. Field personnel are responsible for the implementation of this procedure.

5.0 PROCEDURES

5.1 Constant Discharge Aquifer Pumping Tests

Constant discharge aquifer pumping tests are commonly performed at environmental sites to estimate the hydraulic conductivity, transmissivity, specific yield, and/or storativity of an aquifer. These data assist in analyzing contaminant fate and transport and assessing site remediation options. A wide variety of aquifer test methods and aquifer conditions (e.g., confined, unconfined, leaky) exist and each test must consider both the goals of the test and site conditions. Pumping tests that are properly designed and implemented can evaluate well efficiency and detect hydraulic boundaries, vertical leakage, or delayed yield effects, and allow assessment of hydraulic conductivity and storativity. The proper design and implementation of a pumping test requires knowledge of the hydrogeologic setting. Information required prior to the design of the test includes:

- Objectives of the pumping test;
- Location of observation and pumping wells;
- Climatic conditions;
- Screened intervals of all wells;
- Installation and completion methods (“as-builts”);
- Generalized hydrogeologic conditions;
- Regional groundwater flow direction;
- Boundary conditions;
- Existence of improperly completed or developed wells;
- Presence of pumping or irrigation;
- Potential for the capture of insoluble or dissolved contaminants;
- Hydraulic conductivity estimate for aquifer;
- Presence and location of confining layers;
- Potential well water disposal problems;
- Potential for tidal effects; and,
- Previous sampling results and development records

The pumping test interpretation method is based upon an analytical solution that considers well and site conditions. The hydraulic response of the aquifer is compared to a theoretical analytical response. Different analytical solutions exist for unconfined and confined aquifers, each taking into account assumptions about test and aquifer conditions. It is important to document the assumptions applied to the interpretation of a particular test. It is beyond the scope of this procedure to provide a detailed explanation of aquifer testing analytical solutions. Several texts that address pumping test theory are included in Section 8, References. Constant discharge pumping tests provide results that are more representative of aquifer characteristics than those provided by slug tests; however, pumping tests require greater effort and expense. In general, slug testing should be used only in situations where hydraulic conductivity is sufficiently low to preclude a pumping testing.

5.1.1 Interferences and Potential Problems

The conditions that exist at a site during the performance of a pumping test are often far from ideal. Hydrogeologic factors that may be encountered at a site include:

- Localized or regional pumping;
- Barometric effects;
- Tidal effects;
- Aquifer compression (e.g., trains, traffic);
- Boundary effects;
- Recharge effects;
- Leakage from underlying or overlying aquifers; and,
- Heterogeneous and anisotropic aquifers

Many of these potential complications may be detected during the pre-test period or anticipated from an examination of existing hydrogeological data. Information about the location, completion, and development of the pumping and observation wells may be useful in evaluating potential complications. Complicating factors may include:

- Partially penetrating wells;
- Improperly completed or developed wells;
- Low-permeability conditions that may lead to well-bore storage effects, well dewatering, or slow responding observations wells; and,
- Wells completed within aquitards, possibly designed to evaluate the pressure response and leakage into adjacent aquifers; Potential skin effects caused by well-bore conditions.

5.1.2 Pumping Test Planning

Prior to implementation of the pumping test, consider:

1. Monitoring pre-test and post-test water levels (preferably for at least 3 days). Groundwater systems are rarely static and localized conditions, such as nearby pumping wells, tidal effects, barometric effects, variable recharge conditions, and other ”non-ideal“ conditions, are likely to be present at a site.
2. The volume of water that will be generated during the test, and storage, treatment, and disposal methods for the water generated during the test for the performance of a long-term, constant discharge pumping test. If free product is present within the vicinity of the pumping well, include an oil-water separator as part of the groundwater treatment process.
3. Observation of well design, location, and installation.
4. Use of subcontractors for installing and operating pumping equipment during constant discharge pumping tests.
5. Selection of pumping equipment.
6. Pump placement in well.
7. Staff scheduling, and security and safety during overnight aquifer testing.
8. How equipment will be decontaminated and how potentially impacted water will be handled (IDW Management). Select a well containing unimpacted groundwater for pump testing, if possible. Water derived from a potentially impacted well may have to be temporarily stored on site. Once the analytical results are obtained, the disposition of the water can be determined. In some instances, flammable/explosive fluids and gases may be collected in which case onsite storage procedures must allow for the hazards of storing these substances. If possible, avoid aquifer tests of highly contaminated wells.

5.1.3 Field Procedures

5.1.3.1 Preparation

1. Review the PDIWP and become familiar with information about the wells to be tested (e.g., depth to water, well depth, aquifer hydraulic conductivity, distances between pumping and observation wells, and anticipated drawdown).
2. Test the operation of all field equipment. Use a data logger for all aquifer testing unless the PDI Lead or Technical Director approves other methods. Ensure that the electronic datalogger is fully charged. Calibrate the electronic data logger and transducers at measured depths in a container of water. Always bring additional transducers in case of malfunctions. Calibrate the flow meter at several known discharge rates. Ensure that the calibration is linear in the anticipated test range.

Have pH (indicates the hydrogen ion concentration - acidity or basicity) and conductivity meters onsite to assess water quality periodically during the pumping test.

3. Assemble a sufficient number of field pumping test forms.
4. Ensure that the pumping well has been properly developed prior to testing.
5. If a flow meter is not operating properly, calibrate an orifice weir, bucket, or other type of water measuring device to accurately measure and monitor discharge from the pumping well.
6. Have sufficient lengths of pipe on hand to transport the discharge from the pumping well to a holding tank or to a discharge point well beyond the influence of the expected cone of depression.
7. Install a gate valve on the discharge pipe to control the pumping rate.
8. Install an outlet at the wellhead to obtain water quality samples during the pumping test.
9. Install a check valve on the pump so water cannot flow back into the well after the pump is shut off.
10. Install transducers in wells, making sure to secure them firmly at the wellhead, and allow sufficient depth for drawdown (generally 5 to 10 feet below the water surface in the well). Measure the depth to the transducer, and ensure that the transducer is not placed at a depth below the water surface beyond its range (this will ruin the transducer).
11. Arrange for treatment, special storage and handling, or a discharge permit before impacted water is pumped.

Monitor pre-test water levels at the test site for at least 3 days prior to performance of the test. A continuous-recording device is recommended. This information allows the field team to evaluate the barometric efficiency of the aquifer when comparing with barometric readings at the site. It helps to determine if the aquifer is experiencing variations in head with time due to tidal influences or recharge or pumping in the nearby area. If barometric pressure is found to significantly affect water levels in the aquifer, then record changes in barometric pressure during the test (preferably using an onsite barometer) in order to “correct” water levels for fluctuations that may occur because of changing atmospheric conditions. Trends in pre-test water levels can then be projected for the duration of the test. Correcting water levels during the test produces results that are representative of the hydraulic response of the aquifer caused by pumping of the test well in the absence of atmospheric pressure changes.

The influence of ocean tides or localized pumping can mask the water level response to the pumping test. Water levels can be corrected for the effect of ocean tides by adding or subtracting values of tidal fluctuation from the response of the pumping. Pumping test data can be corrected for the effect of localized pumping if the pumping response prior to the test is known and predictable over the duration of the drawdown and recovery phases of the test. Non-rhythmic and “unique” water-level fluctuations might be difficult to resolve and substantial hydrologic judgment is required to properly interpret the data.

5.1.3.2 Step Drawdown Test

Prior to initiating a constant discharge pumping test, conduct a step drawdown test. The purpose of the step drawdown test is to estimate the greatest flow rate that may be sustained during a long-term pumping test. The step drawdown test is typically conducted over a 4- to 8-hour period prior to commencing the constant discharge test.

To correctly assess the maximum yield of the well, pump the well at discharge rates varying from relatively low to the maximum rate that the well can produce. Distribute the discharge increments for each step as evenly as possible through the range of well yields. Utilize four steps for the pumping test. Each step shall last approximately 2 hours depending on the response of water levels to pumping.

Measure water level recovery following the test for approximately 8 hours. Measure water levels periodically during the step test within the pumping well and within observation wells that may be used during the constant discharge test. For each step increment, measure levels within the pumping well on the same time basis as that used for the beginning of the constant discharge test (i.e., approximately on a logarithmic basis). Observation wells may be measured using a longer time scale since the primary reason for measurement is to assess whether the aquifer responds to pumpage rather than to gather data for quantitative analysis. Also measure water levels during the recovery phase of the step test.

Prior to initiating the constant discharge test, analyze the data from the step drawdown test to identify the appropriate discharge rate for the longer-term test. Plot the generated drawdown versus time data on a semilogarithmic graph, and determine the sustainable discharge rate from this graph by projecting the straight line formed by each data set for each step increment to the longer pumping times associated with the constant discharge test. Determine the optimum pumping rate based on the projected drawdowns associated with these longer time periods and the amount of drawdown available in the pumping well. The step drawdown data can also be evaluated more quantitatively using methods described by Birsoy and Summers (1980) and Lohman (1982).

5.1.3.3 Constant Discharge Pumping Test

Time Intervals

After the pumping well has fully recovered from the step drawdown test, the constant discharge pumping test may begin (typically 24 hours after step drawdown testing). At the beginning of the test, set the discharge rate as quickly and accurately as possible. Record the water levels in the pumping well and observation wells using a data logger according to Table 1 and Table 2.

Table 1: Pumping Well Measurements

Elapsed Time Since Start of Test (Minutes)	Intervals Between Measurements (Minutes)
0 - 10	0.5 - 1
10 - 15	1
15 - 60	5
60 - 300	30
300 - 1,440	60
1,440 - termination	480

Note: Similar time intervals shall be used during water level recovery, with short time intervals at the start of recovery.

Table 2: Observation Well Measurements

Elapsed Time Since Start or Stop of Test (Minutes)	Intervals Between Measurements (Minutes)
0 - 60	2
60 - 120	5
120 - 240	10
240 - 360	30
360 - 1,440	60
1,440 - termination	480

During the early part of the test, station at least one person at the pumping well and at least one other person to handle other pump test logistics. Readings at the wells need not be taken simultaneously. It is very important to accurately measure depth to water readings, and to record readings at the exact time of measurement. Use pressure transducers and electronic data loggers to record water levels in the pumping well and nearby observation wells. Perform manual checks of the depth to water to verify the pressure transducer measurements. In some instances, the pressure transducer may be unstable and “drifting” may occur.

During a pumping test, record the following data on the aquifer test data form (see attached):

Site Identification - Project number, site name, well identification number, indication as to whether the well is an observation or pumping well
Location - The location of the well in which water level measurements are being taken
Distance from Pumping Well - Distance the observation well is from the pumping well in feet
Personnel - The company and individual conducting the pumping test
Test Start Date - The date when the pumping test began
Test Start Time - Time, using 24-hour clock, at which a field measurement was taken (e.g., 1030 hours for 10:30 A.M., and 1350 hours for 1:50 P.M.).
Test End Date - Same as above
Test End Time - Same as above

Depth to water, in feet (to an accuracy of 0.01 feet), in the pumping well at the beginning of the pumping test
Depth to water, in feet (to an accuracy of 0.01 feet), in the observation well at the beginning of the pumping test
Depth of pressure transducers
Average Pumping Rate - Summation of all entries recorded in the pumping rate (gallons/minute [gpm]) column divided by the total number of pumping rate readings
Measurement Methods - Type of instrument used to measure depth to water (this may include steel tape, electric sounding probes or pressure transducers)
Comments - Appropriate observations or information including notes on sampling
Actual time the test started
Elapsed Time - Time elapsed since the start of pumping in minutes
Depth to Water - Depth to water, in feet (tenths and hundredths of feet), in the observation well at the time of the water level measurement
Pumping Rate - Flow rate of pump measured from an orifice weir, flow meter, container, or other type of water measuring device in gal/min

Water Chemistry Measurements

During the pumping test, use portable field-grade water testing equipment to measure parameters at periodic intervals including pH, electrical conductivity, and temperature of the water. These parameters are used to qualitatively evaluate aquifer conditions. Recalibrate water testing equipment during the pump test on a predetermined schedule with known calibration standards.

Test Duration

The duration of the test depends on the properties of the aquifer that the project seeks to characterize. The duration may be determined by plotting the drawdown data on both log-log and semi-log graphs and preliminarily evaluating it during the pump test. Doing this allows possible identification of recharge boundaries or permeability barriers that might be further evaluated with a longer pump test. Optimally, flow conditions should approach steady state where the observed drawdowns reach near constant values prior to terminating the test.

The minimum time necessary for the test is indicated on the semi-log graph when the log-time versus drawdown for the most distant observation well plots as a straight line (assuming $u < 0.01$) (Jacob's). Longer tests tend to produce more reliable results. Longer tests are usually necessary for unconfined aquifers to allow evaluation of delayed yield effects. A pumping duration of 24 to 72 hours is desirable, followed by a similar period for monitoring the recovery of the water level. Consider knowledge of the local hydrogeology, combined with a clear understanding of the overall project objectives in selecting duration of the test and the effect of boundary conditions. There is little need to continue the test once the increase in drawdown in all observation wells becomes insignificantly small; however, delayed yield effects and boundary effects may be observed with continued pumping.

Recovery

Once the pump has been shut down, record the recovering water levels in the same manner and using the same time intervals as were used during the beginning of the constant discharge test (i.e., at approximately logarithmic time intervals). Monitor recovery for a period corresponding to the length of the pumping portion of the test or when water levels have recovered to 95 percent of their original level. Continue tidal and barometric monitoring during the recovery portion of the test.

5.1.3.4 Post Operation

Perform the following activities after completion of water level recovery measurements:

1. Decontaminate and/or dispose of equipment as listed in SOP, Equipment Decontamination.
2. For the electronic data-logger, use the following procedures:
   - Stop the logging sequence.
   - Print data, or
   - Save memory at the end of the daily activity.
3. Replace the testing equipment in storage containers.
4. Check the sampling equipment and supplies, and repair or replace all broken or damaged equipment.
5. Replace expendable items.
6. Return equipment to the Equipment Storage Office and report malfunctions or damage.
7. Review field forms for completeness.

8. Interpret slug or aquifer test field results with the Project Hydrogeologist and/or PDI Lead. Analyze the slug test using appropriate software packages or graphical solutions.

5.1.4 Pumping Test Interpretation

There are several accepted methods for determining aquifer properties, such as transmissivity, storativity, and hydraulic conductivity. Kruseman and de Ridder (1990), Freeze and Cherry (1979), or Theis (2010) present methods of interpretation; however, the appropriate method depends on the characteristics of the aquifer being tested (e.g., confined, unconfined, leaky confining layer). When reviewing pumping test data, generate both log-log and semi-log plots of drawdown with time. Loglog plots, however, cannot be used for quantitative analysis of data obtained from the pumping well. The interpretation of pumping test data attempts to match or duplicate the observed field response with a theoretical water level response to pumping. Aquifer parameters can be estimated on the basis of such a match using commercially available software such as AQTESOLV.

A range of aquifer parameter values are likely to occur at a site. For example, hydraulic conductivities are typically log normally distributed. The estimate of the values may vary with the interpretation method. It is important to verify that the assumptions used to derive a particular method of solution are reasonable in view of the test conditions. For example, storativity values should be less than 0.005 for a confined aquifer.

5.1.5 Quality Assurance/Quality Control

Calibrate all gauges, transducers, flowmeters, and similar equipment used for conducting pumping tests before use at the site. Obtain copies of the documentation of instrumentation calibration, and file them with the test data records. The calibration records shall consist of laboratory measurements and, if necessary, any onsite zero adjustment and/or calibration performed. Where possible, check all flow and measurement meters on site using a container of measured volume and a stopwatch. Verify the accuracy of the meters before testing proceeds. Also verify the water levels measured by a pressure transducer-based data logger by manual measurements.

5.2 Slug Tests

5.2.1 Scope and Application

A common procedure for single-well hydraulic testing is a slug test. A slug test is restricted in application because it is a measure of the well and near-well hydrogeologic conditions. The results of the test provide an order of magnitude estimate of the horizontal hydraulic conductivity of the aquifer, and are most useful in low-permeability materials. This method cannot determine storativity very accurately.

5.2.2 Method Summary

A slug test involves the instantaneous injection or withdrawal of a mass (slug) of water or object that displaces a known volume of water into or from a well, and measuring the induced water level fluctuation. The primary advantages of using slug tests to estimate hydraulic conductivities are that:

(1) estimates can be made in situ, thereby avoiding errors incurred in laboratory testing of disturbed soil samples;

(2) tests can be performed quickly at relatively low cost because only one observation well is required; and,

(3) the hydraulic conductivity of small discrete portions of an aquifer can be estimated (e.g., sand layers in a clayey formation). Slug tests cannot reliably establish estimates of storativity or specific storage. Use slug tests only to evaluate water-bearing zones with relatively low hydraulic conductivities. In addition, always conduct slug testing with a data logger coupled to a pressure transducer.

5.2.3 Interferences and Potential Problems

The zone of investigation covered by a slug test is limited to the immediate vicinity of the well bore. Thus, interpretation of the test may be strongly influenced by the hydraulic properties of the well casing, filter pack, and borehole, and may possibly reflect variations in well development. When possible, use consistent methods of well construction and development at a site to minimize the potential for variation in slug test results. Problems associated with pump tests may affect a slug test.

Water levels within a borehole will often oscillate rapidly after the introduction/withdrawal of a slug volume. This does not indicate a problem with performance of the slug test. If a well is screened above and below the water table, a slug injection method will tend to store water in the filter pack and yield a higher estimate of hydraulic conductivity than would be expected. In these cases, the slug withdrawal method may yield more accurate data.

5.2.4 Field Procedures

5.2.4.1 Preparation

Office Procedures

1. Review the WP and the procedure, including well construction, development, and sampling information on the wells to be tested.
2. Review the operator’s manual provided with the electronic data-logger.
3. Verify the displacement volume of the slug. This may be accomplished by accurately measuring the dimensions of a solid displacement slug or by accurately measuring the volume of water discharge from a liquid slug.
4. Ensure the proper operation of all field equipment. Ensure that the electronic data-logger is fully charged. Test the electronic data-logger using a container of water (e.g., sink, bucket of water). Bring additional transducers to the site in case of malfunctions.
5. Assemble a sufficient number of field forms to complete the field assignment.
6. Assemble the appropriate testing equipment.

Equipment List

Decontaminate and test all equipment prior to commencing field activities. The following equipment is needed to perform slug tests:

- Tape measure (subdivided into tenths of feet);
- Water pressure transducer;
- Electric water level indicator or steel tape (subdivided into hundredths of feet);
- Electronic data-logger;
- Solid or liquid slug of a known volume (stainless steel, polyvinyl chloride, and ABS plastic are appropriate construction materials);

- Watch or stopwatch with second hand;
- Semi-log graph paper;
- Water proof ink pen and logbook;
- Temperature/pH/electrical conductivity meter (optional);
- Appropriate references and calculator;
- Electrical tape; and,
- Health and safety equipment, as required

Data Form

Use the slug test data form to record observations. Make all entries in indelible ink. The form shall include the following data:

- Site identification - the identification number assigned to the site and the well
- Date - the date when the test data were collected: year, month, and day (e.g., 080115 for August 1, 2015)
- Slug Volume (ft^3) - manufacturer's specification for the known volume or displacement of the slug device
- Logger - identifies the company or person responsible for performing the field measurements
- Test Method - either injected (dropped) or withdrawn (pulled out) from the monitoring well
- Comments - appropriate observations or information for which no other blanks are provided
- Depth to Water (ft) - Depth of water recorded to 0.01 feet
- Configuration of the Data Logger (e.g., sample rate, duration, transducer type)

5.2.4.2 Performing the Slug Test

Use the following procedures to collect and report slug test data. They may be modified to reflect specific site conditions:

1. Store all data internally or on computer diskettes or tape using the electronic data-logger and pressure transducer. Transfer the data to a computer for analysis. Keep a computer printout of the data in the field as documentation.
2. Decontaminate the transducer and cable.
3. Collect initial water level measurements from monitoring wells in an upgradient to downgradient sequence, if possible.
4. Before beginning a slug test, record information and enter it into the electronic data-logger. The type of information will vary depending on the model used. Consult the operator's manual for the proper data entry sequence.
5. Test wells from least contaminated to most contaminated, if possible.
6. Determine the static water level in a well by measuring the depth to water periodically for several minutes.
7. Cover sharp edges of the well casing with duct tape to protect the transducer cables.
8. Install the transducer and cable in the well to a depth below the target drawdown estimated for the test, but at least 2 feet from the bottom of the well. Be sure this depth of submergence is within the design range stamped on the transducer. Temporarily tape the transducer cable to the well to keep the transducer at constant depth.
9. Connect the transducer cable to the electronic data-logger.
10. Enter the initial water level and transducer design range into the recording device according to the manufacturer's instructions (the transducer design range will be stamped on the side of the

transducer). Compare manual and pressure transducer measurements to check that the transducer is operational and accurate. Thermal drift may occur until the transducer equilibrates with the water in the well. Record the initial water level on the recording device.

11. “Instantaneously” inject or withdraw a known volume (slug) of water to the well. The preferred test method is to introduce a solid cylinder of known volume to displace and raise the water level. Let the water level re-stabilize, and remove the cylinder. It is important to inject or withdraw the volumes as quickly as possible because the analysis assumes an “instantaneous” change in volume is created in the well.
12. Measure and record the depth to water and the time using the data-logger, with the moment of volume injection or withdrawal assigned time zero. The number of depth-time measurements necessary to complete the test is variable and can be determined from previous aquifer tests or evaluations. It is critical to make as many measurements as possible in the early part of the test.
13. Continue measuring and recording depth-time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a semi-log plot of time versus depth.
14. Retrieve the slug (if applicable) and follow appropriate decontamination procedures.

The time required for a slug test to be completed is a function of the volume of the slug, the hydraulic conductivity of the formation, and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours. If the well is to be used as a monitoring well, take precautions to ensure that the well is not contaminated by material introduced into the well. If water is added to the monitoring well, clean it from an uncontaminated source, and transport it in a clean container. Clean bailers or measuring devices prior to the test. If tests are performed on more than one monitoring well, take care to avoid cross-contamination of the wells. Conduct slug tests on relatively undisturbed wells. If a test is conducted on a well that has recently been pumped for water sampling purposes, the measured water level must be within 0.1 foot of the static water level prior to testing.

5.2.4.3 Post Operations

Decontaminate and/or dispose of equipment according to SOP for Equipment Decontamination. Implement the following procedure for the electronic data-logger:

1. Stop the logging sequence.
2. Print the data, if available.
3. Save the data, and disconnect the battery at the end of the daily activity.
4. Inventory sampling equipment and supplies, and repair or replace broken or damaged equipment.
5. Replace expendable items.
6. Return equipment to the Equipment Storage and report malfunctions or damage.
7. Review field forms for completeness.
8. Interpret slug test field results with the Project Hydrogeologist and/or the PDI Lead. Analyze the slug test using appropriate software packages or graphical solutions.
9. Send data-logger or pressure transducers to factory for recalibration, if needed.

5.2.5 Slug Test Interpretation

The results of slug tests should be viewed as order of magnitude estimates of hydraulic conductivity and should not be performed as a substitute for constant discharge pump tests. The interpretation of the water level response usually requires a number of simplifying assumptions, and the physical properties of the well casing and filter pack are rarely included in the analysis. A limited number of test interpretation methodologies exist. The following three approaches are most commonly used:

1. *Cooper Bredehoeft-Papadopulos Method* (Cooper, Bredenhoeft, and Papadopulos 1967, Papadopulos, Bredenhoeft, and Cooper 1973) - The U.S. Geological Survey developed a more physically based model for the slug test. It involves a curve-fitting procedure that may not always produce a unique fit and is the only method discussed herein to produce an estimate of specific storage.
2. *Bouwer and Rice Method* (Bouwer 1989, Bouwer and Rice 1976) - This is a popular approach to the interpretation of slug test data obtained from unconfined aquifers. It is a graphical method and relatively straightforward to apply.
3. *Hvorslev Method* (Hvorslev 1951) - This is a popular approach to the interpretation of slug test data obtained from confined aquifers. It is a graphical method and relatively straightforward to apply.

5.2.6 Quality Assurance/Quality Control

The QA/quality control procedures for slug tests are similar to the pumping test analysis.

6.0 RECORD KEEPING REQUIREMENTS

All data collected in the field shall be maintained onsite during field activities, and then transferred to the office project files upon completion of the aquifer test(s). Computerized data (e.g., from dataloggers) shall be stored in ASCII format. The PDI Lead or designee shall review all aquifer test forms upon completion of the aquifer test(s).

7.0 HEALTH AND SAFETY

Standard health and safety practices should be observed as stated in the site-specific health and safety plan (HASP). Prior monitoring should have determined contaminant concentrations and, thus established any required personal protective equipment (PPE). Suggested minimum protection during aquifer test activities shall include inner disposable vinyl gloves, outer chemical protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek suits may be necessary depending on the contaminant concentrations and shall always be available on site. Depending upon the type of contaminant expected or determined in previous sampling efforts, employ the following safe work practices:

7.1 Particulate or Metal Compounds

- Avoid skin contact with and/or incidental ingestion of water.
- Wear long-sleeved protective gloves and splash protection (i.e., Saranex or splash suits and face shields), as warranted.

7.2 Volatile Organic Compounds

- Avoid breathing constituents venting from the tanks by approaching upwind, and/or by use of respiratory protection.
- Survey the well headspace and the personnel breathing zone with a flame ionization detector/photoionization detector prior to and during sampling.
- If monitoring results indicate organic vapors that exceed action levels as specified in the site-specific HASP, sampling activities may need to be conducted in Level C protection. At a minimum, skin protection will be required by use of Tyvek or other media that is protective against the media being encountered.

7.3 Flammable or Explosive Compounds

- Periodically monitor flammable or explosive gases using an explosimeter and oxygen meter.
- Place all ignition sources upwind or crosswind of the well or borehole (i.e., generators).
- If explosive gases exceed the designated action levels as specified in the site-specific HASP, cease operations and evaluate conditions.

7.4 Physical Hazards Associated with Aquifer Testing

- To avoid back injuries associated with moving generators and pumps, always use two people and the large muscles of the legs, not the back.
- To avoid slip/trip/fall (wet) conditions as a result of leaking pumps or discharge, use textured boots/boot cover bottoms.
- To minimize fire/explosion hazards, follow the following guidelines:
  - Use monitoring equipment, such as explosimeters, to detect flammable/explosive atmospheres.
  - Keep all potential ignition sources out of the work area.
  - Keep two generators on site and gassed up alternately when the engines are cool - the filling of generators with fuel while they are running is strictly prohibited.
  - Keep at least one ABC- or BC-rated fire extinguisher within 75 feet of the work area to prevent the spread of small fires should they occur.
  - Conduct all work being performed at night in areas where lighting equals or exceeds five foot-candles.
  - Personnel should avoid climbing on tanks as much as possible to eliminate the possibility of injuries due to falls.
  - To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1to 2 cups/hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
  - Be aware of restricted mobility due to PPE.

8.0 REFERENCES

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Appendix B: Community Air Monitoring Plan

COMMUNITY AIR MONITORING PLAN

The Community Air Monitoring Plan (CAMP) provides for real-time monitoring of Volatile Organic Compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when ground-intrusive activities are implemented. The CAMP was developed from the New York State Department of Health (NYSDOH) Generic CAMP that is provided in the DER-10 Technical Guidance for Site Investigation and Remediation (May 2010). The CAMP provides a measure of protection for the downwind community (potential receptors include residences, businesses, and workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The CAMP also addresses ground intrusive activities within twenty (20) feet of a potentially exposed population or occupied structure and for indoor air monitoring activities. Contractors should employ Best Management Practices (BMPs) and common sense measures to minimize VOCs, dust, and odors around work areas.

Table B-1 provides action levels and corresponding required actions for VOCs and particulate monitoring that include increased monitoring, corrective actions to abate emissions, and/or work shutdown.

1.0 VOLATILE ORGANIC COMPOUND (VOC) MONITORING, RESPONSE LEVELS AND ACTIONS

Real time air monitoring for VOCs and/or particulate levels is required at the perimeter of the Exclusion Zone.

Periodic monitoring for VOCs will be required during non-intrusive activities, such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. Periodic VOC monitoring of the breathing space area during a sample collection event will occur upon arrival at a sample location, while opening a well cap or overturning soil, during well bailing/purging, and prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring will be required during sampling activities. Examples of such situations include groundwater sampling adjacent to or within twenty (20) feet of structures.

Continuous monitoring for VOCs will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

VOCs will be monitored at the downwind perimeter of the immediate work area on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions. The monitoring equipment must be appropriate to measure the types of contaminants known or suspected to be present. The equipment must be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment must be capable of calculating fifteen (15) minute running average concentrations, which will be compared to the following levels:

- If the ambient air concentration of total VOCs at the downwind perimeter of the work area exceeds five (5) parts per million (ppm) above the determined background level for the fifteen (15) minute average, work activities must be temporarily halted and monitoring continued. If the total VOC level decreases rapidly to less than five (5) ppm over background, work activities can resume with continued monitoring.

- If total VOC levels at the downwind perimeter of the work area persist at levels in excess of five (5) ppm over background but less than twenty-five (25) ppm, work activities must be halted, the source of vapors investigated, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the Exclusion Zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than twenty (20) feet, is below five (5) ppm over background for the fifteen (15) minute average.

- If the organic vapor level is above twenty-five (25) ppm at the perimeter of the Exclusion Zone, activities must be halted.

- All fifteen (15) minute readings must be recorded and should be available for review by the NYSDOH, New York State Department of Environmental Conservation (NYSDEC) and Rockland County Health Department, if requested. Instantaneous readings, if any, used for decision purposes should also be recorded.

2.0 PARTICULATE MONITORING, RESPONSE LEVELS AND ACTIONS

Particulate concentrations must be monitored continuously for all ground intrusive activities at the upwind and downwind perimeters of the work area at temporary particulate monitoring stations. The particulate monitoring must use real time monitoring equipment capable of measuring particulate matter that are less than ten (10) micrometers in size (PM-10) and is capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) greater than background (upwind perimeter) for the fifteen (15) minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with the implemented 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.

- 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 must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 $\mu g/m^3$ of the upwind level and in preventing visible dust migration.

- All readings must be recorded and be available for review by the NYSDOH, NYSDEC and Rockland County Health Department, if requested.

3.0 GENERAL RECOMMENDATIONS FOR WORK AREAS WITHIN 20 FEET OF POTENTIALLY EXPOSED POPULATIONS OR OCCUPIED STRUCTURES

When work areas are within twenty (20) feet of potentially exposed populations or occupied structures, the continuous monitoring locations for VOCs and particulates must be based on the nearest potentially exposed individuals and the location of ventilation system intakes for nearby structures. The use of engineering controls such as vapor/dust barriers, temporary negative-pressure enclosures, or special ventilation devices will be considered to prevent exposures related to the work activities and to control dust and odors. Consideration will be given to implementing the planned activities when potentially exposed populations are at a minimum, such as during weekends or evening hours.

- If total VOC readings exceed one (1) ppm at locations that are next to the walls of occupied rooms or next to intake vents, monitoring will also occur within the adjacent occupied room(s). Depending upon the nature of contamination, chemical-specific colorimetric tubes of sufficient sensitivity may be necessary for comparing the exposure point concentrations with appropriate pre-determined response levels and response actions. Background readings in the occupied rooms must be measured prior to commencement of the planned work. Any background readings that are greater than one (1) ppm should be discussed with the NYSDEC prior to commencement of the work.

- If total particulate readings exceed 150 $\mu g/m^3$ next to the walls of adjacent occupied room(s) or next to intake vents, work activities should be suspended until controls are implemented and are successful in reducing the total particulate concentration to 150 $\mu g/m^3$ or less at the monitoring point. Depending upon the nature of contamination and remedial activities, other parameters (e.g., explosivity, oxygen, hydrogen sulfide, carbon monoxide) may also need to be monitored. Particulate response levels and actions should be pre-determined.

Table B-1

Air Monitoring Action Levels at Downwind Perimeter of Exclusion Zone

Parameter/ Instrument	Action Level	Action
VOCs/PID	The 15-minute average of continuous readings for Total VOCs at downwind perimeter of Exclusion Zone exceeds 5 ppm above the determined background level.	Work activities are temporarily halted and VOCs monitoring continued. If downwind Exclusion Zone VOC readings decrease to < 5 ppm above background level, work can resume with continuous monitoring.
VOCs/PID	The 15-minute average of continuous readings is greater than 5 ppm but less than 25 ppm over the background level at the downwind perimeter of the Exclusion Zone.	Work activities must be halted, the source of vapors must be identified and corrective actions taken to abate emissions. Following these steps, work may continue if air monitoring readings indicate the Total VOCs level is 5 ppm or less over background for the 15-minute average at 200 feet downwind of the Exclusion Zone, or at half the distance to the nearest potential receptor or building, whichever is less (but in no case less than 20 feet).
VOCs/PID	Continuous reading of 25 ppm or greater over the background level at the downwind perimeter of the Exclusion Zone.	Stop Work. Reevaluate work conditions and procedures. Contact NYSDEC for authorization prior to resuming work.
Particulates/ Monitor Unit and Direct Observation	PM-10 particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) or greater than the background level for the 15-minute period at the downwind edge of the Exclusion Zone or visible dust is leaving the Exclusion Zone.	Suppress particulates by spraying the dusty area with water, 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 Exclusion Zone.
Particulates/ Monitor Unit and Direct Observation	After implementation of dust suppression techniques, downwind PM-10 particulate levels at the downwind edge of the exclusion zone are greater than 150 $\mu g/m^3$ above the upwind level.	Work must be stopped and the NYSDEC must be notified. Re-evaluate dust suppression techniques. Workers are required to use full face respirators with NIOSH approved P100 cartridges or combination cartridges. Work can resume 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.

References:

DER-10 Technical Guidance for Site Investigation and Remediation, NYSDOH Generic Community Air Monitoring Plan

Appendix C: Guidance for Data Deliverables and Development of Data Usability Summary Reports

1.0 Data Deliverables

(a) DEC Analytical Services Protocol Category A Data Deliverables:

1. A Category A Data Deliverable as described in the most current DEC Analytical Services Protocol (ASP) includes:

i. a Sample Delivery Group Narrative;

ii. contract Lab Sample Information sheets;

iii. DEC Data Package Summary Forms;

iv. chain-of-custody forms; and,

v. test analyses results (including tentatively identified compounds for analysis of volatile and semi-volatile organic compounds)

2. For a DEC Category A Data Deliverable, a data applicability report may be requested, in which case it will be prepared, to the extent possible, in accordance with the DUSR guidance detailed below.

(b) DEC Analytical Services Protocol Category B Data Deliverables

1. A Category B Data Deliverable is includes the information provided for the Category A Data Deliverable, identified in subdivision (a) above, plus related QA/QC information and documentation consisting of:

i. calibration standards;

ii. surrogate recoveries;

iii. blank results;

iv. spike recoveries;

v. duplicate results;

vi. confirmation (lab check/QC) samples;

vii. internal standard area and retention time summary;

viii. chromatograms;

ix. raw data files; and

x. other specific information as described in the most current DEC ASP.

2. A DEC Category B Data Deliverable is required for the development of a Data Usability Summary Report (DUSR).

2.0 Data Usability Summary Reports (DUSRs)

(a) Background. The Data Usability Summary Report (DUSR) provides a thorough evaluation of analytical data with the primary objective to determine whether or not the data, as presented, meets the site/project specific criteria for data quality and data use.

1. The development of the DUSR must be carried out by an experienced environmental scientist, such as the project Quality Assurance Officer, who is fully capable of conducting a full data validation. The DUSR is developed from:

i. a DEC ASP Category B Data Deliverable; or

ii. the *USEPA Contract Laboratory Program National Functional Data Validation Standard Operating Procedures for Data Evaluation and Validation*.

2. The DUSR and the data deliverables package will be reviewed by DER staff. If full third party data validation is found to be necessary (e.g. pending litigation) this can be carried out at a later date on the same data package used for the development of the DUSR.

(b) Personnel Requirements. The person preparing the DUSR must be pre-approved by DER. The person must submit their qualifications to DER documenting experience in analysis and data validation. Data validator qualifications are available on DEC's website identified in the table of contents.

(c) Preparation of a DUSR. The DUSR is developed by reviewing and evaluating the analytical data package. In order for the DUSR to be acceptable, during the course of this review the following questions applicable to the analysis being reviewed must be answered in the affirmative.

1. Is the data package complete as defined under the requirements for the most current DEC ASP Category B or USEPA CLP data deliverables?

2. Have all holding times been met?

3. Do all the QC data; blanks, instrument tunings, calibration standards, calibration verifications, surrogate recoveries, spike recoveries, replicate analyses, laboratory controls and sample data fall within the protocol required limits and specifications?

4. Have all of the data been generated using established and agreed upon analytical protocols?

5. Does an evaluation of the raw data confirm the results provided in the data summary sheets and quality control verification forms?

6. Have the correct data qualifiers been used and are they consistent with the most current DEC ASP?

7. Have any quality control (QC) exceedances been specifically noted in the DUSR and have the corresponding QC summary sheets from the data package been attached to the DUSR?

(d) Documenting the validation process in the DUSR. Once the data package has been reviewed and the above questions asked and answered the DUSR proceeds to describe the samples and the analytical parameters, including data deficiencies, analytical protocol deviations and quality control problems are identified and their effect on the data is discussed.

Appendix D: Site-Specific Health and Safety Plan

Site Specific
Environmental Health and Safety Plan

Clove and Maple Avenues Former MGP
OU1 - Pre Design Investigation

Project Title/Description

120 Maple Avenue, Haverstraw, Rockland County, NY

Project Location

PO # 2037462

Oracle Project Number

Natural Resource Technology

Contracting Company

Orange & Rockland EHS
REVIEW and Signature Page

O&R ENVIRONMENTAL SERVICES

ACCEPTED BY: Maribeth McCormick

DATE: 4/20/15

O&R SAFETY

ACCEPTED BY: [illegible]

DATE: 4/20/15

O&R PROJECT MANAGER

ACCEPTED BY: Maribeth McCormick

DATE: 4/20/15

CONTRACTOR REPRESENTATIVE

ACCEPTED BY: [illegible]

DATE: 4/17/15

Contact Information

Contracting Company Natural Resource Technology, Inc.

Contractor Project Manager John Magee

Phone ______ Cell 609-975-2900

Emergency Contact ______ E-mail Address jmagee@ silarservices.com

Contractor Job Site Supervisor Mark Williams

Phone (518) 456-4900 Cell (518) 222-6616

Emergency # ______ Pager ______

Orange & Rockland EHS/Safety Representative Mark Impomeni (Safety Officer)

Phone 845-577-3277 Cell 845-988-6546

Orange & Rockland EHS/Environmental Services Representative Maribeth McCormick

Phone 845-783-5534 Cell 914-557-1361

Orange & Rockland Site Representative Maribeth McCormick

Phone 845-577-3534 Cell 914-557-1361

Site Location Description 120 Maple Avenue, Haverstraw, Rockland County, NY

Hospital Phone Number 845-348-2000

Fire Dept. Phone Number 911 / 845-429-0300

Off-Site Contacts: Orange & Rockland Utilities

Name:	Title:	Company:	Office Phone:	Cell/Vehicle:
Mark Travers – Section Manager	Safety	ORU	845-577-3241	914-447-6918
Denise Coyle Specialist			845-577-3383	845-590-0226
Tom Lennon Eastern Division			845-577-3895	845-608-6033
Anthony Lombardo Northern Division			845-342-8952	845-629-1410
Mark Impomeni Compliance			845-577-3277	845-988-6546
Gwen Keeble – Section Manager	Environmental	ORU	845-577-3534	917-418-5764
Bobta Kim			845-577-3577	845-558-6644
Gregory Eiband			845-577-3309	845-664-9397
Arthur Barikyan			845-577-3440	845-597-8333
Maribeth McCormick Technical Manager	Environmental	ORU	845-783-5534	914-557-1361

Off-Site Contacts: Contractor

Name:	Title:	Company:	Office Phone:	Cell/Vehicle:
John Magee	Project Manager	Silar Services, Inc.		609-975-2900

COMMITMENT TO SAFETY

The following Environmental Health and Safety Plan (EHASP) has been submitted for review and acceptance by O&R.

The above stated contractor is committed to providing a safe and accident free work environment. The purpose of this written plan is to establish requirements that will assist our field representatives in monitoring and maintaining the desired level of safety and environmental compliance on O&R projects. While written plans and procedures can offer guidance towards a safe and accident free jobsite, it must be realized that the most important safety device is a well trained, mentally aware worker. It shall be the field supervisor's responsibility to ensure that each and every employee working under him/her is aware of and familiar with the requirements of this plan. It shall be Company policy to expect every employee to abide by the provisions of this plan. Penalties for failure to comply with established EH&S procedures include reprimand, suspension and/or permanent dismissal.

In order to assure a safe and accident free work site, all operations will be conducted in accordance with the applicable provisions of this document as well as O&R Safety Requirements, policies, and procedures, 29 CFR 1926 and 1910, Occupational Safety and Health Administration (OSHA), Federal DOT, the Overhead Proximity Act, and all federal, state, and local environmental regulations. Where differences exist between standards, the one affording the greater employee protection shall govern.

Each contractor site supervisor will have the responsibility to ensure all activities performed by his/her crew are performed in a safe and proper manner. The contractor site supervisor will continually monitor the jobsite for health and safety compliance. Should any unsafe practices or equipment be identified, the contractor site supervisor will take immediate steps to correct the situation. All safety problems and corrective actions will be noted and reported to the project manager who in turn will report to the Safety Department. All injuries and spills shall be reported as soon as possible to the O&R project manager who will in turn make the appropriate notifications in accordance with O&R company policy.

If any unusual hazards are found or anticipated at any time during the course of the project, they will be discussed with the O&R Project Manager at that time and an addendum submitted to this EHASP to cover same.

Subcontractors of the above stated contractor will be given copies of this EHASP and will be required to abide by all policies and procedures contained herein. If a subcontractor's work entails tasks not covered by this EHASP an addendum to cover the subcontractors work will be submitted for approval a minimum of 5 business days prior to the subcontractor beginning work on site. It is the responsibility of the Contractor to ensure that any subcontractor is aware of the provisions of this EHASP.

Rules We Live By

The following rules have been established by Orange & Rockland Utilities to prevent employee exposure to hazards that pose imminent danger and can result in serious injury or death. If a Rules We Live By Violation is determined and verified, the contractor employee will be suspended from all O&R and CECONY work for a minimum of 20 days and the Contractor company will have an action line placed against them, at a minimum.

PPE for Hazardous Energy Sources

- Prior to working on hazardous electrical or gas energy sources; use the appropriate rubber gloves, rubber sleeves, fire retardant clothing/coveralls, eye protection/face shield, rubber hose, blankets, hoods etc. as required for exposure to the greatest hazard.

Electric Operating Orders and Clearances

- Do not perform work without properly obtaining permission / clearance from the Operating Authority
- Do not change the status of a piece of equipment without permission from the Operating Authority.
- Follow the proper sequence of all Operating/Switching Orders

Atmospheric Testing

- Before entering and while working in a confined space or in a permit-required confined space proper atmospheric testing and monitoring must be performed.

Verify Dead/Lockout-Tag Out – Before beginning work:

- Conduct or ensure proper lock out/tag out of equipment.
- Properly test or verify that equipment is tested dead and grounded for equipment that is to be worked dead.

Fall Protection/Rescue/Retrieval

- Properly utilize enclosed/confined space rescue equipment.
- Properly utilize fall protection equipment.

Sheeting/Shoring

- Do not enter excavations five feet or deeper unless they are properly sheeted and shored, sloped or benched.

Introduction of Gas to Mains and Services

- Main – A gas main shall not be energized without proper authorization from the Gas Distribution Control Center (GDCC).
- Service – Gas shall not be introduced into an existing service without first closing the riser valve.
- Customer Piping – A proper integrity test must be performed on customer-owned piping after the meter before gas can be restored.

Environmental Health and Safety Plan (EHASP)

1) <u>Work Description</u>

The PDI will consist of the following activities:

- Topographic, property boundary, and utility surveys will be completed to provide a Site map for remedial design and to meet requirements for utility protection.
- Geotechnical drilling will include hollow stem auger (HSA) methods and cased drive and wash rotary methods, if required. Standard penetration testing (SPT) will be used to collect soil samples for geotechnical analysis and delineation of excavation limits.
- Physical soil testing will be performed to evaluate geotechnical properties.
- Direct-push drilling will be used to collect soil samples for chemical analysis to facilitate delineation of excavation limits.
- Aquifer testing will be performed to define aquifer parameters and allow evaluation of excavation dewatering alternatives.
- Perform exterior inspections of adjacent structures, including photographic documentation from the Site or and/or adjacent rights of way (i.e. no access agreements will be required).

The description and rationale for these activities are described in more detail below.

Utility Clearance - Underground and overhead utilities, including electric lines, gas lines, storm and sanitary sewers, and communication lines will be identified prior to initiation of drilling and other subsurface work. This will be performed in conjunction with the Level B Utility Survey.

Site Survey - A field survey will be conducted to assist with the preparation of a base map suitable to support the project design work. Property Boundary Survey - This effort would consist of establishing and recording property boundaries for each of the parcels (Site and drainage swale) in the affected area to be used for preparation of access agreements and designing the remediation work. This survey will meet the DER-33 requirements so that it can be used for any environmental easements or deed restrictions that may be required following the completion of remedial construction. Level B Utility Survey - The NRT Team will perform a Level B utility survey to satisfy mapping requirements. This level of utility survey involves the application of appropriate surface geophysical methods to determine the existence and horizontal position of virtually all utilities within the project limits. The information obtained in this manner is surveyed to project control. Topographic Survey - A topographic survey will be completed concurrently with the subsurface investigations. Following completion of the PDI, all sampling and investigation locations will be surveyed for elevation and location using a licensed New York surveyor. This information, as well as previous sample locations throughout the project area, will be incorporated on the site base map.

Delineation Borings - In order to fill data gaps, further identification of the vertical and horizontal limits of MGP impacts on the Site is required. Thirteen (13) delineation borings will be advanced by a combination of hollow stem auger and direct push drilling methods to depths up to 30 feet below ground surface (bgs). All borings and wells that are drilled/ installed at the Site will require a permit from the Rockland County Department of Health (RCDOH). The borings will be continuously logged, recording the presence of fill material or subsurface obstructions, the nature of each geologic unit encountered, observations regarding moisture content, the PID readings, and visual and olfactory observations regarding the presence of hydrocarbon-like residuals. Samples will be collected from borings and selectively submitted for chemical laboratory analysis. Samples will be submitted for laboratory analysis of Benzene, Ethylbenzene, Toluene and Xylenes (BTEX), and Polynuclear Aromatic Hydrocarbons (PAH) via standard turnaround time.

Delineation of Source Material - Thirteen (13) soil borings are proposed to delineate source material within the various excavation areas and will be advanced by a combination of hollow stem auger and direct push drilling methods to depths up to 30 feet bgs. Two (2) of these borings will be converted into 1¼-inch I.D. observation wells. The borings will be continuously logged, recording the presence of fill material or subsurface obstructions, the nature of each geologic unit encountered, observations regarding moisture content, the PID readings, and visual and olfactory observations regarding the presence of hydrocarbon-like residuals. Samples will be collected from borings and selectively submitted for chemical laboratory analysis. Samples will be submitted for laboratory analysis of BTEX and PAHs via standard turnaround time.

Geotechnical Borings - Six geotechnical borings will be advanced to gather geotechnical information for the purpose of designing the excavation shoring. All borings will be advanced using a truck-mounted drilling rig equipped with 4¼-inch I.D. Hollow Stem Augers (HSA) to a depth of 65 feet bgs. If auger refusal is encountered prior to reaching a boring's target total depth, flush-joint drill casing of appropriate size will be advanced through the augers using drive and wash methods to reach the desired depth. Continuous two (2)-inch Outside Diameter (O.D.) split spoon soil samples will be collected from each soil boring. The geotechnical borings will be continuously logged, recording blow counts, the presence of fill material or subsurface obstructions, the nature of each geologic unit encountered, observations regarding moisture content, the PID readings, and visual and olfactory observations regarding the presence of hydrocarbon-like residuals. All boreholes will be abandoned using non-shrinking cement-bentonite grout to fill the void space left by the auger flights and/or flush-joint casing. Sufficient geotechnical samples will be analyzed to provide a realistic representation of soil conditions. Thin-walled tube samples (Shelby tubes) will be collected for a representative portion of the fine grained soils (clay) encountered.

Hydrogeologic Data Collection - Hydraulic conductivity testing will be performed on seven (7) existing shallow overburden monitoring wells and two (2) newly-installed observation wells using slug and/or bail testing. Further, a k test will be performed on deep overburden monitoring well MW-07, screened in the glacial till unit, to evaluate the hydraulic conductivity of this lower confining unit. Groundwater elevations at existing and new observation wells will be measured to provide data to support dewatering design for construction. Aquifer testing (i.e., a pumping test) will also be performed to allow evaluation of hydraulic parameters. One 4-inch I.D. pumping well (PW-1) and two 1¼-inch I.D. observation piezometers (OW-1 and OW-2) will be co-located with geotechnical and/or delineation borings, based on current knowledge of the Site subsurface conditions. Geologic and hydrogeologic information will be recorded as each boring/well is advanced to the top of the glacial till layer. After completion, the observation wells and pumping well will be developed to ensure proper communication with water-bearing zones of the Alluvial unit.

Exterior Structural Evaluation - The NRT Team will collect data from previous work (e.g., 93B IRM) and perform exterior inspections of adjacent structures, which will include photographic documentation. Photographs and field measurements will be taken from the Site and adjacent rights of way and no access to properties is anticipated.

Waste Characterization - No waste characterization data exists to evaluate various disposal options. The NRT Team will collect waste characterization samples, for profiling purposes, during select PDI activities in order to document waste profiles and evaluate disposal options. Two (2) soil samples and one (1) groundwater sample will be analyzed for appropriate parameters that may include hazardous waste characteristic including corrosivity, ignitability, reactivity and select toxicity (TCLP VOCs, TCLP SVOCs, TCLP Metals, TCLP Pesticides, select TCLP herbicides) as well as PCBs and other facility required parameters. Results will be compared to NYSDEC's Universal Treatment Standards as set forth in 6 NYCRR Part 376.4(j). In addition, abandoned piping present at the site will be exposed and examined via vacuum excavation. This effort will be performed in conjunction with the utility clearance and utility survey. If buried piping is observed to be coal tar-wrapped, up to two (2) samples will be collected and analyzed for waste characterization parameters including PCBs and asbestos so that disposal options may be evaluated.

Investigation-Derived Waste Management - All investigation-derived waste (IDW) generated during the PDI will be collected in properly labeled, new (not refurbished) 55-gallon drums or bulk containers (e.g. roll-off container lined with polyethylene sheeting for solids, fractionation tanks for liquids). IDW includes soil cuttings, recirculation water, decontamination pad and plastic sheeting, personal protective equipment (PPE), decontamination water, well development water, and pumped groundwater. Drums and containers of material will be labeled as "PENDING ANALYSIS – INVESTIGATION-DERIVED WASTE" with a description of the source (e.g., soil cuttings, decontamination water, pumping test water, etc.) and temporarily stored pending characterization and proper disposal. The containerized soils will be disposed of offsite at a facility permitted to accept such material.

The locations for investigation activities are presented on Figure 3 of the Pre-Design Investigation Work Plan, which is attached.

Are permits and/or licenses needed for this work?

Yes [X] No [ ]

If yes, identify the licenses/permits and effective dates and provide attachments.

A drilling permit will be obtained from the Rockland County Health Department and will be submitted to O&R prior to the start of work.

2) Emergency Procedures

Provide emergency evacuation procedures for job location including all emergency contacts (Fire Dept., Police Dept. Nearest hospital etc.). Provide nearest hospital and route map. List all applicable emergency equipment. See Attachment 1 for a listing of local area hospitals and directions. Note: This list may not be all inclusive.

HOSPITAL INFORMATION

Nyack Hospital
160 North Midland Avenue
Nyack, New York
845-348-2000

Emergencies

In the event of a medical emergency, the following procedures should be used:

1. If serious injury or life-threatening condition exists, call 911. Clearly describe the location, injury, and conditions to the dispatcher. Designate a person to show emergency responders to the injured person(s).

2. Call the project manager.

3. Implement steps to prevent the reoccurrence of the accident.

Chemical Emergencies

1. If serious injury or life-threatening condition exists, call 911. Clearly describe the location, injury, and conditions to the dispatcher.

2. Evacuate other on-site personnel to a safe place in an upwind direction until it is safe for work to resume.

3. Call the PM.

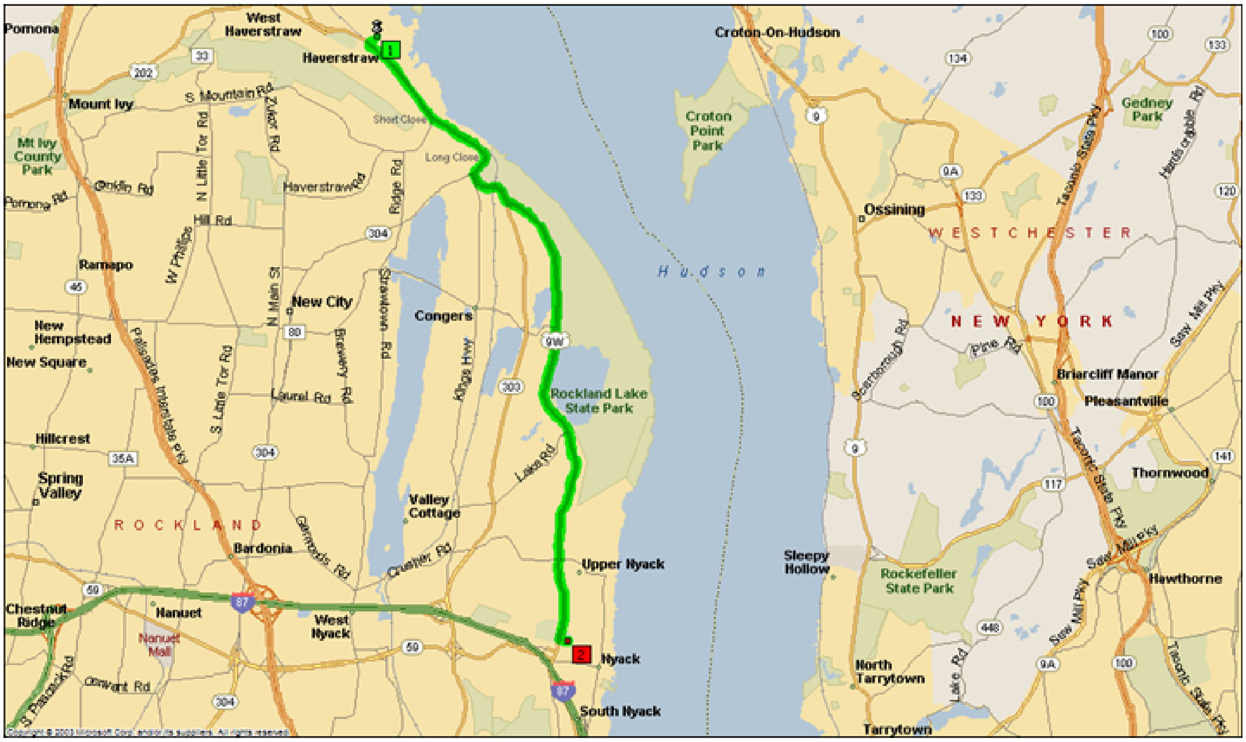
4. If necessary contact clean-up contractor.

5. If release requires contacting government agencies the PM makes the appropriate calls (PM also contacts Client).

General Emergencies

In the case of fire, flood, explosion, spills, severe weather, tank or pipe punctures, or other hazard, work shall be halted and if applicable, 911 called. On-site personnel will immediately be evacuated to a safe place the site via the same route to the hospital as described below. Staff will seek shelter in the nearest sturdy building to get out of harms way. The site safety officer will use the site control sign-in/out sheet to account for all personnel on site during an emergency.

HOSPITAL ROUTE MAP



HOSPITAL ROUTE DESCRIPTION

1. Turn right onto Maple Avenue (maple Avenue becomes West street, West Street becomes Riverside Ave)
2. Turn left onto Short Clove Rd
3. Turn left on US 9W
4. Turn left on 5th Avenue
5. Turn right onto North Midland Avenue
6. 160 North Midland Avenue is on the right

<u>EMERGENCY CONTACT LIST</u>

	Agency Name and Address (if	Contact Number(s)
Fire Dept:	Haverstraw Fire Department	911 / 845.429.0300
Police:	Haverstraw Police Department	911 / 845.354.1500
Sheriff:	Rockland County Sheriff's Department	911 / 845.638.5400
Local Utilities:	Dig Safely New York	800.962.7962
Orange and Rockland	Maribeth McCormick	845. 783-5534
Orange and Rockland	Emergency number	845-577-3600

NRT Team Project Mgr:	John Magee	609.975.2900 office/cellular
Ambulance	911	911
Hospital:	Nyack Hospital 160 North Midland Avenue Nyack, New York 10960	911 Emergency General (**845.348.2000**) Emergency Center (if

3) <u>Site Control</u>

The site is fenced with a locked gate located on Clove Avenue. Site personnel will enter and exit through this gate. All personnel (including subcontractors) entering/leaving the site will be required to sign-in/out using the site control sheet.

Prior to entering any substation, the operating authority shall be contacted and authorization granted prior to entry. Only authorized persons shall enter a substation; non-authorized persons must have an authorized escort.

Buddy System

Each worker will maintain visual contact with another worker. The buddy system will try to ensure against an employee becoming stressed with a co-worker being aware of his or her condition. Workers should watch out for each other while working close to potential chemical and physical hazards. For example, work in the exclusion zone should be scheduled so that no employee works alone in this zone at any time.

Safe Work Practices

To prevent accidental ingestion of chemical contaminants, the following rules must be compiled with when working within the exclusion/contamination reduction zones, and when taking or handling samples.

- No eating, drinking, or smoking is allowed at work locations.
- No fires are allowed at work locations unless approved by the Project Health and Safety Officer on a site-specific, task-specific basis. If fires or propane torches are used, fires will be maintained away from potential ignition sources and site personnel will not leave the fire unattended and a fire extinguisher will be immediately available.
- NRT and contractor personnel must wash their hands, arms, face, and neck immediately after leaving the exclusion/contamination reduction zones. This must also be done after taking samples and prior to eating, drinking, smoking, or using the restroom.

Work Zone Definition

Work crews, whether drilling, excavating, or performing other activities, must prevent the uncontrolled movement of contaminated or potentially contaminated soil, water, PPE, and equipment. Soil and water removed from its natural setting should be considered contaminated unless proven otherwise by chemical analysis or specifically known to be clean material in which verification sampling is occurring. This is also the case for PPE and equipment which either must be decontaminated or disposed. Work crews will prevent migration of contaminated materials by establishing work zones and decontamination procedures. Work zones will be delineated. Only persons certified as having the necessary training and medical qualifications will be allowed in the Exclusion Zone (EZ) or Contamination Reduction Zone (CRZ). The following describes the zones to be established during drilling or excavation:

- Exclusion Zone – An EZ will be established surrounding the drilling or excavation site, if necessary and is the area where contamination does exist or could occur. The EZ will comprise an area of at least as large as a circle having a diameter equivalent to one half the mast height of the drilling equipment or arm of excavating equipment. The size and shape of the EZ will be identified by the PHSO. No personnel will be permitted in the EZ unless they are in full compliance with the site health and safety plan.

- Contamination Reduction Zone - This is the transition area between the exclusion zone and the support zone. It is the area where the decontamination of equipment and personnel takes place. Its purpose is to keep the support zone free of contamination.

- Support Zone: The support zone is the area free of contamination. People wear normal work clothes in this area. The personnel in this zone are responsible for organizing off-site emergency response teams in the event of an emergency.

Daily Start-up and Shutdown Procedures

The following protocols will be followed daily prior to the start of work activities:

- The PHSO will review site conditions to determine if modifications of the work and safety plans are needed.

- Personnel will be briefed and updated at the daily tailgate safety meeting on any new safety procedures based on the previous day's findings and the planned work activity for that day.

- Safety equipment will be checked for proper function.

- The PHSO will try to ensure that the hospital route map and first aid equipment are readily available.

- The PHSO will initiate appropriate observation.

The following protocol will be followed at the end of daily operations and before breaks:

- Personnel will proceed through appropriate decontamination procedures and facilities.
- The work site will be left clean. Drums will be properly labeled and staged.
- All PPE must be removed prior to eating, drinking, smoking, or using the restroom.
- Equipment will be decontaminated and properly stored.

Equipment

Drilling rigs, trucks and heavy equipment should be reviewed at the start of each day to detect equipment problems. Particular attention should be paid to cables and hydraulic lines. Examine them for evidence of stretching, fraying and cracking. The fuel system and hydraulic system should be in good repair (free from leaks) to avoid the potential for fire or explosion. Kill switches should be tested and functioning properly. The drill rig and heavy equipment should be equipped with or have stationed in the area two 20-pound type BC fire extinguishers.

In addition certain equipment (cranes) requires regular inspection and maintenance. A log book is required to document these inspections and maintenance. It is the responsibility of the subcontractor using the equipment, but it is also good practice for the on-site health and safety person to check that the required inspections and maintenance are being performed.

Drilling/Excavation Area

The drilling/excavation area should be located away from overhead electrical lines. The location of buried water, storm and sanitary sewer, electrical, telephone, and gas utility lines must be identified and marked by the authorized personnel. Slope of terrain, stability of embankments, soil load bearing ability, etc. should be evaluated in selection of the drilling/excavation locations.

In addition, a “competent person” as defined by CFR 1926.650 (b) must be designated for excavation safety at the site:

- Competent person means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

The designated competent person has the abilities described above either through onsite experience, classroom training or the combination of both.

4) Job Hazard Analysis and Control

Hazard Identification: Identify all environmental health and safety (EHS) hazards that will be encountered when performing this work. Below are general hazard classifications that you are required to select. All O&R Policies and Procedures are to be followed as directed by the O&R Project Representative.

General Hazard Classifications			Yes	No
1.0	Air Resources			X
2.0	Asbestos Awareness			X
3.0	Asbestos Abatement			X
4.0	Bloodborne Pathogens Exposure Control Plan		Yes	
5.0	Chemical Safety and HAZCOM	*****	X	
6.0	Confined Space Program (Permit-Required)	*****		X
7.0	Crane & Derricks (29 CFR 1926 Subpart CC)	*****		X
8.0	Electrical Safety		X	
9.0	Excavation and Trenching			X
10.0	Fish, Wildlife and Wetlands			X
11.0	Fire Protection and Prevention		X	
12.0	Flame Retardant (FR) Clothing		X	
13.0	Hearing Conservation	*****	X	
14.0	Insulation Materials (Xn-Asbestos)			X
15.0	Lead Management Program			X
16.0	Lockout/Tagout (L.O.T.O)	*****	X	
17.0	Management of Change		X	
18.0	Materials Handling		X	
19.0	Mechanical Equipment		X	
20.0	Noise		X	
21.0	Oil and Dielectric Fluid			X
22.0	PCB Management			X
23.0	Personal Protective Equipment		X	
24.0	Pesticide Use, Storage, and Disposal			X
25.0	Respiratory Protection Program	*****	X	
26.0	Sampling		X	
27.0	Vehicle Management			X
28.0	Waste Management		X	
29.0	Water Resources			X
30.0	Welding and Burning			X
31.0	Work Area Protection		X	
32.0	Working at Elevations			X

Additional hazards not identified include the following:

- **Aquifer Testing**
- **Lockout/Tagout for Service of Drill Rig**

- **Drilling and soil and groundwater sampling**
- **Hydraulic probe and soil and groundwater sampling**
- **Well drilling and abandonment**

NRT's additional Activity Hazard Analyses identified above are included in Attachment B. The following NRT Control Programs are included in Attachment A:

- **Hazard Communication**
- **Aural Conservation**
- **Operations with High Hazard Potential (includes Lockout/Tagout)**
- **Respiratory Safety Protection**
- **Task-Operation Safety and Health Risk Analysis**

This Environmental, Health and Safety Plan (EHASP) has been developed by Orange & Rockland Utilities to serve as a guideline only and does not claim to be an all-inclusive list of each and every possible hazard that can exist on the site. **The contractor identified herein is ultimately responsible for worksite safety, providing on-site EH&S oversight and for informing Orange & Rockland utilities of any changes or EH&S concerns not specifically contained herein.**

Job Briefings

The contractor employee in charge shall conduct a documented signed off job briefing with the employees involved before they start each job, when the scope of work changes, or when new employees enter the work zone. The briefing shall cover at least the following subjects: hazards associated with the job, work procedures involved, special precautions, energy source controls, personal protective equipment requirements, spill reporting and waste management.

5) Hazard Analysis

See attached .pdf file for O&R Hazard Analysis and Attachment B for NRT Activity Hazard Analyses.

The hazards denoted below will also require the contractor's written program as an attachment for review.

******* Hazard 5: Chemical Safety and HAZCOM**
******* Hazard 13: Hearing Conservation**
******* Hazard 16: Lock Out/Tag Out**
******* Hazard 25: Respiratory Protection Program**

Refer to NRT's written programs in Attachment A.

6) Housekeeping

The following protocol will be followed at the end of daily operations and before breaks:

- Personnel will proceed through appropriate decontamination procedures and facilities.
- Tools and equipment will be cleaned and properly stored.
- The work site will be left clean of any debris. Drums will be properly labeled and staged.
- All PPE must be removed prior to eating, drinking, smoking, or using the restroom.
- Any hoses or electric cords that are required to be on the ground will be marked with cones to prevent trips and falls.

Upon completion of the work, the Contractor will remove all work-related materials, chemicals and equipment from the site, unless directed otherwise.

7) Training and Hazard Communication

Safety Data Sheet (SDS) Requirements: All products, materials and chemicals brought to an O&R facility and/or will be used in/on O&R equipment or systems must be approved by the O&R EHS Department prior to initiating work. SDS sheets not older than 5 yrs shall be submitted to O&R for acceptance. List (below) product names of all products and materials for this project, and attach SDS's to this EHASP.

SDS Product/Material Name	Method or Manner In Which It Is To Be Used
Hydrochloric acid	**Preservative for groundwater**
Nitric acid	**Preservative for groundwater**
Methanol	**Preservative for soil**
Isobutylene gas	**Calibration gas for photoionization detector (PID)**
Alkaline batteries	**Batteries for groundwater quality meter**
Lithium batteries	**Battery for PID**
Deep Woods Off	**Bug spray for staff**
Alconcox	**Decontamination of equipment**
Sodium hydroxide	**Preservative for groundwater**
Nicad batteries	**Field equipment**
YSI turbidity solution	**Calibration solution for water quality meter**

Sun X SPF 30 Broad Spectrum Spray	**Prevention of sun burn**

Are all your personnel (including sub-contractors) trained to conduct their job responsibilities in this plan?
Yes [X] No [ ]

Are your employees Haz-Com trained in the hazards they will be confronting for this project?
Yes [X] No [ ]

Job Briefings will be conducted with employees at the start of the shift?
Yes [X] No [ ]

How often are documented safety talks conducted?
Daily [X] Shift [ ] Weekly [ ]

Will all visitors be briefed on evacuation/fire/emergency procedures?
Yes [X] No [ ]

Will all Sub-Contractors be covered under this site-specific HASP?
Yes [ ] No [X]

If respirators are used, will all employees be medically qualified, clean-shaven and fit-tested in the respirator?
Yes [X] No [ ]

Comments (explain all negative responses and discuss with the O&R Representative):
Subcontractors will be required to have their own HASP but will need to adhere to all the requirements of this HASP.

8) <u>Environmental Management</u>

Check-off and address all environmental issues for this work:

Spill Management	[ ]	Waste Management	[X]
Asbestos Management	[ ]	Hazardous Waste Management	[ ]
PCB Management	[ ]	Water Resources: streams, lakes, erosion	[ ]
Wetlands	[ ]	Protected Species: fish and wildlife	[ ]
Air Resources	[ ]	Other	[ ]

Explain in detail all issues identified above and control methods to manage or avoid the concern:

Waste Management

Prior to commencing work, the O&R project coordinator will notify O&R Environmental Services of the project schedule.

Soil and groundwater investigative derived waste (IDW) will be assumed to contain volatile organic compounds and polycyclic organic compounds (based on previous data). Soil and groundwater IDW will be contained in 55-gallon Department of Transportation (DOT) approved drums. All containers of wastes will be properly labeled with all pertinent information including waste description, date, location, and names of the O&R Site Representative and Contractor. The Contractor will transfer the labeled containers of waste(s) to the onsite O&R waste storage area/building designated by the O&R Site Representative and Environmental Services. The O&R Site Representative will then immediately notify O&R Environmental Services about the waste(s).

Soil and groundwater samples will be sampled and analyzed for waste characterization parameters for disposal purposes as described in the PDI workplan. If Hazardous Waste is generated by this work, the Contractor will immediately notify the O&R Site Representative who will contact O&R Environmental Services for guidance on management of the wastes.

Upon completion of the work, the Contractor will remove all work-related materials, unused products, chemicals, equipment and non-hazardous waste from the site, unless directed otherwise. Waste disposal will be in accordance with all applicable laws and regulations, and with the requirements of Section 9.

9) Waste Disposal

Soil and groundwater IDW will be generated during site activities. The number of drums of soil and water is unknown at this time. IDW will be stored in DOT – approved 55 gallon drums and properly labeled with all pertinent information including waste description, date, location, and names of the O&R Site Representative and Contractor. The Contractor will transfer the labeled containers of waste(s) to the onsite O&R waste storage area/building designated by the O&R Site Representative and Environmental Services. The O&R Site Representative will then immediately notify O&R Environmental Services about the waste(s).

Soil and groundwater samples will be sampled and analyzed for waste characterization parameters for disposal purposes as described in the PDI work plan. If Hazardous Waste is generated by this work, the Contractor will immediately notify the O&R Site Representative who will contact O&R Environmental Services for guidance on management of the wastes.

Waste transportation companies and disposal facilities for the project will be approved by O&R Environmental Services prior to initiating the work.

10) Contractor Employee Acknowledgement

Contractor site supervision is responsible for assuring the contents of this EHASP are known by all contractor employees and are implemented on site during performance of the work.

Typical Hazards of Concern

Physical					
Heat	X	Noise	X	Radiation	
Cold	X	Confined Space		Excavation	
Trenching		Welding		Burning	
Electrical	X	Fire Protection	X	Road Work	X
Rotating Equipment	X	Cranes		Work in Elevations	
Scaffolding		Rigging		Material Handling	X
Grinding		Hand Tools	X	Demolition	
Ladders		Steel Erection		Concrete	
Power Tools	X	Mechanical Equipment	X	Slippery Surfaces	
Chemical					
Lead	X	Asbestos		PCBs	
Mercury	X	Oil		Lubricants	
Cement	X	Dielectric Fluid		Solvents	
Gasoline		Diesel		Other Fuels	
Silica		Carbon Monoxide		Pesticides	
Dust-Particulates		Hydrogen Sulfide		Isocyanates	
Acids	X	Caustics		Glues	
Adhesives		Epoxies		Detergents	
Bleach		Ammonia		Heavy Metals	X
Benzene	X	VOCs	X	Lacquers	

Solders	☐	Asphalt	☐

Attachment 1
(This list may not be all inclusive, be sure to complete section 2.0 - Emergency Procedures with the appropriate information.)

Hospital Locations

NYACK HOSPITAL – NYACK, NY

Main Hospital Phone:
845-348-2000

Address:
160 North Midland Avenue
Nyack, NY

From New Jersey and Upstate New York.

From New Jersey, take the Garden State Parkway North to the New York State Thruway South. From upstate New York, take the New York State Thruway South, or the Palisades Parkway South to the New York State Thruway South. Exit the Thruway (I-287/I-87)at Exit 11, Nyack. At the traffic light, turn left onto Route 59 East. Proceed ahead under the overpass to the next traffic light (corner of Route 9W). Turn left onto Route 9W North. Proceed to the next traffic light, then continue ahead one block. The hospital entrance is on the right.

GOOD SAMARITAN HOSPITAL – SUFFERN, NY

Main Hospital Phone:
845-368-5000

Address:
255 Lafayette Ave.
(Route 59) Suffern, NY

Good Samaritan Hospital is located 30 miles north of New York City, in the southwest portion of Rockland County, New York, and just one mile from Bergen County, New Jersey.

From the Tappan Zee Bridge
(from Westchester County and points southeast)

1. From the Tappan Zee Bridge toll plaza, continue northwest approximately 14 miles on 287/87 (New York State Thruway).
2. Take Exit 14B and go to the traffic light. At the traffic light, make a left onto Airmont Road.
3. Proceed to the second traffic light and make a right onto Route 59 (Lafayette Avenue).
4. Proceed approximately one mile. Good Samaritan Hospital is on the left side of Route 59. Park in visitor's lot and proceed to information desk in lobby.

From the Garden State Parkway North
(from New Jersey)

1. Take the Garden State Parkway North.

2. Proceed onto Route 287/87, also known as the New York State Thruway, following signs to Albany. Proceed to Exit 14B.
3. At the traffic light, make a left onto Airmont Road.
4. Proceed to the second traffic light and make a right onto Route 59 (Lafayette Avenue).
5. Proceed approximately one mile. Good Samaritan Hospital is on the left side of Route 59. Park in visitor's lot and proceed to information desk in lobby.

From the Palisades Interstate Parkway North
(from Bergen County, lower Rockland and New York City)

1. Take the Palisades Interstate Parkway north to Exit 9W (Albany - Route 287/87 - New York State Thruway).
2. Proceed on the New York State Thruway to exit 14B.
3. At the traffic light make a left onto Airmont Road.
4. Proceed to the second traffic light and make a right onto Route 59 (Lafayette Avenue).
5. Proceed approximately one mile. Good Samaritan Hospital is on the left side of Route 59. Park in visitor's lot and proceed to information desk in lobby.

From Route 17 North
(from Bergen County and Orange County)

1. Follow signs to New York State Thruway (287/87) southeast. Signs will indicate New York City.
2. Proceed to Exit 14B and at the traffic light make right onto Airmont Road.
3. Proceed to the second traffic light and make a right onto Route 59 (Lafayette Avenue).
4. Proceed approximately one mile. Good Samaritan Hospital is on the left side of Route 59. Park in visitor's lot and proceed to information desk in lobby.

From Route 4
(Ramsey/ Mahwah area)

1. Continue on Route 17N for 7-8 miles.
2. Follow signs for Route 202-Suffern, just past the Toyota Dealership and Quest Fitness Center on the right.
3. Continue bearing right and follow H signs, this becomes Washington Avenue.
4. At the end is Sacred Heart School/ Church and a light - make right turn.
5. Continue for approximately 1 mile on Route 59 (Lafayette Ave). Hospital is on the right. Park in visitor's lot and proceed to information desk in lobby.

THE VALLEY HOSPITAL – RIDGEWOOD, NJ

Main Hospital Phone:
201-447-8000

Address:
223 N. Van Dien Avenue
Ridgewood, NJ 07450

The Valley Hospital is located at 223 N. Van Dien Avenue in Ridgewood. A parking attendant is on duty at the Main Entrance to assist you.

From New Jersey & South: Take Garden State Parkway North to Exit 163. Follow Route 17 North. Exit at Linwood Avenue Westbound. Cross over Route 17 and continue on Linwood Avenue to third traffic light. Turn right on North Van Dien Avenue to Main Entrance.

From New York City Area: Take George Washington Bridge to New Jersey. Follow I-80 (express or local lanes) to Garden State Parkway North exit. Follow **directions** above (From New Jersey & South).

From New York State & North: Take NY Thruway (I-87) south to Suffern (Route 17) exit. Follow Route 17 South. Exit at Linwood Avenue Westbound. Proceed on Linwood to third traffic light. Turn right on North Van Dien Avenue to Main Entrance.

From Westchester & New England: Take Connecticut Turnpike (I-95) and Cross-Westchester Expressway (I-287) to Tappan Zee Bridge. Continue to Exit 14A, the Garden State Parkway extension exit. Travel south to New Jersey to Exit 166. Turn right off ramp, then left onto Linwood Avenue (at Charlie Brown's), crossing over Route 17, to third traffic light. Turn right on North Van Dien Avenue to Main Entrance.

From Northern Pennsylvania & West: Take I-80 East to Garden State Parkway North. Follow **directions** above (From New Jersey & South).

SAINT ANTHONY COMMUNITY HOSPITAL - WARWICK

Main Hospital Phone:
845-986-2276

Address:
15-19 Maple Avenue
Warwick NY 10990

From the NJ Turnpike:

1. NJ Turnpike North to Route 3 West exit (when going north on the Turnpike, the road divides for "W" and "E" exits- KEEP LEFT for "W" exit).
2. Route 3 West will turn into Route 46 West.
3. Proceed approximately 5 miles on Route 46 West, then take Route 23 North.
4. Proceed approximately 40 miles, then turn right onto Route 515 (Highland Lakes exit).
5. Proceed approximately 7 miles on Route 515 to traffic light. Continue straight on Route 94 for approximately 7 miles through the Village of Warwick. The hospital is on your left (at the corner of Grand Street and Maple Avenue).

OR

1. NJ Turnpike North to NYS Thruway North to Exit 16 (Harriman).
2. Proceed West on Route 17.
3. Take Exit 127 (Warwick/ Sugar Loaf); bear left at stop sign.
4. At the multiple light intersection, proceed straight across Route 17A to Kings Highway (County Rt. 13).
5. Follow Kings Highway (County Rt. 13) past Sugar Loaf, making a right at the stop sign.
6. Make a left at the next stop sign and proceed about 3-4 miles to the end of the road.
7. Turn right at the light at the Mobil gas station. The hospital is on your left (at the corner of Grand Street and Maple Avenue).

From the Tappan Zee Bridge:

1. After the Tappan Zee Bridge, take NYS Thruway to Exit 16 (Harriman exit).
2. Follow directions above from line 2.

From the George Washington Bridge:

1. Take Route 80 West to Route 17 North.
2. Continue on Route 17 to New York and proceed through Tuxedo.
3. At the traffic light (Sterling Forest/Greenwood Lake exit) make a left onto 17A West.
4. Continue on 17A until you get to Warwick (road ends).

5. Make a right onto Route 94 and go through center of town, the hospital will be on your left (at the corner of Grand Street and Maple Avenue).

From Albany:

1. Take the NYS Thruway South to Exit 17, Stewart Airport exit.
2. Take the second exit onto Route 84 West.
3. Take 84 West to Middletown, take Exit 4 to Route 17 East.
4. Proceed on Route 17, take exit 124 (Florida/Goshen).
5. Proceed to the stop light at the end of the ramp and turn left onto Route 17A (also Route 94) towards Florida.
6. Proceed approximately 10 miles into the Village of Warwick. The hospital will be on your right (at the corner of Grand Street and Maple Avenue).

From Port Jervis:

1. Take Route 84 East to Exit 2 (Greenville) and turn left.
2. Proceed 1/4 mile and turn left onto Route 6 and continue for 2/3 mile.
3. Turn right onto County Route 1 (look for sign to Warwick).
4. Continue through Pine Island staying on Route 1.
5. Turn left at the blinking light; proceed ½ mile and bear right at the "Y".
6. Continue into the village of Warwick. The hospital will be on your left (at the corner of Grand Street and Maple Avenue).

FIRST CARE ASSOCIATES - MONROE

Main Phone:
845-783-6699

Address:
505 Route 208 #15
Monroe, NY 10950

From NYS Thruway- Take Route 17W, exit 130. Go straight through light, we are located on bottom level.

NEED DIRECTIONS FOR ORANGE REGIONAL

BON SECOURS COMMUNITY HOSPITAL – PORT JERVIS

Main Hospital Phone:
845-858-7000

Address:
160 East Main Street
Port Jervis, NY 12771

From New York:

1. Take New York State Thruway North over Tappan Zee Bridge to exit 16 (Harriman).
2. Take Route 17 West.
3. Take Exit 123 for Port Jervis - Route 84 West.
4. Take 84 West to last exit in New York (Exit 1).
5. At end of ramp, turn left follow. The hospital is located on the right hand side.

From Pennsylvania:

1. Interstate 84 East into New York.
2. Take first exit (Exit 1) which says Port Jervis.

3. At the end of the ramp, turn right. Proceed to traffic light.
4. At traffic light, turn left onto Main Street, Route 6.
5. Go through two additional traffic lights, over the bridge.
6. Proceed approximately 1/2 mile. You will see the hospital on your right. Parking is in the back. You may enter the building through the back main entrance.

From New Jersey:

1. Take Route 80 W to Route 15 N (Exit will also say Sparta).
2. Take 15 N to 206 N (straight through a four-way light 15 becomes 206).
3. Continue on 206 N all the way to the entrance to the bridge to Pennsylvania (Montague/Milford) bridge. DO NOT CROSS THE BRIDGE.
4. Bear right onto 521 - this is River Road - continue to end of 521 (light) There is a fish market on the left.
5. Turn left, cross the bridge, this is East Main Street. Continue on East Main Street about ¼ mile. Hospital is on right.

MILFORD URGENT CARE - PENNSYLVANIA

Main Hospital Phone:
570-409-9700

Address:
111 E. Catharine Street – Suite 130
Milford, PA 18337

<u>From Newton Memorial Hospital</u>
Left out of driveway (Route 94 N). Follow Route 94 around Newton town square to US Route 206. Continue for 4.9 miles. Left at light in Augusta (continuation of US 206). Follow for approx 16 miles, (will cross into Pennsylvania) turn slight right onto US 209. Continue for 8/10 mi. Turn right onto us 6/ Broad St. Proceed for 1/10 mi., turn right onto E. Catherine Street. Milford Health & Wellness Center will be approx. 1/10 mi. on right.

<u>From Eastern New Jersey</u>
Take I-80 West to exit 34B Route 15N Jefferson/Sparta. Continue on 15N to end (approx 18 miles). 15N turns into US 206N, follow for approx. 16 miles (will cross into Pennsylvania). Turn slight right onto US 209. Continue for 8/10 mi. Turn right onto us 6/ Broad St. Proceed for 1/10 mi., turn right onto E. Catherine Street. Milford Health & Wellness Center will be approx. 1/10 mi. on right.

NEWTON MEMORIAL HOSPITAL – NEWTON, NJ

Main Hospital Phone:
973-383-2121

Address:
175 High Street
Newton, NJ 07860

<u>From Northeastern New Jersey</u>
Take I-80 West to exit 25 marked "Exit 25 US-206 N to Stanhope / Newton" and go North for 0.3 miles.
Bear left onto US-206 and go North for 12 miles. Turn left onto Liberty Street (Dennis library will be on right corner).
At end(1/10 mi.), turn left onto Hwy 94 West (High Street). Newton Memorial Hospital will be on right, approx. 1/10 mi.

<u>From Northwestern New Jersey</u>
Take I-80 East to exit 25 and then follow directions from Northeastern New Jersey (above).

<u>From Central and Southern New Jersey</u>
Take I-287 North to Exit 22B "US-202 N / US-206 N to Bedminster / Netcong" and go South for 0.3 miles.
Bear right on US-206 and go North for 18 miles. Turn left on ramp at sign reading "I-80 W / US-206 N to Newton" and

go West for 0.4 miles. Continue on I-80, US-206 and go Northwest for 1.4 miles. Exit I-80, via ramp at sign reading "Exit 25 US-206 N to Stanhope / Newton" and go North for 0.3 miles. On US-206 go North for 12 miles. Turn left onto Liberty Street (Dennis library will be on right corner). At end(1/10 mi.), turn left onto Hwy 94 West (High Street). Newton Memorial Hospital will be on right, approx. 1/10 mi.

From Newark Area
Take I-280 West to I-80 West to exit 25. Follow as road goes into US 206 North. Turn left onto Liberty Street (Dennis library will be on right corner). At end(1/10 mi.), turn left onto Hwy 94 West (High Street). Newton Memorial Hospital will be on right, approx. 1/10 mi. Follow signs to Hospital entrance.

From Eastern Pennsylvania
Take I-78 East to State Route 57 East. Exit onto US 46 East and turn left onto I-80 East.to exit 25. Follow as road goes into US 206 North. Turn left onto Liberty Street (Dennis library will be on right corner). At end(1/10 mi.), turn left onto Hwy 94 West (High Street). Newton Memorial Hospital will be on right, approx. 1/10 mi. Follow signs to Hospital entrance.

ORANGE REGIONAL MEDICAL CENTER – MIDDLETOWN, NY

Directions to:
Orange Regional Medical Center, 707 East Main Street, Middletown:

From the East:
Take I-84 West. Merge onto NY-17 East via Exit 4E toward New York.
Take Exit 122 - East Main Street / Crystal Run Road.
Take left at light onto East Main Street.
Drive approximately 0.3 miles.
Hospital entrance will be on your right.

From the West:
Take I-84 East.
Merge onto NY-17 East via Exit 4E toward New York.
Take Exit 122 - East Main Street / Crystal Run Road.
Take left at light onto East Main Street.
Drive approximately 0.3 miles.
Hospital entrance will be on your right.

From the North:
Take I-87 South / New York State Thruway South.
Take Exit 17 - Route 17K / I-84 / Newburgh / Stewart Airport.
Pay toll and follow signs for I-84 West.
Merge onto I-84 West.
Merge onto NY-17 East via Exit 4E toward New York.
Take Exit 122 - East Main Street / Crystal Run Road.
Take left at light onto East Main Street.
Drive approximately 0.3 miles.
Hospital entrance will be on your right.

From the South:
Take I-87 North / New York State Thruway North.
Take Exit 16, NY 17 toward US 6 / Harriman.
Merge onto NY-17 West. Take Exit 122 - Crystal Run Crossing
Turn right at first light.
Turn right at next light onto Crystal Run Road; Crystal Run Road turns into East Main Street.
Drive approximately 0.6 miles.
Hospital entrance will be on your right.

LIST OF ATTACHMENTS

5) Hazard Analysis

1.0 Air Resources

Air Resources

Federal, State and local laws require that the public and the environment be protected from nuisance levels of dust, smoke, odors and other airborne contaminants. Regulations have been adopted that limit the release of materials such as particulates, combustion exhaust, volatile solvents, paint fumes and many other chemicals. The operation of specific types of equipment may require a permit, certificate, or other approval from the appropriate regulatory agency. Similarly, the construction and operation of certain types of facilities may also be regulated. The contractor shall ensure that all applicable permits, licenses or certificates are obtained and maintained onsite and provided to Orange & Rockland when requested.

- All sources of potential air contaminants (e.g. combustion exhaust, volatile solvents, cleaners or coatings, etc.) that might result from activities on the site are identified and control measures implemented to minimize or eliminate the contaminants released to the environment. Testing, monitoring or other recognized means of ensuring that the implemented controls measures are effective in controlling the contaminant generation to a level that is, at a minimum, compliant with all existing federal, state and local regulations and requirements shall be available for immediate implementation. All air permits and approvals necessary for any project related construction and/or equipment operations shall be obtained.

- All monitoring, recordkeeping, and reporting requirements shall be documented in written format.

- Architectural coatings shall meet applicable volatile organic compounds (VOC) content limitations.

- Surface coatings containing asbestos are prohibited and may not be applied or otherwise used on O&R projects unless written authorization to use such products is obtained from O&R.

- Motor vehicles are prohibited from excessive idling, follow local, state, and federal regulations.

- Verify that the use of solvent or other materials comply with applicable VOC limits as well as established storage, emissions and equipment specifications.

- Fuels transported, stored, or burned must meet applicable limitations on sulfur content, waste content, gasoline volatility and oxygen content, particulate matter (PM), nitrogen oxides (NO_x), and VOC emission limitations, exhaust opacity, equipment requirements and testing, monitoring, recordkeeping, and reporting.

- Procedures for storage and transfer of petroleum or volatile organic liquids must meet specific emission control equipment requirements and performance requirements.

- Facilities storing and dispensing gasoline must comply with specific equipment and vapor recovery emission control requirements.

- Commercial and consumer products supplied to or used on O&R property as part of the project must comply with any applicable VOC content limitations.

- Ozone depleting chemicals must be controlled and disposed of in accordance with the United States Environmental Protection Agency (USEPA) regulations.

Regulatory Citations

- Full text for regulatory requirements can be found in:
- Title 40 Code of Federal Regulations (CFR), USEPA, Parts 50 through 93;
- Title 6 New York Code of Rules and Regulations (NYCRR), Parts 200 through 258;

Contacts

For additional information contact the following agencies:

- Projects in Orange County, contact the Region 3 at 21 South Putt Corners Rd, New Paltz, NY 12561 (914-256-3000). www.dec.state.ny.us.
- Projects in Rockland County, contact Rockland County Department of Health on Sanatorium Road, Pamona, NY 10970 (914-634-2500). www.co.rockland.ny.us.

2.0 Asbestos Awareness

Asbestos Awareness

Asbestos has been used in thousands of different types of insulation materials, friction products and building materials. If damaged, asbestos-containing materials (ACM) can release asbestos fibers, which tend to remain airborne for long periods of time and pose an inhalation hazard. Within the O&R system, asbestos may be found in boiler thermal insulation, electrical arc proof tape, coal tar wrap, transite arc proofing tape, prevention panels, gaskets, valve packing material, etc. If asbestos is suspected or found regardless of location, all work will stop and the O&R representative will be notified immediately. All unknown suspect material shall be treated as asbestos material. **Only O&R approved asbestos abatement contractors shall be utilized for work involving asbestos.** O&R has an established Asbestos Management Program to control and manage ACM and contractors operations will be consistent with this program.

All asbestos related work must be conducted in compliance with all regulatory requirements.

- Contractor employees working under this EHASP are trained to the Asbestos Awareness level and have been informed of the varying types of asbestos containing materials they may encounter.

Non Approved Asbestos Abatement Contractor

- If asbestos and/or ACM is encountered or suspected, the Contractor will suspend work, the work area will be secured and the Contractor will immediately notify the O&R Site Representative, who will contact O&R EHS Department for guidance.
- Contractors are required to ensure that ACM is not inadvertently contacted or disturbed.
- Suspect materials must be assumed to be ACM until results of sampling by a certified individual and/or analysis by a certified lab proves the material to be non-AC, or historical documentation shows the material to be non-asbestos containing.
- **Contractors must inform the Safety Department prior to performing work which will have the potential to disturb materials which may contain asbestos. New York State requires nearly every material to be tested for asbestos unless it is assumed to contain asbestos. Only approved asbestos contractors are permitted to handle ACM.**

Approved Asbestos Contractor

- Contractors will comply with the local, state and federal regulations for ACM work.

- All contractors handling ACM will have a current DOL Handling License, and all workers must be certified by the Department of Labor. Workers shall be trained in the specific tasks they will perform**.** Asbestos awareness training will be provided for all personnel working in areas that may contain ACM.

- **Contractors must inform the Safety Department prior to performing work that will disturb materials which may contain asbestos. New York State requires nearly every material to be tested for asbestos unless it is assumed to contain asbestos.**

- The contractor will use necessary equipment (neg. air machines, HEPA vacuums, wet methods) for activities that disturb ACM to control the releases of fibers and appropriate PPE (respirators, protective coveralls, gloves, etc.) to ensure the safety of personnel.

- The contractor will comply with federal, state and local regulations, including approved site work procedures, appropriate notifications, asbestos abatement, disturbance control, personal and facility decontamination procedures, housekeeping practices, final cleanup requirements and clearance procedures, and project engineering control methods.

- The contractor will use the proper personal protective equipment and air monitoring procedures.

- The contractor will provide and maintain a Medical Surveillance Program and Respiratory Protection Program for employees.

- The storage/transport/disposal of ACM will comply with federal, state, and local regulations.

- The contractor will maintain asbestos project and employee records for projects including, but not limited to, exposure monitoring records, medical records, training records, fit-test records, and project specific records, such as the amounts and types of asbestos abated, logbooks, waste transportation information and site identification information, etc.

Regulatory Citations
Federal:

- Title 29, Code of Federal Regulations (CFR), Occupational Safety and Health Administration (OSHA), Part 1910.1001 - General Industry Standards for Asbestos.

- Title 29, CFR, OSHA, 1926.1101 - Construction Standards for Asbestos.

- Title 40, CFR, Environmental Protection Agency (EPA), Part 61, Subpart M - National Emission Standards for Hazardous Air Pollutants (NESHAPS) - Asbestos.

- Title 40, CFR, EPA, Part 763, Subpart E, Revised Appendix C - Asbestos Hazard Emergency Response Reauthorization Act (AHERA).

- Title 49, CFR, Department of Transportation, Part 172 - Hazardous Materials Table.

Contacts:
For additional information contact the following agencies:

- Region 3 NYSDEC office located at 21 South Putt Corners Road, New Paltz, NY 12561 (914-256-3000). NYDECS's website can be found at www.dec.state.ny.us.
- OSHA's website can be found at www.osha.gov

3.0 Asbestos Abatement

Asbestos Abatement

Asbestos has been used in thousands of different types of insulation materials, friction products and building materials. If damaged, asbestos-containing materials (ACM) can release asbestos fibers, which tend to remain airborne for long periods of time and pose an inhalation hazard. Within the O&R system, asbestos may be found in boiler thermal insulation, electrical arc proof tape, coal tar wrap, transite arc proofing tape, prevention panels, gaskets, valve packing material, etc. If asbestos is suspected or found regardless of location, all work will stop and the O&R representative will be notified immediately. All unknown suspect material shall be treated as asbestos material. **Only O&R approved asbestos abatement contractors shall be utilized for work involving asbestos.** O&R has an established Asbestos Management Program to control and manage ACM and contractors operations will be consistent with this program.

All asbestos related work must be conducted in compliance with all regulatory requirements.

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- All contractors handling ACM will have a current DOL Handling License, and all workers must be certified by the Department of Labor. Workers shall be trained in the specific tasks they will perform**.** Asbestos awareness training will be provided for all personnel working in areas that may contain ACM.

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- The contractor will comply with federal, state and local regulations, including approved site work procedures, appropriate notifications, asbestos abatement, disturbance control, personal and facility decontamination procedures, housekeeping practices, final cleanup requirements and clearance procedures, and project engineering control methods.

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Contacts:
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- Region 3 NYSDEC office located at 21 South Putt Corners Road, New Paltz, NY 12561 (914-256-3000). NYDECS's website can be found at www.dec.state.ny.us.

OSHA's website can be found at www.osha.gov

4.0 Bloodborne Pathogens Exposure Control Plan

Bloodborne Pathogen/First Air/CPR

Bloodborne pathogens (BBP) are pathogenic microorganisms that may be present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV). A source of occupational exposure may occur when an employee gives First Aid and CPR to an individual who has infectious blood. The occupational exposure occurs when there is the possibility for an employee's eyes, mucous membranes, non-intact skin (i.e., cut and abraded skin) to come into contact with potentially infectious materials from another employee. Additional sources of exposure are contact with infectious waste found at project sites, glassware, needles and other sharp objects which have been involved in injuries to personnel and are contaminated with blood or related bodily fluids.

- Contractors shall report all injuries/illnesses immediately to the O&R representative, regardless of the severity.
- For any serious injury, contractors shall call the local emergency contact number or 911 as appropriate. **Injuries that occur at an operating facility contact 845-577-3600 for emergency notification.**
- All jobsites will be equipped with First Aid Kits.
- If there is a reasonably anticipated contact with any potentially infectious materials, the contractor's **written** BBP Exposure Control Plan must be available to all contractor and O&R personnel for review upon request.
  - The Exposure Control Plan must include procedures for:
    - Exposure determinations;
    - Methods of compliance;
    - HBV vaccinations and post-exposure evaluation and follow-up;
    - Communications of hazards to workers;
    - Worker training.
- Universal precautions (i.e., treat all potentially infectious material as if it were infected) must be used at all times.

- Proper PPE must be used at all times when there is a chance for exposure to infectious materials.

- Hand-washing facilities or products (antiseptic hand cleaner, etc.) must be readily available to all employees.

- All infectious material must be placed in appropriate, labeled containers (sharps containers, biohazard bags, etc.) and disposed of properly.

- All infected equipment and surfaces must be decontaminated with an appropriate disinfecting solution prior to reuse.

- All employees with a reasonable risk for exposure must attend appropriate training.

- All required records for exposed employees must be kept confidential.

No exposure to blood borne pathogens (BBP) is expected during the normal course of work in this EHASP. Contractor employees working under this EHASP will be trained in basic first aid and be knowledgeable in the proper handling and disposal of infectious waste. Notification of injuries will be made immediately to the O&R Representative who will in turn notify the Safety Department. BBP spills will be reported immediately to the O&R Environmental Services Department.

Regulatory Citations

A complete text of the requirements for BBP can be found in Title 29 Code of Federal Regulations, 1910.1030.

Contacts

For additional information regarding BBP requirements or clarification of these requirements, contact the New York regional OSHA office or visit the OSHA web site at: www.OSHA.gov

5.0 Chemical Safety & HAZCOM

Chemical Safety & Hazard Communication (HAZCOM)

Several entities at the local, state and federal level regulate the usage, storage and handling of potentially hazardous chemical. OSHA focuses on worker exposure. The OSHA regulations require that the potential hazards associated with all chemicals used or stored at a job site be evaluated. This information, along with appropriate protective information, must then be communicated to workers who may be exposed to these chemicals or use them in their daily jobs.

Federal, state and local regulations also regulate the storage of materials from a public health perspective. These regulations are designed to protect against accidental release of chemicals due to spills, emissions and other causes. In addition to established codes, regulations and ordinances, O&R has established additional requirements that must be followed when storing, handling, transferring and processing specific chemicals.

For the purposes of this document, a hazardous chemical is defined as a chemical for which there is valid evidence that exposure to the chemical may result in acute or chronic health effects upon exposure. Physical hazards are defined as materials which are combustible, flammable, explosive or otherwise reactive.

- The SDS for the chemical(s) is required to be on site when the chemical(s) is present
- All chemicals must be approved for use in or on O&R facilities **prior** to bringing onsite.
- If any hazardous material is used or stored at the job site, the contractor's **written** HAZCOM program must be available to all contractor and O&R personnel for review upon request.
- The HAZCOM program must include procedures for:
  - Labeling containers and the use of warning forms;
  - Obtaining and retaining Safety Data Sheets (SDS);
  - Specific worker training requirements;
  - Documentation that these training requirements have been completed by each worker;
  - A list or inventory of hazardous material at the job site.

- The supervisor must inform all workers about the hazardous materials at the job site when they are first assigned to a project and whenever a new hazardous material is brought to the site.

- Workers must be informed of the location of:

    - The HAZCOM program;

    - The list/inventory of hazardous substances;

    - The locations of SDSs and the procedures for obtaining a copy of an SDS;

    - These must all be available for each worker to review during their work period.

- The O&R representative must be informed of all chemicals brought to or delivered to the site.

- When more than one contractor is working at a site, each contractor must inform each other about the products that will be brought to the site and the location of their HAZCOM programs and SDS sheets.

- **THE PRIME CONTRACTOR IS RESPONSIBLE FOR COORDINATING THE HAZCOM PROGRAM ON THE JOB SITE.**

- Contractors must ensure that all containers are appropriately labeled as per the labeling requirements including:

    - Labels on hazardous material containers will not be defaced or removed.

    - The labels will identify the substance in the container and appropriate warnings about the substance.

    - The material identity will match the material currently in the container, its SDS, and the overall list/inventory.

- A documented training program is to be developed, implemented and maintained and that every employee at the jobsite participates in the training. This training shall include:

    - Information regarding the HAZCOM program

    - Health, safety and environmental hazards of all chemicals used at the job site

    - Ways to detect the presence of hazardous materials at a job site, including monitoring methods and devices used
    - How to read and understand the information contained on a SDS
    - How workers can protect themselves from harmful exposure (e.g., safe work practices, personal hygiene, and protective equipment, etc.)

- All employees shall be trained in the proper use, storage, and handling of chemicals in the workplace.

Regulatory
A complete text of the requirements for HAZCOM can be found in the Code of Federal Regulations, 1910.1200.

Contacts

For projects located in Rockland County, contact the Rockland County Department of Health on Sanatorium Road, Pamona, NY 10970 (914-634-2500). www.co.rockland.ny.us.

Region II office of the Environmental Protection Agency (EPA) is located at 290 Broadway, New York, New York 10007 (212-637-3000). The EPA's website is www.EPA.gov.

6.0 Confined Space Program (Permit Required)

Confined Space Program

A confined space is any space having a limited or restricted means of entry or exit, large enough and designed that an employee can enter and perform tasks; however, it is not designed for continuous employee occupancy. These include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation and exhaust ducts, sewers, underground utility vaults, tunnels, and pits more than 4 feet deep.

- Contractor, if required in contract, will have a written Confined Space Entry Program and this program will be available to all contractor employees and Orange & Rockland Utilities personnel for review upon request.

- Prior to entry, all spaces will be tested for the presence of unsafe atmospheres (hydrogen sulfide, carbon monoxide, oxygen and flammable atmospheres at a minimum) using approved, calibrated meters.

- All personal protective equipment (PPE) and other equipment will be inspected for integrity and proper operation before it is brought into the space.

Prior to entry the supervisor will:

- Coordinate the entry with Orange & Rockland Utilities contract coordinator
- Ensure the space is properly labeled
- Conduct a planning session with workers to determine objectives, assignments, and safety watch
- Perform an activity hazard analysis to identify chemicals or materials stored in the space, leaks or spills into the space, existing or probably physical hazards, methods of ventilation, and safety procedures for emergencies
- Test the atmosphere of the space and ensure continuous monitoring for the duration of work
- Provide adequate ventilation
- Lock out/tag out all electrical and mechanical equipment in the space
- Complete an entry permit and ensure the permit is available at all times

- Contractor will provide records of training for all people on the job that is consistent with their responsibilities.

All work must be in compliance with 1910.146 – Permit required confined space.

<u>The contractor will utilize non-entry rescue for all permit required confined space.</u>

<u>(Contractor to Add info):</u>

7.0 Crane and Derrick (29 CFR 1926 Subpart CC)

Crane and Derricks

Acceptance of all EHASP's involving work covered under this standard, will require the contractor or vendor provide written confirmation of their compliance with the requirements set forth under this regulation (29 CFR 1926, subpart CC – Cranes and Derricks in Construction).

Provide Statement (if required):

8.0 Electrical Safety

Electrical Safety

Electrical safety is an important component to any safety program. To minimize personal injury from contact with energized sources, workers must be trained in the fundamentals of electrical safety to minimize the potential of personal injury from contact with energized sources. All electrical hazards on a project must be identified and corrected. Only properly licensed electricians may perform any electrical work on O&R projects.

- No electrical equipment shall be used on or around live gas lines.
- Workspaces, walkways, and similar locations must be kept free of electric cords and tools.
- Equipment shall not be stored around electrical cabinets in such a manner that it might prevent or impede access.
- Workers must inspect all electrical equipment, including extension cords, for the following hazards:
    - Missing ground pins on plugs (except double-insulated);
    - Insulation pulled free from plugs or support connections;
    - Damaged insulation;
    - Exposed wires;
    - Evidence of arcing, sparking, or smoking;
    - Proper rating of extension cords; and
    - Splices and/or taps, both of which are prohibited on extension cords.
- When any conditions are identified on equipment that makes it unsafe to operate, the equipment must be removed from the site until repaired by a qualified person.
- Flexible cords must be suitable for the condition and location of use and must be used as appropriate.
- Three-wire extension cords must be used and must be rated for hard or extra-hard use.

- Power tools will be inspected prior to use. Any equipment showing cords with cuts or frays will be immediately tagged out of service and repaired or discarded.

- Extension cords must not be fastened with staples, hung on nails, or suspended on wires.

- **ALL** electrical equipment used on a project (hand tools, etc.) must be protected with a ground-fault circuit interrupter (GFCI).

- Workers must be trained in the safety-related work practices that pertain to their job and cannot work near electrical hazards without training to recognize and avoid the hazard.

- All electrical facilities located in trenching/excavations and underground structures shall be considered live until O&R representative confirms facility is de-energized. All workers who perform work on energized electrical equipment shall be trained in the requirements of 1910.269.

- All underground utilities must be marked prior to any groundbreaking activities. .

- Only qualified, trained workers may test electrical equipment.

- When working on energized equipment, a lockout/tagout program shall be specified to verify that the equipment is de-energized.

- Materials must not be stored in transformer vaults.

- AC and DC wiring systems must be properly grounded.

- The potential for stray voltage must be assessed and corrected if present.

- Proper clearance from overhead power lines must be maintained at all times as directed (OSHA, M.A.D, O&R policies and procedures). The regulation, policy, or procedure that affords the employee the greatest protection shall be followed.

- Cradle to cradle policy is in effect at O&R. Employees shall be dressed for the greatest hazard (i.e. prior to un-cradling the bucket, the employee shall don gloves and sleeves for work that is planned to be completed in the vicinity of primary conductors).

- Use of mechanical equipment within substation properties shall follow Substation Work Procedures at all times. Mechanical equipment shall be operated so that the required clearance distances are maintained for exposed energized lines and equipment.

- Personal protective equipment used by electrical workers must be appropriate and in good condition.

- When handing or working on any wire or equipment that is energized or may become energized at 50 volts or more, rubber protection equipment shall be used in accordance with work and safety procedures.

- Class 2 gloves shall be worn when hand digging in an energized trench (i.e combo trench).

- Rubber gloves must be worn when handling or working on any line or piece of equipment operating at 50 volts or more that has not been de-energized, tested and grounded. Visual inspection of Rubber Gloves shall be performed each time the gloves are to be worn.

- Class 2 rubber sleeves are required from the time the bucket leaves the ground until it returns to the ground, during overhead line operations where there is primary voltage present, and when working within the minimum approach distance or extended reach. Use of a hot stick would alleviate the sleeve requirement. Sleeves are also required if climbing the pole.

- Sleeves must also be worn when approach distances cannot be maintained to lines and equipment that are energized in excess of 600 volts.

- Rubber gloves shall be worn by workers when handling poles or structures that are being set or removed and that are in close proximity to energized conductors or equipment.

- Work Procedure 2101C **must** be followed when prepping cable ends at the riser pole.

- During a storm or other inclement weather, rubber gloves shall be worn at all times, unless the lines are de-energized, tested and grounded.

- Class 2 rubber gloves shall be worn when operating any “GOAB” or Capacitor Control Box (except by remote control).

- The use of rubber gloves without sleeves shall be permitted:
    - When working with approved live-line tools, in the medium-voltage range when clearance can be maintained to other energized or grounded equipment not being worked on.

    - For secondary work or on any job where there is no primary work to be done and the work is outside the minimum approach distance (including the extended reach of the primary conductor).

- The O&R representative shall be contacted regarding specific requirements for grounding at Company facilities (i.e. substations).

- The following clearances shall be followed at all times while working near electric power lines and energized sources by non-qualified employees with the exception noted in: “Use of Electrical Mechanical Equipment within Substation Properties and Substation Work Procedure SP-0110,” or most recent procedure.
  - 50 kV or below – Clearance 10 Feet
  - Above 50 kV to 200 kV– Clearance 15 Feet
  - Above 200 kV to 350 kV – Clearance 20 Feet
  - Above 500 kV to 750 – Clearance 35 Feet

  * Note: Clearances based on ANSI Standard B30.5-1994

- Tree Trimmers shall maintain minimum approach distances at all times (MAD).

  - A tool constructed of a material that the employer can demonstrate has insulating qualities meeting OSHA regulations of the pertinent section is considered as insulated if the tool is clean and dry.

  - Branches that are contacting exposed energized conductors or equipment or that are within distances specified in Table R-6, R-9, and Table R10 may be removed through use of insulating equipment. (1910.269(r)(1)(iv).

  - If insulated tools are used to remove branches as described above, the employee shall maintain MAD clearances at all times.

Regulatory Citations

A complete text of the requirements for Electrical Safety can be found in Title 29 Code of Federal Regulations, 1910.147 and Subpart S, 1910.269, and Part 1926, Subpart K.

Contacts

For additional information regarding Electrical Safety requirements or clarification of these requirements, contact the New York regional OSHA office or the website can be found at www.OSHA.gov.

9.0 Excavation and Trenching

Excavation and Trenching

Although excavation work is conducted largely at the start of the job, it requires as much, if not more, attention than the scheduled work to be performed. Accidental cave-ins of earth and other excavated materials are responsible for a significant number of workplace injuries and fatalities each year. For this reason, it is essential that all excavation work be conducted in a manner consistent with the existing laws, regulations, and O&R procedures.

- Ensure compliance with Industrial NYS Code Rule 753, or the State having jurisdiction, which requires that the site must be marked out by the facility owner prior to the use of mechanical excavation equipment. One Call Center must be used to request mark out. No digging will be done prior to mark out.

- As the contractor, you shall make the necessary calls and arrangements for the mark out of the jobsite per NYS Code 753, or the State having jurisdiction, requirements.

- A trench is considered an excavation.

- Confirm with O&R if the area was used as a Manufactured Plant site before starting excavation work.

- Ensure that underground utilities or installations, such as sewer, telephone, fuel, gas, electric or water line, etc., that may be encountered during excavation work be delineated prior to opening an excavation.

- Hand digging must be conducted near known or suspected underground systems.

- **Proper PPE (i.e. class 2 rubber gloves) shall be worn when hand excavating over a combination trench that has electric present.**

- Ramps or runways used as a means of entry/exit for excavations must be designed by a competent person.

- Ladders must extend 3’ above the surface and must be place at intervals of 25’. Ladders must be fiberglass (metal or wooden ladders are not permitted), must be appropriately rated for the load they must handle, and must be regularly inspected. Any defective ladders may not be used and must be tagged and removed from the jobsite at the end of the shift.

- Entering an excavation during mechanical digging is prohibited.

- Ensure that all excavations 4'and greater are tested for atmospheric hazards before being entered by employees. Atmospheric testing shall assess oxygen, carbon monoxide and combustible gas. Adequate precautions, including proper respiratory protection or ventilation, shall be maintained to prevent employee exposure to hazardous atmospheres.

- Tests shall be conducted as often as necessary as determined by the Competent Person to ensure a safe atmosphere. Contractors shall conduct testing at the beginning of each shift and again after lunch and extended breaks, in addition to any time when conditions may have changed. Field conditions may warrant continuous air monitoring (i.e. work being completed in the vicinity of a landfill, etc.).

- Daily inspections of the excavation and surrounding areas must be conducted by a competent person before work begins and as needed during the shift. Additional inspections shall be conducted as needed in the event of a rainstorm or other occurrence that may impact the excavation or the surrounding area.

- Ensure that the stability of nearby buildings, walls or other structures is not affected by the excavation. If they are affected, these structures shall be supported by the use of shoring, bracing or underpinnings.

- Ensure that excavations are shored or braced if work on nearby structures affects the integrity of the excavation or surrounding area.

- Ensure that surface encumbrances that are located as to create a hazard to personnel shall be removed or supported, as necessary to safeguard workers. At a minimum, a 2' clear walkway shall be maintained around the perimeter of the excavation. This area shall remain free of tools, soil & other debris.

- Workers may only pass over an excavation on properly constructed walkways/bridges with guardrails in place.

- Work area protection (signs, barricades, cones, tape etc.) is necessary to avoid automobile and pedestrian traffic hazards for the safety of the public and our own employees. Details are provided in The Manual on Uniform Traffic Control Devices (MUTCD) and the Work Area Protection Guide.

- All excavations equal to and greater than 5 feet deep must be adequately protected by sloping using a horizontal distance of 1.5 feet for every 1-foot increase in depth or by using an appropriate shoring system designed and signed off by a professional engineer. Depending on soil conditions, Shoring may be required in excavations less than 5'.

- Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

- If a potentially hazardous material is encountered during excavation, all work must stop until the material can be evaluated.

- Ensure that all excavation work, including sheeting and shoring, will be performed in accordance with OSHA Excavation Standard and shall be supervised by the designated Competent Person who will be on location.

- Ensure that the Competent Person assesses site conditions and takes appropriate action to address site conditions that may arise and present a potential health and safety hazard or concern.

- Ensure that no person shall enter an excavation greater than 5' without sheeting and shoring.

- Ensure that employees are not exposed to falling loads. At no time shall workers be permitted underneath loads handled by lifting or digging equipment. Slings shall be inspected and checked for condition before use.

- Ensure that appropriate warning systems for mobile equipment operating adjacent to an excavation are utilized. These systems may be comprised of barricades, hand or mechanical signals or stop logs. All excavators and dump/utility trucks will be equipped with DOT approved back-up beepers.

- Ensure that workers shall not work in excavations where there is accumulated water unless adequate precautions have been taken to protect against the hazards posed by water accumulation (e.g. cave-ins, submersion below water, etc.)

- The following steps shall be taken in the event that excavation work results in the discovery of potentially contaminated soil:

    - If any excavated material, including pavement is suspected (by either sight, smell or other reason) of being contaminated (i.e. fuel and/or motor oils, loose asbestos, pesticides, gasoline, etc.), stop the job and notify the O&R representative and site foreman immediately. Suspected contaminated material shall be immediately roped-off and attended to until relieved by O&R personnel.

    - If any existing gas pipe coating material is exposed during excavation or pipe movement operations is found to be disbanded, or appears "loose and flaky", stop the job and notify the O&R representative and site foreman immediately. Site must be secured and roped-off until relieved by O&R personnel.

- If any existing gas facility (live or abandoned) is found to be corroded with liquids seeping from the facility, stop the job and notify the O&R representative and site foreman immediately. Site must be secured and roped-off until relieved by O&R personnel.

    - Note: An EHASP in compliance with 1910.120 shall be submitted to O&R for review for all work that takes place on MGP sites and sites with known hazard contamination.

Regulatory Citations

A complete text of the requirements for Excavations can be found in Title 29 Code of Federal Regulations,1926, Subpart P. OSHA 1926.651.

Contacts

For additional information regarding Excavation requirements or clarification of these requirements, contact the New York regional OSHA office or www.OSHA.gov

10.0 Fish, Wildlife, Wetlands

Fish, Wildlife and Wetlands

When working around any wetland, stream, drain, culvert, lake, run-off dike, waterway, storm drain that leads to surface waters, or any other environmentally sensitive area, our company recognizes that it is responsible for ensuring that these areas are not adversely affected.

- Consult with the O&R Representative to ascertain whether the jobsite has been reviewed for environmentally sensitive areas such as wetlands or critical wildlife habitat.

- Ensure that Soil Erosion and Sediment controls are installed and maintained in accordance with New York Standards and Specification for Erosion and Sediment Control. All environmentally sensitive areas such as steep slopes, wetlands, water bodies, culverts, streams, storm drains and other routes to surface waters are protected from storm water runoff. All soil erosion and sediment control must be maintained at all locations until the work area is permanently restored. If at any time the erosion controls are identified as having failed (i.e., sediment has entered storm drains, culverts, run-off dikes, surface waters, etc.), O&R will be notified and the erosion controls will be immediately re-established.

- Ensure that all necessary permits and approvals are obtained prior to working. It is the responsibility of the foreman to request of the O&R representative whether the jobsite has been reviewed for permit requirements.

- If an endangered/threatened species is unintentionally destroyed, the contractor must notify NYSDEC, and the dead animal must be turned over to NYSDEC.

- Contractor must view wetland maps for projects in a wetland or its buffer zone. If the project is within a wetland or buffer zone, wetland permits must be obtained.

Regulatory Citations

A complete text of the requirements for fish and wildlife can be found in:

- Title 50 Code of Federal Regulations (CFR), Parts 10, 17 and 402.

- Title 6 New York Code of Rules and Regulations (NYCRR), Parts 175, and 182.

- Text of the requirements for wetlands can be found in Title 40 CFR, Parts 131 and 230.

- Title 6 NYCRR, Parts 608, 660, 661, and 663.

Contacts For additional information contact the following agencies:

- Projects in Orange, or Rockland Counties, contact the Region 3 NYSDEC office at 21 South Putt Corners Road, New Paltz, NY 12561 (914-256-3000).

11.0 Fire Protection and Prevention

Fire Protection and Prevention

All work conducted by contractors at O&R facilities or worksites must be conducted in a manner that guards against the possibility of fire or explosion. All contractors performing construction and maintenance operations shall implement measures to prevent fires and in the event that a fire occurs, respond effectively.

- In the event that a fire is detected, the fire department shall be notified immediately. For a fire emergency within the O&R facilities, dial 3600.
- Only trained personal are permitted to use a fire extinguishers and/or fire fighting techniques to fight a fire during the early or incipient stages of a fire.
- An O&R Representative will be informed of all fire or explosion occurrences.
- Ensure all field offices and storage facilities are constructed in accordance with applicable codes, and fabricated noncombustible material for protection against fire.
- Contractor must identify procedures to eliminate and control fire hazards including housekeeping, electrical safety, safety procedures for hot work, storage and handling of flammable and combustible liquids and compressed gases.
- Good housekeeping standards must be enforced in the work area, including the requirements that waste, rubbish and flammable materials and rags be removed from the area daily.
- All waste, rubbish, and flammable materials must be stored in approved containers.
- Handling procedures must address safe transport, use, and storage of flammable materials.
- Noncombustible tables or shelves, or protected work area will be used for hot work.
- All fire extinguishers must have the necessary tags indicating they have been inspected and are ready for use.
- Store all flammable and combustible liquids (FCL) in closed approved metal cabinets and only store quantities of these liquids on-site that do not exceed the minimum amount required for efficient operation.

- Store bulk drum quantities of FCL liquids in storage rooms specially designed for fire and spill protection.

- Prohibit the use of gasoline and other highly flammable liquids for cleaning.

- Use approved pumps, or approved self-closing faucets and drip pans when dispensing FCL from drums or portable tanks.

- Class B/C rated fire extinguishers must be located in close proximity to FCL areas and monthly and annual inspections shall be performed to ensure that the units are ready for use.

- In the event of a fire involving compressed gases, the gases will be permitted to burn and not extinguished, under any circumstances, unless it is possible to control the gas flow.

- Oil, grease, and highly volatile liquids must not be stored near oxygen cylinders or other oxidizers such as chlorine gas.

- Smoking is prohibited in the vicinity of flammable or combustible liquids and gases.

- Open flames or spark-producing tools must not be used in any enclosure where an explosion concern may exist until testing indicates that an explosion hazard does not exist.

- When "hot work" must be performed in the vicinity of combustible materials, the combustible materials should be wetted and a trained fire watch shall be assigned to the location for a minimum of 30 minutes after the work is complete. An additional inspection shall be completed 30 min after the first inspection is complete.

- A fire watch shall be assigned to welding operations

Regulatory Citations

A complete text of the requirements for Hot Work can be found in Title 29 Code of Federal Regulations, Part 1910, Subpart Q and Part 1926, Subpart J.

Contacts: For additional information or clarification of these requirements, contact:

- The New York regional OSHA or visit the OSHA web site at: www.OSHA.gov.

12.0 FR Clothing

FR Clothing

Contractor employees shall wear flame retardant (FR) clothing when performing tasks that may expose them to the hazards of flame or electric arc. Employees are required at a minimum to wear 100% natural fiber (wool or cotton) clothing, including undergarments; elastic undergarment waist bands are acceptable. In all cases, the outermost layer of clothing shall be FR if exposed to hazards of arc or flame. The use of clothing containing polyester, nylon, rayon, and acetate (alone or in blends) which are not FR treated and/or rated, or having **silk screening is strictly prohibited** for field work activities at O& R Utilities.

> **NOTE**: HRC 1 FR rated clothes cannot be worn alone while in the Minimum Approach Distance (MAD) to electric energy or in areas with potential for gas flash fire. The minimum FR protection required when working in the MAD or with live gas is HRC 2. In those situations, an outer layer of FR clothing with an HRC 2 rating must be worn. Follow all O&R policies and procedures.

While performing tasks that may expose the employee to flame or electric arc, garments must be worn properly. Shirts shall be tucked in, buttoned up, and sleeves rolled down.

In the event a situation presents the potential for flame or an operation involving an electric arc exposure and also may involve soiling the garments with oil, PCB-containing oil, or other liquid, limited-use FR disposable outerwear shall be worn over the FR coveralls. These disposable FR garments shall not be worn alone; they must be worn over FR coveralls.

13.0 Hearing Conservation

Hearing Conservation

Noise is defined as unwanted sound. Depending on the particular worksite, workers may be exposed to excessive noise levels from both operating and construction equipment. All employers are responsible for protecting their workers from the potentially harmful effects of excessive noise.

- Workers must not be exposed to noise levels above those stated in the regulations.
- When possible, engineering controls such as equipment isolation, enclosure or insulation shall be implemented to reduce the amount of noise generated by equipment.
- When engineering controls are not adequate or practical, administrative controls involving worker rotation and reducing the amount of time that workers are exposed may be implemented.
- Personal Protective Equipment including ear muffs, inserted and similar devices with suitable noise attenuation ratings shall be implemented.
- All Company personnel exposed to 85 dBA as an 8-hour time weighted average (TWA) shall be enrolled in the Contractor Company's Hearing Conservation Program. This Program is incorporated as part of the Contractor Company's overall Health and Safety Program.
    - A hearing conservation program must include:
        - Noise monitoring;
        - Procedures for employee notification;
        - Provisions to permit employees to observe monitoring;
        - Initial and annual audiometric testing, and an evaluation of the audiogram by a qualified professional;
        - A noise training program for all affected workers; and
        - Formal record keeping.

The following table is a guide to common noise levels:

Permissible Duration	**dBA**	**Examples of Noise Sources**
No protection or time exposure calculation required.	15	Wooded Forest
	25	Quiet Bedroom
	35	Library
	65	Normal Speaking
	75	General Office Area
Action Level for Hearing Conservation Program	85	Average Machine Shop
8 Hours	90	
6 Hours	92	
4 Hours	95	
3 Hours	97	
2 Hours	100	Air Spray Operation
1.5 Hours	102	
30 Minutes	110	Power Table Saw
15 Minutes	115	
7.5 Minutes	120	
4 Minutes	125	Rock-n-Roll Concert
2 Minutes	130	Aircraft Jet Engine/Ear Pain Threshold
NOT TO EXCEED	140	

- A standard rule-of-thumb for noise states that when standing face-to-face at a distance of 1 to 2 feet, if it is necessary to raise your voice to be heard, the background noise exceeds 85 dBA.

- Hearing protection is required to be worn when operating a chainsaw, chippers, etc.

Regulatory Citations
A complete text of the requirements for Hearing Conservation can be found in Title 29 Code of Federal Regulations, 1910.95 and 1926.52.

Contacts
For additional information regarding Hearing Conservation requirements or clarification of these requirements, contact the New York regional OSHA office or www.OSHA.gov.

14.0 Insulation Materials

Insulation Materials (Non-Asbestos)

Insulating materials include fiberglass, calcium silicate, foamglass, and textile-grade fiberglass such as TempMat. These materials are found on equipment including, but not limited to: boiler interior and exterior surfaces, boiler piping and valves, water pipes and fittings, turbines, ducts, flues, hoppers, and steam piping and valves. Proper work procedures and requirements for controls and personal protective equipment during the installation, removal, and handling of non-asbestos thermal insulation are necessary to protect workers and the public.

- Thermal insulating materials must be handled by methods that minimize airborne dust and the spread of contamination (e.g., wet methods or HEPA vacuuming).
- Compressed air must not be used for cleaning clothes, machinery, or other surfaces.
- Smoking, drinking, eating, or chewing gum in the controlled thermal insulating work area is prohibited.
- Prior to smoking, drinking, eating, or chewing gum and at the end of a work period, personnel must wash their hands and face with soap and water to remove fibers from skin.
- All individuals who work with thermal insulating material must receive initial and refresher training in the proper work practices and other information set forth in applicable Safety Data Sheets for non-asbestos insulation.
- Engineering controls (such as local exhaust ventilation or dampened or wetted material) must be used as the primary means of reducing the concentration of airborne non-asbestos thermal insulation.
- All individuals removing, installing, or handling thermal insulating, or remaining in the controlled area while work is in progress must wear proper PPE, which may include respiratory protective equipment, unless it can be demonstrated through sample data that respiratory protection is not required.
- Proper disposal of non-asbestos insulation is required.
- Thermal insulating material must be stored, handled, and delivered to the job site in its original packaging, and unpacked materials must be protected against damage due to weather or mechanical forces.

Regulatory Citations

A complete text of the requirements for Non-Asbestos Insulation can be found in Title 29 Code of Federal Regulations, 1910.1000 (Air Contaminants).

Contacts

For additional information regarding Non-Asbestos Insulation requirements or clarification of these requirements, contact the New York regional OSHA office or visit the OSHA web site at: www.OSHA.gov.

15.0 Lead Management Program

Lead Management Program

Incidental lead-based paint disturbances resulting from contact with lead-based materials may occur during work activities not associated with lead abatement. These incidental work activities include drilling into walls, replacing valves, and installing or removing locks. Lead abatement activities involve more direct and longer duration exposure to lead containing materials and present a significantly greater potential for exposure

ALL PAINTED OR COATED SURFACES MUST BE ASSUMED TO CONTAIN LEAD AND PCBS, UNLESS DOCUMENTED LABORATORY OR MANUFACTURER DATA PROVES OTHERWISE.

- **CONTRACTOR PERSONNEL SHALL NOT CONDUCT LEAD ABATEMENT ACTIVITIES UNLESS THIS IS THE STATED INTENT OF THE REQUIRED WORK AND ALL OF THE REQUIRED LEAD REQUIREMENTS INCLUDING LICENSES, PERMITS, AND TRAINING HAVE BEEN MET TO THE SATISFACTION OF O&R.**

- IF THE LEAD AND PCB CONTENT OF PAINTED SURFACES IS NOT KNOWN, THE PAINTED OR COATED SURFACES MUST BE ASSUMED TO CONTAIN LEAD AND PCBs. Waste paint chips generated by disturbance of these surfaces are considered Hazardous Waste. No lead-containing paint or material will be disturbed by work during this project unless the contractor is specifically trained and qualified to so the work.

- Contractors who may be required to weld, sleeve, recoat or impact painted surfaces during the course of their work must be trained in Lead Safe Work Practices in accordance with OSHA 29 CFR 1926.62. Those contractors must also wear appropriate respiratory protection or be able to show personal exposure monitoring data for similar work activities which indicate their exposure was below the Permissible Exposure Level (PEL) for Lead.

- Paint and coatings shall be handled in a fashion which minimizes disturbance. No open flame burning of painted or coated surfaces is permitted unless approved by the O&R EH&S Department. If approval is granted, SCBA respiratory protection may be required.

- **Contractor personnel working under this EHASP who are not trained or authorized shall not work with, handle, manage or dispose of lead contaminated waste.**

- If conditions change, the O&R Site Representative shall contact O&R EH&S for guidance, and, if necessary, an addendum must be submitted to the EHASP

Regulatory Citations
A complete text of the requirements for Lead can be found in Title 29 Code of Federal Regulations, Part 1910.1025 and Part 1926.62.

Contacts
For additional information regarding Lead requirements or clarification of these requirements, contact the New York regional OSHA or visit the OSHA web site at www.OSHA.gov.

16.0 Lockout Tagout

Lockout / Tagout

Energy sources including electrical, mechanical, hydraulic, pneumatic, chemical, thermal or other sources in machines and equipment can be hazardous to workers. During the servicing and maintenance of machines and equipment, the unexpected startup or release of stored energy could cause injury to employees.

Workers servicing or maintaining machines or equipment may be seriously injured or killed if hazardous energy is not properly controlled. Injuries resulting from the failure to control hazardous energy during maintenance activities can be serious or fatal! Injuries may include electrocution, burns, crushing, cutting, lacerating, amputating, or fracturing body parts, and others.

All contractor employees who are involved in servicing and maintaining machines and equipment shall be properly trained and will follow Lockout / Tagout policies and procedures that are compliant with OSHA regulations.

(Contractor to Add info):

Regulatory Citations

The OSHA standard for The Control of Hazardous Energy (Lockout/Tagout) (29 CFR 1910.147) for general industry outlines measures for controlling different types of hazardous energy

The control of hazardous energy is also addressed in a number of other OSHA standards, including marine terminals (1917 Subpart C), longshoring (1918 Subpart G), construction (1926 Subparts K and Q), electrical (1910 Subpart S), and electric power generation, transmission and distribution (1910 Subpart R and 1926 Subpart V).

Contacts

For additional information regarding Lockout / Tagout or clarification of these requirements, contact the New York regional OSHA or visit the OSHA web site at www.OSHA.gov.

17.0 Management of Change

Management of Change

Orange & Rockland Utilities requires that all contractors comply with all environmental, health and safety (EH&S) regulations. This includes EH&S regulations that are identified prior to beginning each project and those that become apparent after the job has begun. To ensure that all EH&S requirements are met during the project, the contractor must develop a process to manage change. This management of change process will allow the contractor to meet all EH&S obligations required by the regulations and to keep Orange & Rockland Utilities informed of changing conditions that may trigger modifications to the contractor anticipated work plan.

- Contractor will notify the Orange & Rockland Utilities Representative of any change in working conditions that could affect compliance with environmental or health and safety requirements as soon as the changed conditions are identified.

- An example of change in conditions can include, but is not limited to the following:

    - Unforeseen hazards not anticipated during the bidding process.
    - Weather conditions that could affect worker safety.
    - Unexpected changes in the scope of the project which requires different or more extensive safety procedures.
    - The potential to generate wastes not expected during project planning.
    - The potential for unexpected sample collection.
    - Unforeseen buried utilities
    - Unforeseen buried materials, chemicals or contaminated soil.
    - Inclement weather.
    - Presence of wetlands, streams, water bodies.

- Take all appropriate precautions prior to implementing any contingencies prepared to manage change. Precautions can include the following:

    - Increasing or decreasing the levels of personal protective equipment.
    - Taking special safety precautions to deal with unsuspected conditions (for example, unanticipated confined space conditions).
    - Planning for inclement weather.
    - Ascertaining that hazardous material testing has been analyzed by O&R

The contractor shall make sure the change of scope is approved by Orange & Rockland Utilities and that the changes are addressed in the EHASP prior to continuing work.

All personnel shall be appropriately trained to perform their job function under the changed conditions prior to being allowed to work under the changed conditions.

Subcontractors will be held to the management of change procedures outlined by the Prime Contractor.

THE PRIME CONTRACTOR SHALL HAVE THE ULTIMATE RESPONSIBILITY FOR IMPLEMENTING MANAGEMENT OF CHANGE PROCEDURES RELATIVE TO THE PROJECT.

18.0 Material Handling

Materials Handling

Due to the various size, shape and weight of workplace materials, the means of moving them can vary greatly from one situation to the next. The required method may range from manual carrying by hand or lift truck to usage of cranes and complex rigging methodologies. Regardless of the methods employed, all types of material handling operations require adequate planning and preparation that are clearly defined to ensure the task is completed in a safe manner.

- **Operations near overhead power lines are prohibited unless the power source has been shut off and locked out/tagged out or the appropriate clearance distances are maintained in accordance with OSHA regulations and O&R policies and procedures.**
- Whenever possible, objects will be lifted and moved by mechanical devices (cranes, manually operated chain hoists, fork trucks, etc.) rather than by manual effort.
- The mechanical devices will be appropriate for the lifting or moving task and will be operated only by trained and authorized personnel.
- Objects that require special handling or rigging will only be moved under the guidance of a person who has been specifically trained to move such objects.
- Lifting devices will be inspected, certified, and labeled to confirm their weight capacities.
- All devices shall be inspected before each use by the user for obvious signs of damage, wear, and failure.
- Defective equipment shall be tagged/marked to identify it as such and is immediately taken out of service and repaired or destroyed.
- Personnel will not pass under a raised load, nor will a suspended load be left unattended.
- The work area shall be secured to ensure that individuals cannot walk near or underneath loads that are being lifted or moved.
- Personnel will not be carried on lifting or hoisting equipment, unless it is specifically designed to carry passengers.
- The wheels of the trucks or vehicles that are being loaded or unloaded shall be chocked to prevent inadvertent movement.

- The lift and swing path of a crane will be watched and maintained clear of obstructions.
- Accessible areas within the swing radius of a crane will be guarded or barricaded.
- All reciprocating, rotating, or other moving parts will be guarded at all times in accordance with manufacturer recommendations and OSHA regulations.
- Accessible fire extinguishers must be available in the immediate proximity of all mechanical lifting devices.
- Lifting devices will never be left near the edge of excavations or unstable areas.
- Mobile lifting equipment, equipped with outriggers shall be positioned and the outriggers deployed and secured before any lifting or hoisting work is begun.
- Cranes may only be moved when directed by a qualified signal person.
- Wire ropes will be removed from service when any abrasion, scrubbing, evidences of corrosion, kinking, crushing, bird caging, or other damage exists.
- Only trained, authorized individuals shall be permitted to operate fork trucks.
- Unsafe behavior while driving a fork truck is not permitted.
- Each fork truck will be provided with an overhead guard.
- All mobile lifting devices shall be equipped with an audible backup warning device.
- All traffic regulations shall be observed when a lifting device is in operation.
- Employees involved in heavy lifting will be properly trained in lifting procedures and should be physically qualified to protect the person and the material.
- Tiered or stacked material will be stored within acceptable height limits to avoid tripping, falling or collapse.
- Personnel will be trained in the procedures used for material handling. This training will address the requirements of applicable regulations, for example the training of personnel who operate powered industrial trucks.
- All material handling, including lifting and hoisting equipment, will be used as designed by the manufacturer.

Regulatory Citations
A complete text of the requirements for Materials Handling can be found in Title 29 Code of Federal Regulations, Part 1910, Subpart N and Part 1926, Subparts H and O.

Contacts
For additional information regarding Materials Handling requirements or clarification of these requirements, contact the New York regional OSHA office or visit the OSHA web site at: www.OSHA.gov.

19.0 Mechanical Equipment

Mechanical Equipment

Hand and power tools are commonplace on most project sites. OSHA requires that these tools be maintained in a safe condition to protect both the worker and the public from injury.

- All hand and power tools must be maintained in a safe condition and used in accordance with manufacturer recommendations.
- Only workers who have been trained in the use of a particular tool may operate that tool.
- All hand and power tools must be inspected prior to use to ensure proper operation and satisfactory condition. This includes:
    - Wrenches of any kind shall be removed from the project site when the jaws are worn to the point where slippage may occur.
    - Mushroomed heads on impact tools (chisels, etc.) shall be repaired or the tools removed from the site.
    - Wooden tool handles shall be free of splinters and cracks and be tightly secured in the tool.
- All hand and power tools that are damaged must be immediately removed from the job site until they are repaired.
- Removing any guards attached to a power tool and using a power tool without its guards is prohibited.
- Moving parts of equipment (belts, pulleys, shafts, etc.) must have guards that comply with the appropriate American National Standards Institute (ANSI) standards.
- Workers who are exposed to flying objects, dust, fumes, vapors, etc. when using hand or power tools must wear the appropriate personal protective equipment (PPE).
- All hand and power tools shall be used for their intended purpose only.
- Electric hand tools must be double insulated or grounded and protected by a ground-fault circuit interrupter (GFCI).
- All fixed electric tools must have a disconnect switch that can be locked or tagged in the off position.

- The use of compressed air for personal cleaning is prohibited.

- Fuel-powered hand tools must be turned off and allowed to cool prior to being refueled or serviced.

- Powder-actuated hand tools must be inspected tested and inspected daily prior to use to ensure proper working conditions.

- Grinding machines must be guarded in accordance with applicable ANSI standards.

    - Work rests on stationary grinders must be within inch of the grinding wheel surface and the tongue guard must be within ¼ inch of the grinding wheel surface.

- The manufacturer's capacity rating must be marked on all jacks and must never be exceeded.

- As soon as a load has been raised by a jack, the load must be cribbed, blocked, or otherwise secured.

- Mechanical equipment shall be operated so that the required clearance distances are maintained for exposed energized lines and equipment.

- Equipment and the attached load operating near energized lines or equipment shall be treated as energized by persons on the ground.

- The following clearances shall be followed at all times while working near electric power lines and energized sources by non-qualified employees with the exception noted in: "Use of Electrical Mechanical Equipment within Substation Properties and Substation Work Procedure SP-0110."
    - 50 kV or below – Clearance 10 Feet
    - Above 50 kV to 200 kV– Clearance 15 Feet
    - Above 200 kV to 350 kV – Clearance 20 Feet
    - Above 500 kV to 750 – Clearance 35 Feet

    * Note: Clearances based on ANSI Standard B30.5-1994

Regulatory Citations

A complete text of the requirements for Hand and Power Tools can be found in Title 29 Code of Federal Regulations, Part 1910, Subparts O and P, and Part 1926, Subpart I.

Contacts

For additional information regarding Hand and Power Tool requirements or clarification of these requirements, contact the New York regional OSHA office or visit the OSHA web site at www.OSHA.gov.

<u>20.0 Noise</u>

<u>Noise</u>

Some local governments in the Company's service area have restrictions on the level of noise that may be produced. In general, these limits apply to two types of situations: ***facility operations***, and ***field operations***.

Equipment and operations associated with O&R facilities and services can produce noise. All equipment used by the contractor should be in good working order, properly maintained, and properly used. Where possible, noisy equipment should not be located near ***noise-sensitive areas and/or sensitive receptors***, i.e., schools, hospitals, and churches.

- Where a given operation could be accomplished using a variety of equipment, equipment with operating characteristics that produce less noise should be used. The contractor or site representative is responsible for ensuring compliance with all federal, state and local noise regulations.

- Most field operations, other than operations undertaken outside of permissible times, can be thought of as construction activities. Construction activities additionally covered include any activity (except tunneling) necessary or incidental to the erection, demolition, assembling, altering, installing, or equipping of buildings, public or private highways, roads, premises, parks, utility lines including such lines in already-constructed tunnels or other property, land clearing, grading, excavating and filling. Many communities have time restrictions on such activities, which must be adhered to.

- In addition to time restrictions, certain noise codes have specific regulations that must be followed regarding field activities. These regulations are summarized below.

    - Construction devices – Prohibiting use of construction devices (e.g., air compressor, pile driver, bulldozer, crane, hoist) so as to create unreasonable noise.

    - Containers and construction material – Prohibiting handling or transport of any container or any construction material in a public place so as to create unreasonable noise.

    - Exhausts -Prohibiting discharge into the open air of the exhaust of any device, including but not limited to any steam engine, diesel engine, internal combustion engine or turbine engine, so as to create unreasonable noise.

    - Power tools – Prohibiting use of power tools (e.g., nail guns, saws, vacuums, drills) so as to create unreasonable noise.

- Schools, hospital, courts – Prohibiting unnecessary noise through the use of any device on any street adjacent to any school or court while the same is in session, or adjacent to any hospital.

- Sensitive receptors – Prohibiting unnecessary noise through the use of any device within 50 feet of a school, house of worship, hospital, retirement community, open tract of serene land, park or recreation area, and psychiatric centers.

- The contractor is responsible for ensuring that all work performed by both his crew and subcontractors complies with applicable noise ordinances.

Contacts

For projects located in Rockland County, contact the Rockland County Department of Health on Sanatorium Road, Pamona, NY 10970 (914-634-2500). Rockland County's web site can be found at www.co.rockland.ny.us.

For information on standard practices for monitoring noise, contact the American National Standard Institute (ANSI) at 11 West 42nd Street, New York, NY 10036 (212-642-4900). ANSIs web site can be found at www.ansi.org.

21.0 Oil and Dielectric Fluid

Oil and Dielectric Fluid

Federal and State laws require that specific procedures are followed to properly handle oil and dielectric fluid to prevent spills. These procedures shall address storing, handling, transferring, and processing these materials. In addition, spills of oils and dielectric fluids must be managed to protect workers, clean up affected areas, and prevent further damage to unaffected areas.

- Dielectric oils in pre-1979 equipment are assumed to contain between 50 and 499 ppm PCBs, unless lab analysis indicates otherwise.
- In Rockland County, temporary oil and/or dielectric fluid storage tank/containers brought on site registered as Petroleum Bulk Storage Facilities must be inspected for leaks daily and meet the following criteria:
    - The number, type and capacity of temporary tanks/containers brought on site shall be monitored to ensure compliance with all requirements.
    - Store containers in a protected leak-proof, diked, roofed area to prevent damage.
- A written plan describing the following items shall be maintained and available onsite and available for review by O&R representatives:
    - Control measures for the source of tanks/containers onsite
    - Procedures for handling rainwater and other contaminated liquids in diked areas
    - Procedures for inspection, reporting and cleanup programs for temporary containers/tanks.
- Storage of oil and/or dielectric fluid in quantities greater than 1,320 gallons above ground in containers larger than 55 gallons requires an SPCC plan to be developed and submitted prior to the storage of oil on-site.
- Comprehensive spill management procedures will be available at the job site. All Company personnel expected to participate in spill related issues must be fully trained to handle them correctly.

- Only trained personnel will handle oil/dielectric fluid as required by OSHA HazCom standard (29CFR 1910.1200) and Hazardous Waste Operations and Emergency Response standard (29 CFR 1910.120).

- All oil spills are immediately reported to the O&R representative.

Regulatory Citations

Requirements for management of oil/dielectric fluids less than 50 ppm PCBs can be found in:

- Title 29 Code of Federal Regulations (CFR) Part 1910.

- Title 33 CFR Parts 153 through 155, Title 40 CFR Parts 112 and 280.

- Title 49 CFR Part 194, Title 16 NYCRR Part 258

- Title 6 New York Code of Rules and Regulations (NYCRR), Parts 612 through 614.

- Title 17 NYCRR Parts 30 through 32, Title 27 NYC Administrative Code Chapter 4.

- Article 10 of the Sanitary Code of the County of Rockland.

Contacts

For additional information or clarification of these requirements, contact the following agencies:

- For projects in Rockland Counties, contact the NYSDEC Region 3 office at 21 South Putt Corners Road, New Paltz, NY 12561

- For projects located in Rockland County, contact the Rockland County Department of Health on Sanatorium Road, Pamona, NY 10970 (914-634-2500).

22.0 PCB Management

PCB Management

Federal and State laws require that specific procedures be followed to manage materials containing polychlorinated biphenyls (PCBs). These procedures include those for use, classification, marking, inspecting, labeling, storing, transporting, and disposing of PCB items. In addition, spills of PCBs must be cleaned up in such a way as to protect workers, fully clean up affected areas, and prevent further damage to unaffected areas from the spilled materials. All clean up related activities must be fully documented.

- The O&R representative shall be contacted immediately if suspect PCB-containing materials are found onsite.
- PCB containing materials shall not be brought onsite.
- Materials shall be disposed of as determined by PCB analysis.
- Combustible materials must be properly stored away from PCB-containing equipment.

The contractor will immediately report all oil and chemical spills to the O&R site representative, who will notify the O&R control center, immediately.

If the PCB content of a dielectric fluid/oil in or from electrical equipment is not known, the dielectric fluid is assumed to be PCB-contaminated, i.e. The dielectric fluid is assumed to contain PCB's at a concentration greater than 50 ppm.
If materials are encountered that are either known or suspected to contain PCB's, work will stop immediately and O&R site representative will be notified. The O&R site representative will contact the O&R EHS department for guidance.

If the PCB content of a painted surface is not known, the paint is assumed to contain PCB's. Waste paint-chips generated by disturbance of these surfaces is hazardous waste. No PCB-containing paint or material will be disturbed by work during this project.

Regulatory Citations

The requirements for management of PCBs (50 ppm PCBs and greater) can be found in:

- Title 40 Code of Federal Regulations (CFR) Parts 262.31, 262.32, 262.34, and 761.
- Title 49 CFR Part 172.

23.0 Personal Protective Equipment

Personal Protective Equipment

For many tasks, personal protective equipment (PPE) is as essential to the job as any tool. OSHA requires that every employer evaluate all tasks associated with a project to determine the hazards associated with these tasks and the appropriate PPE to be worn by each employee. As is always the case with PPE, it shall only be used when engineering and administrative controls are not adequate to address the potential hazard.

Minimum PPE required for all work activities: hard hat, safety glasses with side shields, safety toe boots, FR or natural fiber clothing without silk screening.

- All employers must conduct a hazard assessment prior to the start of every project and as conditions change on the project to determine the types of PPE necessary for each task.

- All workers must be trained in the following:

    - Recognizing the need for PPE
    - Types of PPE necessary
    - Proper use of PPE
    - Limitations of PPE
    - Proper care of PPE
    - Disposal of PPE
    - Inspection of PPE
    - Proper donning and doffing of such equipment to ensure adequate fit.

- All PPE used must meet applicable American National Standards Institute (ANSI) standards.

- All PPE shall be maintained and stored in a sanitary manner that protects it from deterioration, degradation or damage. In situations where workers provide their own PPE, it shall be the responsibility of the contractor to ensure that such equipment is adequate in both quality and quantity and that it is stored and maintained in a sanitary, safe manner.

- ***Hard Hats*** – required for all construction work activities when outside of the protection of a vehicle. These include roadway work zones, in substations, on construction sites, in field work locations, when performing overhead hoisting operations and any time there is a potential hazard to the head. Exceptions would include operators positioned inside the cab of equipment. The hard hat shall be worn in the forward direction. Contractor employees are not permitted to wear Orange & Rockland Utilities hard hats. Hard hats must comply with ANSI Z89.1-2003 or latest version.

NOTE: Welders may be permitted to perform welding tasks without the protection of a hard hat **only when all overhead hazards have been eliminated**. Once the welding operations have been completed, a hard hat must be donned.

- Hard hats shall never be changed or modified in any way that compromises the intended performance of the hard hat.

- ***Safety glasses/goggles/face shield*** – required for all construction work activities when outside the protection of a vehicle. Safety glasses must be ANSI Z-87.1 compliant (latest published date). **ALL** safety eyewear must have side shields attached at any time safety eyewear is required effective January 1, 2012. Face shields are required during any chipping and grinding operations etc.

- ***Class 2 reflective garments*** – Class 2 High Visibility reflective garments, at a minimum, are required for all operations in which employees are exposed to moving vehicles or construction equipment. Garments must be FR if performing hot work or when working with live gas or in proximity to electric energy.

- **Safety shoes** – required during all job operations meeting standards in ANSI Z41.1 or ASTM 2412 or 2413

  - **Metatarsal protection is required when jack hammering**

- **Fire Retardant work clothes (with long sleeves) -** Contractor employees shall wear flame retardant (FR) clothing when performing tasks that may expose them to the hazards of flame or electric arc. Employees are required at a minimum to wear 100% natural fiber (wool or cotton) clothing, including undergarments; elastic undergarment waist bands are acceptable. In all cases, the outermost layer of clothing shall be FR if exposed to hazards of arc or flame. The use of clothing containing polyester, nylon, rayon, and acetate (alone or in blends) which are not FR treated and/or rated, or having **silk screening is strictly prohibited** for field work activities at O& R Utilities.

  FR clothing is also required during all live gas work including welding and live gas sidewall fusion operations, tapping, gas pipe blow downs, purging etc., and in areas that are identified by Orange & Rockland Utilities policies and procedures. Silk screened T-Shirts are not permitted to be worn at any time. When there is a potential exposure to electric arc or gas flame, employees will have appropriate FR clothing on. Shirts will be buttoned up, tucked in, and the sleeves rolled down and buttoned up.

NOTE: HRC 1 FR rated clothes cannot be worn alone while in the Minimum Approach Distance (MAD) to electric energy or in areas with potential for gas flash fire. The minimum FR protection required when working in the MAD or with live gas is HRC 2. In those situations, an outer layer of FR clothing with an HRC 2 rating must be worn.

- **Welders chaps and aprons** – required during all pipe torch cutting and welding operations

- **Welders glasses, goggles, shields** – required during all pipe torch cutting and welding operations

- **Hearing protection** – when using power tools or in areas that exceed 85 dB (i.e. chainsaw, chipping, etc.) Hearing protection is required when closing a cutout/fuse.

- **Respiratory Protection-** (Medical approved and fit tested employees only) ½ face respirator, full face respirator, SCBA, Airline Respirator. Respiratory Protection may be required as deemed appropriate when outlined in procedures required to perform job scope, some examples include: catching gas on the fly, rock drilling, concrete abrasive cutting, etc. Fit Test cards are required to be carried by all fit-tested employees while on-site.

- **Work gloves** – at minimum, workers will wear leather-palmed heavy cotton work gloves. Other hand protection shall be appropriate for work function performed (i.e., welders gloves with gauntlets, riggers gloves, rubber gloves, sleeves, fire gloves etc.)

    - Appropriate rubber glove protection and sleeves are required for the work function being completed (i.e. primary Class 2 gloves, secondary gloves). Gauntlets are required to be worn in conjunction with the primary or secondary glove being worn.

    - Class 2 rubber sleeves are required from the time the bucket leaves the ground until it returns to the ground, during overhead line operations where there is primary voltage present, and when working within the minimum approach distance or extended reach. Use of a hot stick would alleviate the sleeve requirement. Sleeves are also required if climbing the pole.

    - Sleeves must also be worn when approach distances cannot be maintained to lines and equipment that are energized in excess of 600 volts.
    - Rubber gloves shall be worn by workers when handling poles or structures that are being set or removed and that are in close proximity to energized conductors or equipment.

    - Class 2 rubber gloves shall be worn when operating any “GOAB” or Capacitor Control Box (except by remote control).

    - Appropriately rated insulated gloves (i.e. Class 2) and gauntlets shall be worn when hand digging on a combined trench that has energized electric present.

- **Personal Retrieval Device and Safety Harness –** required during operations within permit required confined space.
    - Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

- **Fall Protection –** required for any work which exposes an employee to a potential fall of 4 feet or greater. Reference "Working at Elevations" located in section 31.0 of this document.

- **Chaps-** are required to be worn while operating a chainsaw on the ground. Employees operating a chainsaw while in an aerial insulated bucket are not required to wear chaps.

- **Other PPE** such as poly-coated coveralls, booties; protective glove, etc. that may be required per O&R Procedure or as specified in SDS.

    - Depending on the work being performed, additional PPE may be required. This determination shall be made by the qualified contractor representative as part of the pre-work hazard assessment. Such PPE may include gloves, footwear, eye protection, face protection and/or head protection, blowing gas suit etc.

- Protective clothing (reusable or disposable) must be appropriate for the type of work being performed.

Regulatory Citations

A complete text of the requirements for Personal Protective Equipment can be found in Title 29 Code of Federal Regulations, Part 1910, Subpart I, and Part 1926, Section 28 and Subpart E.

Contacts

For additional information regarding Personal Protective Equipment requirements or clarification of these requirements, contact the New York regional OSHA office or www.OSHA.gov.

24.0 Pesticides Use, Storage, and Disposal

Pesticide Use, Storage and Disposal

Federal and State laws require that pesticides are handled, stored, applied, and disposed of in a manner that protects human health and the environment. Personnel who may inadvertently come into contact with the recently applied pesticides must be notified when pesticides are applied. Requirements include registration of the applicator, compliance with label requirements, proper storage and disposal of pesticides and pesticide containers, and keeping required records.

- Commercial applicators must:
    - Register annually with the NYSDEC and carry liability insurance.
    - File an annual report with the NYSDEC that identifies the amounts and types of pesticides applied during the prior year.
- Individual pesticide applicators must provide proof of NYSDEC certification.
- Permits are required where necessary to apply restricted pesticides or pesticides to control aquatic vegetation and fish and aquatic biocides.
- The application of pesticide in or over waters of the state may require a discharge (SPDES) permit.
- If applying pesticides in a Right-of-Way (ROW), the work must be performed in accordance with O&R's long-term ROW management plan and annual maintenance plan filed with the Public Service Commission.
- Local personnel, including residents and persons who may use a public space, must be notified prior to applying pesticides. This notification involves verbal communication, but written communication in the form of letters and posted signs must be used.
    - Visual notification is required when applying pesticides within an easement ROW, and within an O&R property when application is within 100 feet of a dwelling, multiple dwelling, public building, or public park.
    - Notification must be made before and at least 24 hours following application.
    - The notification must be visible and posted within or along the area treated.
- Pesticides are used in a manner consistent with that described on the pesticide label.

- Pesticides must be stored in a manner to prevent accidental contact.
    - Pesticides must be stored in their original containers, away from sun and heat.
    - Pesticide storage areas must be locked and posted with signs reading "DANGER, POISON, PESTICIDE STORAGE AREA, KEEP OUT".
    - Pesticides must not be stored next to food, feed, or other articles intended for human or animal consumption.
    - Do not eat, drink, smoke, or use tobacco in pesticide storage areas
    - Thoroughly wash hands with soap and water after handling pesticides and pesticide containers.
- Pesticides and pesticide containers must be disposed of properly.
    - Unusable pesticides are returned to supplier or disposed according to its waste type.
    - Pesticide containers must be triple-rinsed prior to disposal with rinse water sprayed over the area of pesticide application.
- Records of amount and type of pesticides applied must be maintained for NYSDEC reporting.

Regulatory Citations

A complete text of the requirements for pesticides can be found in Title 40 Code of Federal Regulations (CFR) Parts 150 through 189 and in Title 6 New York Code or Rules and Regulations (NYCRR) Parts 325, 326, 360, and 371.

25.0 Respiratory Protection Program

Respiratory Protection Program

Respiratory protection is used when unacceptable levels of airborne contaminants or hazardous atmospheres occur during the course of work. Respiratory protection should not be the initial step taken to control such exposures. It should only be used when engineering or administrative controls such as ventilation and safer product substitution do not address the concern.

Proper use of respiratory protection requires proper respirator selection, medical clearance and respiratory fit testing among other requirements. A fully developed and written Respiratory Protection Program (RPP) must be prepared and on hand. Project or site specific respiratory protection details must be provided where required.

- Contractor must ensure that administrative and engineering controls are applied before respirator usage is planned.
- Contractor must provide a written Respiratory Protection Program (RPP).
- Contractor must conduct appropriate job hazard assessments and exposure monitoring to determine the appropriate type of respiratory protection, both initially and on an ongoing basis as required by OSHA.
- Selection of the proper Air Purifying Respirators (APR) or Supplied Air Respirators (SAR) will depend on the characteristics of the workplace and the level of protection necessary. Characteristics include the concentration of airborne contaminants, immediately dangerous to life or health (IDLH) conditions, oxygen-deficient atmospheres, and the protection factor (PF) of each respirator.
- APR's will not be worn in oxygen-deficient atmospheres, IDLH conditions, when the contaminant exceeds the PF of the respirator, or when cartridges do not exist for a particular contaminant.
- Breathing air quality must meet the Compressed Gas Association's definition of "Grade D" air for all supplied air respirator use. This includes breathing air cylinders and 5-minute escape cylinders. Compressors shall meet applicable OSHA standards.
- In IDLH atmospheres prior to entry, a rescue plan shall be conveyed to crew members.
- The contractor will follow OSHA regulations regarding maintenance, inspection, proper use of cylinders, fittings, hoses, manifolds, etc., and recordkeeping.
- Self-Contained Breathing Apparatus (SCBA) or equivalent shall be used in situations where the contaminant or concentration of a contaminant is unknown.

- Respirator use requires training with the properly selected respirator, medical evaluation to wear the respirator, and proper fit-testing of the respirator.

- The contractor shall not permit respirators with tight-fitting facepieces to be worn by employees that have:

    - Facial hair that comes between the sealing surface of the facepiece and the face or that interferes with the valve function or;

    - Any condition that interferes with the face-to-facepiece seal or valve function

- Respirators shall be inspected, maintained, cleaned, disinfected, and stored according to the manufacturers' directions and applicable OSHA guidelines.

- Emergency equipment shall be inspected monthly and all records will be kept on file.

- For welding on gas mains, respiratory protection is required.

(Contractor to Add info):

Regulatory Citations

A complete text of the requirements for Respiratory Protection can be found in Title 29 Code of Federal Regulations, Part 1910, Section 134.

Contacts

For additional information regarding Confined Space requirements or clarification of these requirements, contact the New York regional OSHA office or www.OSHA.gov.

26.0 Sampling

Sampling

Environmental or occupational sampling/monitoring may be required to characterize a material or waste, to confirm the presence or absence of hazardous substances/atmospheres, to determine the extent of a spill, release or exposure, to confirm that cleanup standards have been met, and/or to comply with permit or regulatory criteria or standards. In order to ensure sample validity, it is the contractor's responsibility to ensure that all samples must:

- Be collected in a manner consistent with all regulatory protocols and good sampling practice
- Be representative of the materials/media in question
- Be analyzed by qualified laboratories, if needed
- Asbestos, lead, and similar types of materials shall only be sampled/tested by a trained and qualified person

All generated data must meet the data objectives of the laboratory's quality assurance and quality control (QA/QC) program.

- All sample strategies must be developed and executed by qualified, trained personnel.
- All sample Chains of Custody must be filled out appropriately.
- In case of personal monitoring, all monitored employees must be provided with the monitoring results in a timely manner as required by OSHA regulations.
- Contractors must ensure that laboratories used maintain the appropriate New York accreditations and participate in standardized proficiency analytical testing (PAT) programs.

Regulatory Citations

Documents prepared by United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Control (NYSDEC) governing the collection and analysis of environmental samples include:

The Region II CERCLA Quality Assurance Manual, Revision 1, USEPA, October 1989,

The NYSDEC *Sampling Guidelines and Protocols,* Division of Water, Bureau of Spill Prevention and Response, March 1991.

Contacts

For additional information regarding sampling requirements or clarification of these requirements, contact the following agencies:

Contact the Region 3 NYSDEC office at 21 South Putt Corners Road, New Paltz, NY 12561 (914-256-3000) “www.dec.state.ny.us”.

For information on NYSDOH’s ELAP program, contact the New York State Department of Health office in the Wadsworth Center, Empire State Plaza, Albany, NY 12201-0509 (518-485-5570) “www.health.state.ny.us”.

27.0 Vehicle Management

Vehicle Management

During the course of typical operations, vehicles may be used for personal transport, equipment or material transport, earthmoving/excavation, pile driving, or other purposes. OSHA has specific requirements designed to ensure that vehicles are maintained and operated in a safe condition to protect workers. In addition, state licenses and Department of Motor Vehicle regulations address the proper operation and maintenance of vehicles in order to protect both the driver and the public.

- All personnel shall possess a valid driver's license or Commercial Drivers License (CDL), as applicable.
- Only properly trained personnel will operate the vehicles for which they are trained.
- All over the road vehicles shall maintain and display a current registration and state inspection.
- Keys shall be removed from vehicles when not in use.
- The vehicle must not be loaded or unloaded until the engine is shut off, the wheels are chocked and the parking brake is set, unless the use of the engine is necessary.
- All vehicles must have a functioning service; emergency and parking brake system and functioning brake lights.
- Vehicles will be inspected prior to use and removed from service if deficiencies exist. These vehicles shall not be returned to service until all deficiencies have been corrected in their entirety.
- Vehicles greater than 10,000 lbs which are used on public roads must have U.S. Department of Transportation approved flares, triangles, or other warning devices in the vehicle. Wheel chocks shall be installed, as required.
- Tools and materials carried in passenger compartments must be secured to minimize the risk of flying objects during transport or use.
- Vehicles with cabs must have windshields and functioning powered wipers.
- All vehicles must have proper seats with approved seat belts for each person.
- All vehicles parked or positioned near an active roadway at night shall have appropriate warning devices.

- Workers must not work under or between equipment and vehicles suspended from slings, hoists, or jacks until the equipment is blocked or otherwise supported.

- All vehicles and/or vehicle components shall be fully lowered and blocked during repair or when not in use.

- All trucks and mobile equipment shall have operational backup beepers as required.

- All loads and/or materials which may be disturbed or impacted by wind in transit shall be secured and covered prior to transport.

- Roadway weight limits will be adhered to at all times.

- The following equipment must have Roll-Over Protection Structures (ROPS):

    - Rubber-tired scrapers, loaders, and dozers, Wheeled tractors;

    - Crawler tractors and loaders, and

    - Motor graders.

- ROPS must be labeled appropriately.

- Vehicle idling laws shall be adhered to at all times.

- All vehicles shall be inspected daily for leaks. Attempts shall be made to avoid parking over drains or catch basins.

- All vehicles and mobile equipment shall be free from leaks while on-site. If not, the vehicle or piece of equipment shall be removed from service until the leak is repaired.

All SPILLS from vehicles must be <u>immediately</u> reported to the O&R Site Representative who will immediately notify the O&R Control Center.

<u>Regulatory Citations</u>
A complete text of the requirements for Vehicle Management can be found in Title 29 Code of Federal Regulations, Part 1926, Subparts F and O.

<u>Contacts</u>
For additional information regarding Vehicle Management requirements or clarification of these requirements, contact OSHA or visit the OSHA web site at: www.OSHA.gov.

28.0 Waste Management

Waste Management

Federal and State laws require that wastes be properly classified and managed as hazardous waste, universal waste, or non-hazardous waste. Waste characterization will determine how to manage the materials. Proper waste management includes characterization, labeling, storage, transportation, disposal, personnel training, reporting, and recordkeeping.

- Contractors take title to all wastes generated if so stated in the specifications; however, O&R RESERVES THE RIGHT TO TAKE TITLE TO ALL WASTES AND RECYCLABLES GENERATED BY THE CONTRACTOR’S ACTIVITIES AT O&R FACILITIES AND WORK SITES.

- Contractor will comply with all applicable requirements for hazardous wastes generated, which may be with the assistance of O&R representatives, including:

    - Characterizing the waste, managing accumulated and stored waste.
    - Labeling of containers, storing the waste, inspecting the storage areas.
    - Filling out manifests and Land Disposal Restriction (LDR) forms.
    - Contractor employees must be trained in hazardous waste requirements and emergency response.
    - Ensuring that waste is disposed of and transported using O&R approved treatment, storage, and disposal facilities and transporters.
    - Ensuring that reports and records are maintained.

- Wastes shall be segregated when stored to prevent mixing of waste types.

- Dumpsters / rolloff containers used for storing waste will be properly maintained, sized for the expected waste generation, and covered (with lids, doors, and/or tarps).
- Security measures shall be implemented to prevent non-authorized personnel from tampering with wastes.

- Department of Transportation (DOT) requirements regarding waste packaging, shipping and transport, including container selection and vehicle placards must be followed when shipping waste off-site.

- The contractor shall provide copies of all shipping papers and certificates of disposal that are obtained and prepared for wastes generated at the job site.

- Contractors working on projects in Rockland County shall observe the flow control regulations and dispose of project waste at an approved Rockland County transfer station.

Regulatory Citations

A complete text of the requirements for waste management can be found in:

- Title 40 CFR, US EPA, Parts 172, 173, 260 through 262, 264, 265, and 268;

- Title 6 NYCRR, Parts 360, 364, 367, 370 through 374, and 376;

- Rockland County Flow Control Law

Contacts

For additional information contact the following agencies:

Projects in Orange, and Rockland Counties, contact the Region 3 NYSDEC office at 21 South Putt Corners Road, New Paltz, NY 12561 (914-256-3000). Projects in Rockland County, contact the Rockland County Department of Health on Sanatorium Road, Pamona, NY 10970 (914-634-2500) “www.co.rockland.ny.us”. Projects in Dutchess County, contact the Dutchess County Health Department, Division of Environmental Health Services in Poughkeepsie, NY 12601 (914-486-3404) “www.dutchessny.gov”.

29.0 Water Resources

Water Resources

Federal and State laws require that water resources are protected and that wastewater is properly managed. Regulations have been passed that govern the discharge of process (or industrial) wastewater, sanitary wastewater, and storm water. Generally, water discharges may only be performed under a formal discharge permit.

- Pre-planning how to manage project wastewater (such as dewatering excavations) is done by completing the EHASP prequalification information including hazard analysis, and the A11.03 checklist, with the O&R representative

- Wastewater discharged from a point source to waters of the state may only be discharged under a State Pollutant Discharge Elimination System (SPDES) permit from NYSDEC.

- The application process for a SPDES permit is a complicated and lengthy one. If project wastewater can only be discharged to waters of the state, it may be preferable to collect for shipment to off-site treatment.

- Wastewater discharge into a sewer system requires local municipality approval.

- Contractor must have permission from the authorized O&R representative prior to discharging wastewater into a O&R wastewater treatment system.

- For construction projects larger than 1 acre (or less than one acre if in watershed or designated areas protected by NYCDEP or NYSDEC) and stormwater will discharge to surface waters of the state, contractor must file a Notice of Intent (NOI) and a Stormwater Pollution Prevention Plan (SWPPP) with NYSDEC to obtain coverage under the SPDES General Permit for Stormwater Discharges. The contractor must then comply with the general permit conditions and the SWPPP. Some protected areas are required by NYSDEC to obtain an individual SPDES permit.

- Dredging projects may require applicable permits/approvals including:

    - State Environmental Quality Review Act (SEQRA) evaluation.

    - Waterfront Revitalization and Resources Act review, Coastal Erosion Permit.

    - Uniform Procedures Act review, wetlands permits.

Regulatory Citations A complete text of water resources requirements can be found in:

- Title 40 CFR, US Environmental Protection Agency (USEPA) Parts 122, 125, and 401;
- Title 6 New York Code of Rules and Regulations, Parts 608, 652, and 750 through 758;
- The Rockland County Sanitary Code, Article IV, Part 4.2.0; and
- A complete text of the dredging requirements can be found in:
    - Section 404 of the federal Clean Water Act, Title 33 CFR Parts 320 and 325;
    - Title 40 CFR Parts 230 and 232; Title 19 NYCRR, Part 600;
    - Title 6 NYCRR, Part 505; and The NYSDEC Interim Guidance for Freshwater Navigational Dredging (10/94, guidance, not regulation).

Contacts For additional information contact the following agencies:

For projects in Orange and Rockland Counties, contact the Region 3 office at 21 South Putt Corners Road, New Paltz, NY 12561 (914-256-3000).

Projects in Rockland County, contact the Rockland County Department of Health on Sanatorium Road, Pamona, NY 10970 (914-634-2500).

30.0 Welding & Burning

Welding and Burning

Welding, cutting, brazing, and other hot work activities (i.e., burning, soldering, grinding) can generate a number of potential health hazards and create numerous sources of ignition (sparks, hot slag, and pieces of hot metal), which can ignite nearby flammable and combustible materials. These activities can result in injuries, burns and exposures to potentially toxic fumes.

- All employees involved in cutting, welding or brazing using propane or an oxy-acetylene fuel shall have the appropriate training and qualifications, as required.
- Employees must use appropriate PPE and proper ventilation systems for protection against hazards of hot work.
- Employees shall inspect all welding and cutting equipment prior to use. Equipment shall be inspected during work, as required.
- If the object to be cut or welded can not readily be moved, all movable fire hazards within 35 feet of the welding or cutting must be taken to a safe place and made fire safe.
- Guards and/or welding blankets must be used to confine heat, sparks, and slag.
- When cutting or welding is to be conducted in sprinkler equipped buildings, care shall be taken to ensure that cutting or burning operations in the vicinity of sprinkler heads do not raise the head temperatures and trigger the system.
- Cutting or welding must not be permitted in the presence of explosive atmospheres or in an area where combustible gases, liquids, or dusts could accumulate.
- Containers shall be cleaned and thoroughly purged to ensure no flammable or combustible substances remain prior to work. The inside atmosphere of each container must be checked for combustible gases using the approved testing equipment.
- The appropriate fire extinguishing equipment shall be available during hot work.
- Trained fire watches must be utilized when cutting or welding operations are conducted in areas not designed for welding.
- Fire watches must have fire-extinguishing equipment readily available, must be trained in its use, and must be familiar with the procedures for sounding an alarm.

- Fire watches must make an inspection after completion of the welding operation. The person authorizing welding is permitted to extend the inspection period as required.

- Additional fire watches are assigned with adequate fire protection equipment as needed.

- Coatings must be removed with an approved paint stripper to a point at least 4 inches from the area where heat will be applied.

- Gas cylinders used for hot work must be handled, transported, and stored appropriately.

- When stored, oxygen cylinders must be separated from fuel gases by a 5-foot-high barrier with a one-half-hour fire rating or a distance of 20 feet.

- Approved ground leads must be used when arc welding.

- When arc welding is performed in wet conditions or under conditions of high humidity, special protection against electric shock must be provided.

- Hot work in confined space must follow all confined space requirements.

- A disposable particulate respirator can be used in open-air welding or cutting, and in large well-ventilated areas, or where clean carbon steel is welded or cut with bare or coated carbon steel electrodes and without inert gas shielding.

- Welders shall wear helmets/welding shields that give the maximum eye protection for the welding and cutting process.

  > **NOTE**: Welders may be permitted to perform welding tasks without protection of Hard Hats only when all overhead hazards have been eliminated. Once welding operations have been completed, a hard hat must be donned.

- Protective clothing shall include flame-resistant gauntlet gloves, flame-retardant coveralls (natural fiber garments), flame-resistant aprons or leather vests, and welding helmets with approved ultraviolet radiation filters.

- **For welding on gas mains, respiratory protection is required.**

- Natural ventilation is acceptable when precautions are taken to keep the welder breathing zone away from direct fume path or when samples of the atmosphere shows concentrations of contaminates are below the Permissible Exposure Limits.

- Before welding or burning any metal that is coated with or contains paint, corrosion or preservative coating, the coating shall be removed. The removal shall be at least four (4) inches from the area where the heat is to be applied.

Trained Fire Watch: They shall be assigned no other duties other than to remain alert and guard against fires. Fire Watch personnel must:

- Ensure that safe conditions are maintained prior to and during hot work operations.
- Have the authority to stop the hot work operation if unsafe conditions develop.

- Shall perform two inspections after completion of welding, cutting, and other hot work:
    1. One half hour after completion of the hot work operations
    2. One half hour after the first inspection is completed

- Watch for fires in all exposed areas and try to extinguish them only when the fire is in the incipient stage and can be extinguished by one fire extinguisher.

- If fire is beyond the incipient stage, the fireguard is responsible for "sounding the alarm".

Regulatory Citations

A complete text of the requirements for Hot Work can be found in Title 29 Code of Federal Regulations, Part 1910, Subpart Q and Part 1926, Subpart J.

Contacts

For additional information regarding Hot Work requirements or clarification of these requirements, contact the New York regional OSHA or visit the OSHA web site at: www.OSHA.gov.

31.0 Work Area Protection

Work Area Protection

Workers must not only be protected from hazards on the project site but also from hazards generated by nearby operations. Members of the public passing near work areas must also be protected from any site-generated hazards. It is therefore important that all work areas be properly barricaded and posted with warning signs and that signals be used to control nearby vehicle traffic. In addition to OSHA, local agencies may have specific requirements for work conducted in roadways or near pedestrian traffic.

- All work areas will be sufficiently barricaded to prevent unauthorized access and limit exposure of the public to work area hazards.

- Line of sight shall be maintained with an open substation gate, if line of sight cannot be maintained, the gate shall be closed and latched.

- All signs will conform to the requirements specified by OSHA and be used only for their intended purpose.

- Traffic signs will be placed appropriately to control vehicle traffic on or near project sites and must conform to the MUTCD standard.

- Traffic control set ups will be periodically inspected during the day to ensure their continued effectiveness.

- Flaggers will be used to control traffic when signs, signals and barricades do not provide the necessary protection. Flaggers shall utilize a paddle (stop/slow) to coordinate traffic flow.

- Flaggers and workers in the vicinity of moving vehicles shall wear, at a minimum, an approved DOT Class 2 reflective garment approved by the U.S. Department of Transportation.

- Flaggers will be illuminated during night work activities. Illumination shall be achieved with a lighting source. Utilization of truck head lights which face oncoming traffic is prohibited.

- Only appropriately trained personnel will act as flaggers.

- Caution, warning, and construction information traffic signs will be displayed, as appropriate.

- Safe passage for pedestrians will be maintained at all times.

- During non-working hours a lighted safety barricade will be erected around all open excavations. Lights will be in operation from sunset to sunrise seven days a week until excavation is backfilled and area made safe.

- During non-working hours, roadway work sites will be passable for vehicles and pedestrians.

- “Raise Plow” signs shall be erected at plated excavations, when required.

References
A complete text of requirements can be found in the Manual for Unicorm Traffic Control Devices (MUTCD)

Contacts
For additional information contact OSHA or visit www.osha.gov.

32.0 Working at Elevations

Working at Elevations

Falls from elevated work areas are one of the leading causes of death each year in occupational settings. Hence, it is important that work on elevated areas be performed with extreme caution and in conformance with applicable safety and prevention regulations. Fall prevention is provided by engineering controls such as safety railings or personal fall protection systems. Precautions shall also be taken to protect personnel from the dangers of objects falling on them from higher elevations. All processes involving the assembly, use, movement or disassembly of scaffolding and the use of fall protection systems shall be overseen by a competent person who is knowledgeable in the use and maintenance of these systems.

- Elevated surfaces include openings (pits), open-sided platforms, floors, or runways/ramps; stairs, ladders, mobile scaffolding, lifting equipment (aerial lifts and ladders) and openings (pits) where materials above the work area could potentially fall and injure a worker shall be protected.

- When there is the potential that workers could fall 4' or more to a lower surface or elevation, appropriate fall protection barriers shall be utilized (i.e. harness, positioning belt etc.).

- Lifelines/harnesses must be inspected prior to each use for signs of wear, damage, mildew or other deterioration that could limit their effectiveness and comply with the American National Standards Institute (ANSI) standards and be used according to manufacturers' operating procedures.

- Lifelines must be made of rope with a breaking strength of 5,000 pounds.

- The lanyard must be a minimum of one-half inch nylon or equivalent, and shall be such that the free fall distance shall not exceed six (6) feet or to allow a fall which would allow the worker to contact any lower level.

- A body harness must be worn and a lanyard attached to the boom strap when working from an aerial lift device. Body belts are prohibited.

- Scaffold planking, guardrails, ladders, toe boards and mesh wiring must be installed on scaffolds as required by the regulations. A scaffold must be rated for four times its intended load.

- CLIMBING ON SCAFFOLD CROSS MEMBERS IS PROHIBITED.

- A registered professional engineer must design wood pole scaffolds over 60 feet in height; tube and coupler scaffolds that exceed the parameters listed in the regulations, frame scaffolds over 125 feet in height; and outrigger scaffolds.

- Scaffolding must be cross-braced or braced diagonally and be plumb, square, and rigid. Sections of scaffolding are locked together with cotter pins if uplifting may occur.

- Shore scaffolds or lean-to scaffolds are prohibited.

- Loading limitation of scaffold must not be exceeded.

- Employees working on swinging scaffolds must be attached to a secured lifeline.

- The erection, installation and use of various scaffold types will be in compliance with all laws and regulations and manufacturer's operating procedures.

- The use of a safety harness is required when operating an aerial lift (genie lift, manlift, bucket etc.)

- Aluminum/metal and wood ladders are prohibited.

- Approved ladders will be used and inspected before each use to ensure their integrity.

- **Extension Ladders**:

    - Inspected before each use, used at a 4:1 ratio, footed by another employee or secured from movement and extend 3' above the upper contact surface. When working from an extension ladder, a positioning device must be used. **Three points of contact shall be maintained when working from an extension ladder**. Working from the top step of a ladder is prohibited.

    - Ladders shall be used against a solid surface at an angle of approximately 75 degrees, and the horizontal distance from the solid surface to the base of the ladder shall be one-fourth the working length of the ladder. Extension ladders shall only be raised only in the vertical position. Sufficient overlap shall be allowed: Three (3) ft. for sections up to 36 ft.in length; four (4) ft. for sections between 36 and 48 ft.; and five (5) ft. overlap for 48 to 60 ft. Short ladders shall not be spliced together. A ladder shall never be used in front of a doorway unless the door is locked or the doorway area is barricaded and/or guarded. Only one person shall be on a ladder at one time.

- **Step Ladders:**
    - Stepladders shall be opened fully to allow the spreader bars to lock. Chain or rope shall never be used as a spreader. Stepladders shall be used on firm and level surfaces. Stepladders shall not be used in front of doorways, unless the door is locked or the doorway area is barricaded and/or guarded.

    - The top two steps of any stepladder shall never be used for standing or sitting. Stepladders shall be inspected prior to use for defects in the ladder shoes, treads and side rails, etc. If defects are identified, the ladder shall be immediately removed from service, destroyed and discarded. Stepladders must be fully opened when in use. An employee must not stand on the top two steps under any conditions unless the ladder is designed for such use (i.e., a platform ladder). When step ladders more than ten feet in height are in use, they must be properly secured or held in place (proper use of a step ladder does not require three points of contact (designed use).).

- **Scaffolding**:
  - Must be erected and dismantled under the direction of a Competent Person, inspected each day prior to use and after any abnormal circumstances, used in conjunction with a fall protection system, and rated for the intended load.

- **Aerial Platforms**:
  - Inspected before use and comply with the vehicle management section. A fall harness shall be worn and secured to the Aerial platform from the moment the platform leaves the ground until its return to the ground.

Regulatory Citations

A complete text of the requirements for Working at Elevation and Scaffolds can be found in Title 29 Code of Federal Regulations, Part 1910, Subparts D and F, and Part 1926, Sections 104 and 105 and Subparts L and M.

Contacts

For additional information regarding Working at Elevation and Scaffold requirements or clarification of these requirements, contact OSHA or the OSHA website can be found at www.OSHA.gov.

Rules We Live By

The following rules have been established by Orange & Rockland Utilities to prevent employee exposure to hazards that pose imminent danger and can result in serious injury or death. If a Rules We Live By Violation is determined and verified, the contractor employee will be suspended from all O&R and CECONY work for a minimum of 20 days and the Contractor company will have an action line placed against them, at a minimum.

PPE for Hazardous Energy Sources

- Prior to working on hazardous electrical or gas energy sources; use the appropriate rubber gloves, rubber sleeves, fire retardant clothing/coveralls, eye protection/face shield, rubber hose, blankets, hoods etc. as required for exposure to the greatest hazard.

Electric Operating Orders and Clearances

- Do not perform work without properly obtaining permission / clearance from the Operating Authority
- Do not change the status of a piece of equipment without permission from the Operating Authority.
- Follow the proper sequence of all Operating/Switching Orders

Atmospheric Testing

- Before entering and while working in a confined space or in a permit-required confined space proper atmospheric testing and monitoring must be performed.

Verify Dead/Lockout-Tag Out – Before beginning work:

- Conduct or ensure proper lock out/tag out of equipment.
- Properly test or verify that equipment is tested dead and grounded for equipment that is to be worked dead.

Fall Protection/Rescue/Retrieval

- Properly utilize enclosed/confined space rescue equipment.
- Properly utilize fall protection equipment.

Sheeting/Shoring

- Do not enter excavations five feet or deeper unless they are properly sheeted and shored, sloped or benched.

Introduction of Gas to Mains and Services

- Main – A gas main shall not be energized without proper authorization from the Gas Distribution Control Center (GDCC).
- Service – Gas shall not be introduced into an existing service without first closing the riser valve.

Customer Piping – A proper integrity test must be performed on customer-owned piping after the meter before gas can be restored.

ATTACHMENT A

NATURAL RESOURCE TECHNOLOGY SAFETY PROGRAMS

ATTACHMENT A1

HAZARD COMMUNICATION

HAZARD COMMUNICATION

1.0 PURPOSE

All employers that manufacture, import, distribute, or use hazardous chemicals in the United States are subject to the Hazard Communication Standard (HCS) (29 CFR 1910.1200). The measures described in this section are designed to meet the requirements of 29 CFR 1910.1200 and ensure that all staff are aware of the hazards and safe handling procedures of the chemicals he or she works with. These measures are designed to protect the health and safety of all NRT staff.

2.0 DISCUSSION

NRT offers a variety of services to clients in both government and private industry. These services commonly use chemicals that have inherent chemical and physical hazards. General office activities may also involve working with products which contain regulated chemicals. The HCS requires employers to provide information to their employees about hazardous chemicals in the workplace through a written program, training sessions, material safety data sheets, labels and warnings, and other pertinent information. Manufacturers and importers are required to assess the hazards of the products or chemicals they manufacture or import and to distribute this information to all users of those products or chemicals.

3.0 RESPONSIBILITIES

The Environmental Health & Safety Manager, (EHSM) will assume primary responsibility for implementation and maintenance of NRT's Hazard Communication program.

3.1 Environmental Health & Safety Manager (EHSM)

The EHSM will serve as the focal point of accountability for the health and safety of workers involved in NRT work areas. The EHSM will ensure compliance with all applicable federal and state regulations governing safety and health protection, including the HCS. The EHSM duties include:

- Maintaining NRT's written HCS program;
- Implementing the training required by the HCS;
- Developing and updating annually a written list of chemicals used, stored, or imported into the laboratory or workplace;
- Maintaining a file of material safety data sheets for all products, materials, and chemicals found in the workplace;
- Ensure that his or her subordinates know and follow the health and safety guidelines included in the HCS training;
- Ensure that any new hazards introduced into the workplace receive a proper health and safety review, and that appropriate response plans are developed;
- Ensure that staff has proper training for their anticipated job assignments, including participation in the HCS training program and the use of appropriate personal protective equipment (PPE);
- Ensure that appropriate PPE is available and in good condition, and that it is used properly; and,
- Ensure that each work area has a complete and current set of material safety data sheets (MSDSs) and standard operating practices (SOPs) for applicable health and safety concerns, and that those SOPs are followed.

3.2 All Staff

Each staff person will:

- Read, understand, and comply with the written HCS program plan;
- Perform work safely; and,
- Be aware of any unsafe conditions and report those to his or her immediate supervisor or the EHSM.

4.0 WRITTEN HAZARD COMMUNICATION PROGRAM

NRT is required by the HCS to have a written hazard communication program that describes the requirements of the HCS and states how NRT, as an employer, meets or exceeds those requirements. Topics that must be covered include;

- Hazard determination;
- Labeling requirements;
- Material safety data sheets (MSDS);
- Current inventory of chemicals used (office- and/or site-specific); and,
- Staff information and training.

NRT's program is set forth below:

4.1 Hazard Determination

Chemicals manufacturers and importers are required to evaluate chemicals produced in their workplace to determine if they are hazardous. Mixtures that are not tested as a whole are assumed to be hazardous and are regulated under this standard if any of the components of the mixture are hazardous (as defined by HCS) and are present in the mixture at concentrations of 1% or greater (0.1% or greater for carcinogenic hazards). NRT is not a manufacturer (SIC Codes 20 through 39) of chemicals.

4.2 Labeling Requirements

Chemicals used by NRT are covered under the labeling requirements of the HCS. The labels must include:

- Chemical identity;
- Physical and chemical hazard warnings;
- Name and address of the manufacturer; and,
- Recommended PPE.

NRT must ensure that each container of a chemical used in the workplace has a label that identifies the contents and give appropriate hazard warnings. Existing labels on incoming containers may not be removed or defaced. Labels are not required on portable containers used for immediate transfer.

4.3 Material Safety Data Sheets (MSDSs)

NRT must obtain or develop an MSDS for each hazardous chemical it imports. Each NRT office will maintain copies of MSDSs specific to that office. The EHSM will ensure that these files are complete and readily accessible to all staff. NRT must receive an MSDS with each chemical shipment received. In the event that one is not received, the EHSM or a designee will contact the manufacturer and obtain and review for approval the MSDS. Master MSDS files will be indexed alphabetically by chemical name, the chemical abstract system (CAS) registry number, and known synonyms. All MSDSs received or written by NRT will contain the following information:

- Identity of the chemical;
- Chemical and common name for all ingredients that have been determined to present physical hazards;
- If the compound is a mixture, the chemical or common name for all ingredients that have been determined to be health hazards;
- Chemical and physical characteristics of the hazardous substance;
- Health hazards of the substance, including signs and symptoms of overexposure, and any medical condition which would be aggravated by exposure to the chemical;
- Primary routes of entry;
- The OSHA permissible exposure limit (PEL), ACGIH Threshold Limit Values (TLV), or any other exposure limit used or recommended by the manufacturer;
- Whether the chemical is listed in the National Toxicology Program (NTP) *Annual Report on Carcinogens* or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) *Monographs* or by OSHA;
- Precautions for safe handling and use, including hygienic practices, protective measures, and procedures for cleanup of spills and leaks;
- Known methods of exposure control, including engineering controls, work practices, or PPE;
- Emergency and first aid procedures;
- Date of preparation of the MSDS or of the last change to the MSDS; and,

- Name, address, and phone number of the chemical manufacturer who prepared the MSDS.

4.4 Trade Secret Provisions of HCS

NRT may withhold the specific chemical identity from the MSDS, including the chemical name and other specific identification of a hazardous chemical, if the identity of the chemical is a trade secret. If the specific identity of the chemical is not included on the MSDS, information concerning the effects and the properties of the chemical will be included on the MSDS. The identity of the chemical will be made available to health professionals in an emergency. In addition, the information may be requested by a health professional in writing in a non-emergency situation if studies are necessary to determine exposure levels, proper protective equipment, or engineering controls. NRT will abide by all aspects of the trade secret provisions of this standard.

4.5 Workplace Chemical List

The EHSM will develop and update annually a list of chemicals present in the workplace. The list will contain the following information:

- Chemical name;
- Common or trade name;
- CAS registry number;
- Manufacturer; and,
- Location.

4.6 Staff Information and Training

NRT is required to provide training to staff on hazardous chemicals in the workplace at the time of their initial assignment, when their job duties change significantly, and whenever a new hazard is introduced into the workplace. The training will be conducted by the EHSM, an industrial hygienist, or other qualified person and will include:

- HCS requirements;
- Location and availability of written hazard communication program (this section of the Corporate Health and Safety Manual);
- Health and physical hazards of chemicals present in the work area;
- Operations in the work area where hazardous chemicals are present;
- Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area; and,
- Measures that staff can take to protect themselves from these hazards.

4.7 Health Hazard Categories of Chemicals in the Workplace

The HCS requires that NRT inform staff of the operations in their workplace that involve hazardous chemicals. The following operations potentially involve use of hazardous materials:

- Field laboratory procedures;
- Field projects in or around plant sites;
- Field projects on or around environmental monitoring sites;
- Equipment maintenance operations; and,

- Print shop and graphics operations.

Supervisors will discuss the hazards specific to each employee's work area during initial orientation.

4.7.1 Chemical Hazards

Chemicals in the workplace present health hazards if they meet any of the criteria set by OSHA in the HCS. These criteria are listed below:

- ***Carcinogen****:* The chemical is considered a carcinogen if it is listed by the National Toxicology Program (NTP) *Annual Report on Carcinogens* or has been found to be a potential carcinogen in the International Agency or Research on Cancer (IARC) *Monographs* or by OSHA;
- ***Corrosive****:* A chemical that causes visible destruction, or irreversible alteration in living tissue by chemical action at the point of contact;
- ***Irritant****:* A chemical that is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the point of contact;
- ***Toxic****:* A chemical that has an oral rat LD_{50} - 500 mg/kg, a rabbit skin LD_{50} of 200 mg/kg or less, or an inhalation LC_{50} on rats of 200 ppm or less or 2 mg/liter or less;
- ***Sensitizer***: A chemical which causes a substantial portion of people exposed to it to develop an allergic reaction to normal tissue after repeated exposures to the chemical; or,
- ***Target Organ Effects***: Chemicals which affect target organs are classified as:
  - Hepatotoxins (liver damage),
  - Nephrotoxins (kidney damage),
  - Neurotoxins (primary effect on nervous system),
  - Agents which act on the blood or hematopoietic system,
  - Agents which damage the lung,

- Reproductive toxins,
- Cutaneous hazards (skin), and,
- Eye hazards.

4.7.2 Physical Hazards

For the purposes of the HCS, a physical hazard is defined as a chemical for which there is scientifically valid evidence that it is a:

- Combustible liquid;
- Compressed gas;
- Explosive;
- Flammable material;
- Organic peroxide;
- Oxidizer;
- Pyrophoric material;
- Unstable (reactive) material; or,
- Water reactive.

4.7.3 Methods for Detecting Spills and Leaks

The following methods are used to detect the presence or release of a hazardous material:

- Visual, Auditory, and Olfactory Detection Methods:
  - Seeing liquids accumulated around containers of hazardous chemicals,
  - Seeing gases or other airborne contaminants in the air, such as smoke, dusts, mists, fumes or vapor,

- Hearing the chemical being released from a container (hissing, explosion, etc), and,

- Smelling an odor that would indicate the presence or release of a hazardous chemical.

■ Personal Monitoring:

- Working environments that are suspected of being contaminated with harmful levels of hazardous chemicals will be monitored according to recommended industrial hygiene methods by qualified industrial hygienists. Methods used for the collection and analysis of personal monitoring samples will conform to recognized industrial hygiene standards.

■ Smoke Detection:

- All chemical facilities will be equipped with automatic smoke detectors, which will detect the presence of smoke through photoelectric or ionization methods.

- Sensitive areas in NRT offices are protected with automatic water sprinkler systems to extinguish fires.

4.7.4 Hazards of Non routine Tasks

Staff will be informed of the hazards of non routine tasks via project-specific health and safety plans and standard operating practices.

4.8 Documentation of Training

All HCS training activity must be documented according to the provisions of this manual. The training records will be maintained by the EHSM for compliance tracking. All pertinent training records are maintained in the office and are updated annually.

ATTACHMENT A2

AURAL CONSERVATION

Aural Conservation

All NRT staff who may be exposed to noise levels at or greater than 85 decibals (dBAs) are required to receive training on the following elements:

- The effects of noise;
- The purpose, proper fitting, and selection of hearing protection; and
- The purpose of audiometric testing and an explanation of test procedures.

This training is completed annually during the required 8-hr HAZWOPER refresher training. Audiometric testing is performed during the required annual medical monitoring for all field staff. All staff are required to wear hearing protection when working in noisy environments.

ATTACHMENT A3

OPERATIONS WITH HIGH HAZARD POTENTIAL

OPERATIONS WITH HIGH HAZARD POTENTIAL

1.0 PURPOSE

This section describes the health and safety hazards of, and abatement methods to be employed in, the performance of selected operations having the potential for a high degree of hazard. It is not the intent of this section to exhaustively identify and set specifications for all possible high hazard operations. Rather, certain operations were included because of the frequency of their occurrence, the regulatory requirements pertaining to their performance, and/or the severity of accidents that could happen if the hazards are not abated adequately. This section addresses the following operations:

- Permit-required confined space entry;
- Energy lockout/tagout;
- Compressed gas use;
- Work at elevations above grade;
- Electrical safety;
- Handling and storage of flammable or combustible liquids;
- Excavations;
- Work with asbestos containing materials (ACMs); and,
- Water course-operations on surface waters.

It must be recognized that it is the responsibility of all staff and managers to recognize hazardous operations not discussed in this section (or this Manual) and to seek guidance in adequately abating those hazards.

2.0 PERMIT-REQUIRED CONFINED SPACE ENTRY

Entry into confined spaces has the potential for exposing workers to toxic, flammable, and/or oxygen-deficient atmospheres. Many confined spaces also have the potential for entrapping or engulfing workers. For these reasons the Occupational Safety and Health Administration (OSHA) has promulgated the "Permit-Required Confined Spaces" standard (29 CFR 1910.146). It is NRT's intent to comply with the requirements of this standard and protect its staff against injury and illness due to confined space hazards.

2.1 Scope and Applicability

The requirements set forth in this subsection apply to all operations involving the entry of NRT personnel into a confined space. A permit-required confined space is defined by OSHA as an enclosed space that:

- Is large enough and so configured that any staff can bodily enter and perform assigned work;
- Has limited or restricted means for entry or exit (some examples are tanks, vessels, silos, storage lines, hoppers, vaults, pits, and diked areas);
- Is not designed for continuous staff occupancy; and,
- Has one or more of the following characteristics:
- Contains or has a known potential to contain a hazardous atmosphere;
- Contains a material with the potential to engulf an entrant;
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls, or a floor which slopes downward and tapers to a smaller cross section; or,
- Contains any other recognized serious safety or health hazard.

OSHA defines a hazardous atmosphere as an atmosphere which exposes staff to a risk of death, incapacitation, injury or acute illness from one or more of the following causes:

- A flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);
- An airborne combustible dust at a concentration that obscures vision at a distance of 5 feet or less;
- An atmospheric oxygen concentration below 19.5 percent or above 22 percent;
- An atmospheric concentration of any substance which could result in staff exposure in excess of its permissible limits. [If no OSHA standard has been set for a particular substance, the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs) or manufacturer's recommendations are to be complied with]; or,
- Any atmospheric condition recognized as immediately dangerous to life or health.

NRT managers and personnel are strongly encouraged to avoid performing work in confined spaces if feasible alternatives are available. Alternatives to confined space entry include the use of remote sampling devices or remote visual observation devices.

2.2 Responsibilities

Environmental Health & Safety Manager (EHSM)

The EHSM is responsible for ensuring that resources adequate to perform confined space entry safely are available to the field team and for ensuring that entries are made safely and in compliance with this subsection.

Project Manager (PM)

The PM is responsible for ensuring that his or her field personnel are adequately trained in confined space entry safety, that the necessary personnel and monitoring equipment are available, and that entries are performed safely and in compliance with this subsection. The PM will appoint a field person to authorize confined space entries. This authorizing person must be adequately trained, and possess the judgement necessary to safely authorize confined space entry. The PM will also ensure that an entry checklist and approval form (Figure 06-06.1) is completed and followed for each confined space entry.

Field Personnel

NRT personnel engaged in confined space entry, as either entrants, attendants, or authorizing personnel, are responsible for complying with the requirements of this subsection.

CONFINED SPACE ENTRY PERMIT

Part I - To be completed by Environmental Health and Safety Manager or Project Manager
Project Title: ____
Project Number: ____________________ Location: ____________________
Scope of Work: ____
____
____
____

Name: ______________________ is designated to authorize the confined space entry(s) required to fulfill the Scope of Work specified above. I certify that this person is familiar with the procedures to be employed, the hazards or confined space entry, and his/her responsibilities in safely implementing the required procedures.

Signed: ____________________ Date:
Project Director

Part II - Preparation Checklist

☐ Oxygen Content

Using a calibrated oxygen meter, measure the oxygen concentration of the air in the space to be entered. Be sure that for vertical spaces, the oxygen concentration is measured at both the top and bottom of the space. Record readings below:

Location	Content	Time/Date
______________	______________	
______________	______________	
______________	______________	
______________	______________	
______________	______________	

This oxygen meter was calibrated: (Time/Date)

☐ Flammability

Using a calibrated flammable gas meter, measure the concentration of flammable gases in the space to be entered. If the space is vertical, be sure to measure the flammable gas levels at both the top and the bottom.

Location	% LEL	Time/Date
________________	____________	
________________	____________	
________________	____________	
________________	____________	

☐ Toxic Substances in Air

First, identify the toxic substances that may be present in the confined spaces air, and their applicable exposure limits.

Substances	Applicable Exposure Limit
____________	
____________	
____________	
____________	

Next, test for their presence by using calibrated instrumentation or color indicating tubes. Be sure to use extension probes if necessary to safely determine concentrations at the bottom of the space if it is vertical.

Location	Substances Tested For	Method	Results

☐ Visibility In The Presence of Combustible Dust

Evaluate the visibility in the confined space. If the presence of airborne combustible dust obscures visibility to five feet or less, do not allow entry into the space until dust control or removal measures are used to allow for adequate visibility.

☐ If any of the following conditions have been identified, stop and either provide ventilation sufficient for the space to "pass" a retest or contact the Project Manager or EHSM for assistance:

- Oxygen content less than 19.5% or greater than 22%;
- Flammable gas levels greater than 10% of the LEL;
- Toxic substances in air at levels above exposures limits; or
- Visibility less than five feet due to combustible dust.

Comments:

☐ Engulfment/Entrapment Hazards

Evaluate the confined space to identify any engulfment or entrapment hazards that may be present. If such hazards are present either have them safety removed, or incorporate adequate safeguards into the requirements specified in Part III.

☐ Lock Out/TagOut

Identify all potential sources of energy that could render the space dangerous. Such sources may include electricity, compressed gases, hazardous materials, suspended loads, nitrogen, rainwater runoff, agitators, blenders, conveyors, screw feeders, or pumps. Ensure that all such sources are kept from the confined space by implementing lockout/tagout procedures or <u>totally</u> excluding them from the confined space and the surrounding area.

☐ Rescue Team Identification and Training

Identify the members of the rescue team below:

____

The rescue team should have at least one more member than the entry team. Ensure that all rescue team members are familiar with the rescue techniques that may be required for this work and have practiced them. Ensure that these personnel will be <u>immediately</u> available for rescue assistance throughout the period of the entry.

☐ Attendant Identification and Training

The attendant for this entry is: _____________. Ensure that this person is trained in the recognition of hazards and the notification of entry and rescue personnel. Ensure that this person will maintain continuous visual and/or voice contact with entry personnel.

Preparation Completed By:

Date/Time:

Part III - Entry Requirements

The following requirements shall be met during the performance of this confined space entry.

☐ The identified attendant shall be in continuous voice and/or visual contact with the entry team. The attendant shall order immediate evaluation if a hazard enters or thereafter the entry team or space.

☐ The identified rescue team shall be immediately available for rescue assistance.

☐ Each entry team member shall wear a harness and lifeline capable of and so positioned as to facilitate rescue from outside the space.

☐ Air monitoring shall be performed, during entry and work in the space, according to the following schedule. If any of the stated limits are exceeded, the team shall evacuate the space as soon as possible after detection:

Substance	Frequency	Limit
____________	____________	
____________	____________	
____________	____________	
____________	____________	

☐ The following personnel protective equipment, in addition to the harness/lifeline specified above, shall be worn by all entry team members throughout the entry and work in the space:

Gloves:
Coveralls:
Shoes/Boots:
Head Protection:
Eye Protection:
Respiratory Protection:

☐ Special Requirements:

☐ The following personnel are authorized to enter the confined space to perform the Scope of Work identified in Part I of this permit. The approval is conditional on the adherence of the entry team, attendant, and rescue team to the safety procedures specified in Part III of this permit.

Entry Team Personnel:

Authorizing Signature:

Date/Time:

2.3 Procedures or Work Practices

Identification of Permit-Required Confined Spaces

The highest ranking field team member (e.g., Field Task Leader or Project Manager) will survey the work area and review the scope of work to determine if a confined space requiring an entry permit must be entered by NRT personnel. If such a space is present and it is infeasible to implement an alternative approach, procedures must be implemented as outlined below.

Preparation for Entry

Prior to entry, the entry-authorizing person will ensure that the following steps are taken:

- All electrically powered equipment associated with the space (agitators, pumps, blowers, etc.) are "locked out" (see Section 6.2) in the off position.
- All lines connected to the space that carry gases, liquids, or solids are blanked/blinded, double-blocked and bled, or manually disconnected from the space in such a manner as to prevent the entry of their contents into the space.
- The atmosphere in the space is tested to ensure that it does not meet the definition of a hazardous atmosphere as described above.
- All entrapment/engulfment hazards are either removed from the space, shored or sloped to prevent their movement, and/or that appropriate entry techniques are used to prevent any staff from becoming entrapped.
- An adequately trained attendant is provided to assist the person(s) entering the space.

- An adequately trained rescue team is immediately available for assistance of the person(s) in the space.

At a minimum, monitoring for oxygen and flammable vapor levels will be performed using a calibrated instrument. If the confined space is suspected of containing a substance capable of producing an inhalation hazard, that substance will be monitored for as well. Such monitoring may be performed by using direct reading instruments (e.g., organic vapor analyzer [OVA], HNu) or calorimetric indicating detector tubes (e.g., Draeger tubes).

If the confined space is suspected of containing materials that are toxic via skin or eye contact or irritating to the skin or eyes, appropriate dermal and eye protection will be specified by the entry-authorizing person and worn by entrants.

Entry

Following written approval by the entry-authorizing person, the person(s) working in the confined space will enter the space using procedures and equipment specified by the entry-authorizing person. An attendant will be posted at the entry point. The attendant will:

- Maintain effective and continuous communication with authorized entrants during entry;
- Order authorized entrants to evacuate the space immediately when:

  - The attendant observes a condition not allowed in the entry permit,
  - The attendant detects behavioral effects of hazard exposure,
  - The attendant detects a situation outside the space which could endanger the entrants,
  - The attendant detects an uncontrolled hazard within the space,

  - The attendant is monitoring entry into more than one space and must focus attention on the rescue of other entrants, or,
  - The attendant must leave the work station.

- Summon rescue and other emergency services as soon as the attendant determines that authorized entrants need to escape from space hazards.
- Take the following actions, as necessary, when unauthorized persons approach or enter a space while entry is underway:

  - Warn the unauthorized persons away from the space,
  - Request the unauthorized persons to exit immediately if they have entered the space, and,
  - Inform authorized entrants and any other persons designated by the entry-authorizing person if unauthorized persons have entered the space.

The attendant is not permitted to enter the space to attempt the rescue of entrants but instead will be provided with, and use, the necessary means to rescue entrants without entering the space. Any rescue efforts that involve entry into the space must be implemented by members of the rescue team.

Each confined space entry operation will be provided with a rescue team. The members of the rescue team must be identified and made aware of their duties prior to any confined space entry. The rescue team will be adequately trained, staffed, and equipped to safely perform confined space entry operations. The rescue team will be immediately available for rescue of personnel within the confined space.

3.0 CONTROL OF HAZARDOUS ENERGY SOURCES (LOCKOUT/TAGOUT)

The procedures specified in this section comply with the requirements for the isolation or control of hazardous energy sources set forth in the OSHA standard on this subject (29 CFR 1910.147). The accidental release of energy during maintenance work can and frequently does cause severe injuries, amputations, and death.

3.1 Scope and Applicability

The procedures specified herein will be used whenever NRT staff perform maintenance or installation work on equipment or processes that use or store energy. Energy can be present in the form of electricity, potential energy (due to gravity) stored in elevated masses, chemical corrosivity, chemical toxicity, or pressure.

The only exceptions allowed by OSHA to these requirements are those situations involving "hot tap" operations. For this exception to be valid, the NRT personnel involved must demonstrate that the continuity of services is essential, that shutdown of the energy source is impractical, and that documented (written) procedures and special equipment have been implemented that will provide proven effective protection.

These procedures apply to all operations involving NRT staff in the field as well as to maintenance or installation operations conducted at NRT facilities. When at field locations, NRT personnel will abide by the host plant's requirements unless they are not in compliance with the OSHA standard. In these situations, the NRT procedure will be implemented.

3.2 Procedures

Plug/Cord and Hose Connected Type Equipment

When servicing or installing plug/cord or hose connected electrical, pneumatic, or hydraulically powered equipment, the cord or hose will be disconnected from the equipment to be worked on, prior to starting the work. A tag warning against reconnecting the plug or hose will be affixed to the plug or hose end.

Any stored energy (e.g., capacitor voltage, hydraulic pressure) will be safely released prior to the start of maintenance or installation work.

Electrically Powered Equipment

Electrically powered equipment will be de-energized and their source of electricity manually disconnected from them prior to the removal of protective covers or the start of other maintenance or installation work. It is important that locking and tagging on/off switches is often not sufficient to prevent accidental start up or prevent voltage from being present in the equipment. If the equipment is not wired properly (i.e., polarity is reversed) or the switch is of the single pole type, voltage can be present even if the operating switch is in the off position.

For these reasons, manual disconnects must be placed in the off position and/or the equipment's power fuses removed from the motor control center. The lockout/tagout procedure is as follows:

- Each person working on the circuit or piece of equipment will place a padlock and warning tag on the electrical isolation device (e.g., disconnect switch);

- Each person working on the circuit or piece of equipment will attempt to energize or start the piece of equipment prior to starting work. Each on/off switch capable of energizing the equipment must be "tried";
- If the "try" step reveals that the equipment is capable of being energized, the proper disconnects must be located and locked out and the "try" step repeated;
- As each person completes his or her task, they will remove their padlock and tag from the energy isolating device; and,
- All protective covers or panels will be securely re-attached prior to energizing the equipment after work is completed.

In the event that protective covers must be removed to make adjustments on energized equipment, appropriate guards must be constructed and attached in such a manner as to prevent staff contact with live circuitry capable of causing human injury. Such guards must be of durable construction, adequately prevent injurious contact, and remain in place at all times that the equipment is energized.

The line to be serviced must have tow block valves upstream of the work area or device to be serviced or installed, placed in the closed position and tagged. The bleed valve (between the two block valves) will be opened and tagged so that leakage of the valve upstream would be readily obvious. The line will be depressurized or drained in a safe manner. Lines will be broken in such a manner as to release any stored pressure away from the staff. All solids or liquids drained will be safely collected. This procedure is call "double block and bleed".

If it is possible for pressure or line material to enter the work area from more than one direction, the line in each direction of travel will be "double blocked and bled" as described above.

Chemical and/or Pressurized Lines

Prior to working on any pressurized line or a line containing a toxic, flammable, reactive, or corrosive material, the following procedure must be implemented:

> In the event that "double block and bleed" procedures are infeasible (i.e., the line is not provided with adequate valving), alternative measures will be implemented. One alternate measure is to place a solid "blind" in a flange located between the available upstream valve and the work area. If blinds are used they will be sufficiently corrosion- and pressure-resistant to ensure that if the valve leaks, the blind will stop the material or pressure from reaching the work area.

Stored Mechanical Energy

In situations where equipment to be worked on has stored mechanical energy (e.g., in a flywheel or drop hammer), the stored energy must be released or blocked in a safe manner before starting maintenance or installation work. Effective blocking practices may include the installation of safety blocks or adequate supports. Under no circumstances will "bumper jacks" or "scissor jacks" be considered to be adequate blocks.

3.3 <u>Implementation</u>

As an example, consider the replacement of an electrically powered volumetric flow meter located in a natural gas line. Implementation of the procedures specified above would require the following steps:

- To de-energize the flow meter prior to removal, its electrical supply circuit would first be identified. If the circuit were equipped with a disconnect switch it would be locked in the open or "off" position and tagged. If on a line not fitted with a disconnect, the meter's circuit breaker would be set to the off position and tagged. If a cord is connected, it would be unplugged and the plug would be tagged. If more than one person was working on the meter, each would have to attach their own lock and tag to the isolation device used.
- After attempting to de-energize the meter, the worker would reset the flow meter's on/off switch to the "on" position. If no operating switch were present, "power lights" or other signs of energy would be checked to ensure that the flow meter was indeed de-energized.
- To de-energize the gas line, double block valves would be closed and tagged and the bleed valve between them would be opened and tagged. (If no double block and bleed valves were present, the first valve upstream of the meter would be closed.)

The remaining pressure in the gas line would be released through a downstream bleed valve, or a flange would be loosened. All ignition sources would be removed from the area to prevent combustion of the bled gas. (If no double block and bleed valves were available, the flange between the meter and the upstream block valve would now be blinded.) If the meter were in a transmission line or long run of pipe, the next double block and bleed (or single block and flange) valves downstream of the meter would be blocked and bled prior to releasing the remaining gas pressure.

- Removal, replacement, or maintenance of the meter could now be performed.
- Following completion of the work, each bleed valve would be closed, each block valve (starting upstream of the meter) would be slowly opened, and the line fittings at the meter checked for leaks.
- The locks and/or tags would be removed by each worker from the energy isolation device(s).
- The meter could now be energized.

4.0 COMPRESSED GASES

These procedures are designed to protect against staff injuries due to the improper use of compressed gases. The OSHA standards applicable to compressed gas use and storage may be found in 29 CFR 1910.101 through .105, and .166 through .168.

4.1 Scope and Applicability

These procedures apply to any operations involving compressed gases. Each person receiving, storing, and/or using compressed gases is responsible for implementing the following procedures.

4.2 Procedures

Cylinder Receipt and Content Identification

When a cylinder is delivered to the receiving department, it should have attached:

- An identification label and/or marking indicating contents;
- An I.C.C. label; and
- A valve protection cap.

Under no circumstances should the means of identification be removed from the cylinder. The valve protection cap should also remain in place until the user has secured the cylinder and is ready to withdraw the contents.

Securing of Cylinders

All cylinders must be secured to a wall, I-beam, or other immovable object by a safety chain. If being transported in a portable cart or any other method, the cylinders must be secured by safety chain.

General Precautions for Handling and Storing

Any worker handling compressed gas cylinders will observe to the following precautions:

- Cylinders should never be dropped or permitted to strike each other violently.
- Cylinders may be stored in the open but, in such cases, should be protected against extremes of weather and, to prevent rusting, from the dampness of the ground. During the summer, cylinders stored in the open should be shaded against the continuous direct rays of the sun.
- The valve protection cap should be left on each cylinder until it has been secured against a wall or bench or placed in a cylinder stand, and is ready to be used.
- Cylinders will not be dragged, rolled or slid, even for a short distance. They will be moved by using a suitable hand truck.
- Safety devices in valves or cylinders will not be tampered with.
- All empty gas cylinders will be marked with a tag labeled "EMPTY" or "MT".
- No part of a cylinder should be subjected to a temperature higher than 125^{o} F. A flame should never be permitted to come in contact with any part of a compressed gas cylinder.
- Cylinders will not be placed where they may become part of an electric circuit. When arc welding, precautions must be taken to prevent striking an arc against a cylinder.
- Oil, grease, or lubricants must not be used on any compressed gas tubing or piping fitting or thread.
- Teflon™ tape or pipe joint compound must not be used on any gas compression-type fitting.

Regulator Handling and Use

A regulator should be attached to a cylinder without forcing the threads. If the inlet of a regulator does not fit the cylinder outlet, no effort should be made to try to force the fitting. A poor fit may indicate that the regulator is not intended for use on the gas chosen.

The following procedures should be used to obtain the required delivery pressure:

- After the regulator has been attached to the cylinder valve outlet, turn the delivery pressure adjusting screw counter-clockwise until it turns freely;
- Open the cylinder valve slowly until the tank gauge on the regulator registers the cylinder pressure;
- Never drain a cylinder below a gauge reading of 25 pounds per square inch; and,
- Never use a "valve wrench" to close valves (it can damage some diaphragms).

Handling of Empty Cylinders

When cylinders are considered empty, the valves must be closed. Valve protection caps, outlet dust caps and other accessories shipped with the cylinder should be attached to the cylinder as received. The cylinder should be marked or labeled **"EMPTY".** Cylinders should then be placed in a proper storage area and securely chained in an upright position to await pick-up for return to the supplier.

Carelessness in the handling of an empty cylinder could result in someone mistaking it for a full cylinder. Connecting an empty cylinder to a high-pressure system could cause foreign materials to back up into the cylinder, creating all the attendant hazards of "suck-back" and possibly a violent reaction with the cylinder.

Leak Detection and Control

Leaks can be detected by painting points suspected of leakage with soapy water. A leak will cause bubbling. Never use a flame to detect leaks.

If a leak cannot be easily repaired, it should be returned to the supplier, and the supplier notified of the defect.

Leaks issuing from a closed valve or defective safety devices (fusible plugs) required special handling. The cylinder should be moved to an open space, away from sources of ignition, and clearly tagged as defective. Warnings should be posted to prevent persons approaching the cylinder with lit cigarettes, pipes, cigars or other open flames. The supplier should be informed of the defect.

5.0 WORKING SAFELY AT ELEVATIONS

These procedures are designed to prevent the injury of NRT personnel (or others) due to falls or slips at elevations above grade. Applicable OSHA standards include 29 CFR 1910.21-.68.

5.1 Scope and Applicability

These procedures will apply any time that NRT personnel are working on portable stairs, ladders, or scaffolding, or at elevations of more than four (4) feet above grade.

5.2 Procedures

Ladders

The correct procedures for using ladders are as follows:

- Place the ladder at the proper angle. A good rule of thumb is to stand with your feet at the base of the ladder and hold your arms straight in front of you. If you can grasp the rung without bending your back, the ladder is probably at the proper angle for climbing.
- Do no use ladders in a horizontal position as runways or scaffolds.
- Never place a ladder in front of a door that opens toward the ladder unless the door is locked, blocked or guarded.
- Never place a ladder against a window or sash. If it is necessary to lean against a window, lash a board across the end of the ladder to give it a bearing on either side of the window.
- Place ladders so that both side rails have firm, level footing, and are not on movable objects.
- Never lean a ladder against movable or insecure objects.
- When using a ladder for access to high places, securely lash or otherwise fasten the ladder to prevent its slipping.
- Tie off the top and bottom ends of the ladder to a stationary object whenever possible.
- Whenever possible, do not place a ladder close (within 15 feet) to live electrical energized wiring or operational piping.
- Never use a metal ladder near a potentially energized source.
- Hold on with both hands when ascending or descending a ladder. If material must be moved, raise or lower it with a rope.
- Always face the ladder when ascending or descending.
- Be sure that shoes or hands are not greasy, muddy or slippery before climbing.
- Do not climb higher than the third rung from the top on straight ladders or the second tread from the top of stepladders.
- When using a stepladder, open if fully and lock the metal spreader before you start to climb.

- Never use a defective ladder. Tag or mark it so that it will be repaired or destroyed.
- Do not use ladders in a strong wind except in an emergency, and then only when they are securely tied.
- Do not leave placed ladders unattended unless they are anchored at top and bottom.
- Never attempt adjusting an extension ladder while someone is standing on the ladder.
- When standing on a ladder, do not over-reach. This can cause the ladder to tip over. A good rule of thumb is to always keep your belt buckle between the sides.

Ladder Specifications -- All wooden ladders purchased by NRT will meet OSHA standards (Refer to 29 CFR 1910.25, .26).

The Maximum allowable lengths of portable ladders are:

Stepladders	8 feet
Platform Stepladders	12 feet
Straight Ladders	20 feet
Extension Ladders	36 feet - overlap length w/minimum overlap of 3 feet

Wooden parts used in construction of ladders should be straight-grained; thoroughly seasoned; smoothly dressed; and free of sharp edges, splinters, checks, decay and other defects. Rungs must be parallel, level and uniformly spaced. The spacing will not be more than 12 inches.

Wooden ladders will be coated with a suitable protective coating such as boiled linseed oil, clear varnish or clear lacquer. Paint must **not** be used.

All straight and extension ladders must be equipped with safety feet. All ladders are to be inspected every six months. All ladders will be stored on a ladder support and chained and locked in place.

Scaffolding

Only tube and coupler or tubular welded frame scaffolding will be used by NRT staff. It will be erected according to OSHA standards, as specified in 29 CFR 1910.22, .23, and .28.

Rooftop Work

If the rooftop to be worked on is not provided with an adequate guardrail, the following procedures will apply:

- No staff will come within 10 feet of the roof's edge without wearing a life belt or harness securely attached to a securely anchored rope or line, with the entire system being capable of supporting a minimum dead weight of 5,400 pounds.
- No staff will work on the rooftop if the wind speed exceeds 20 miles per hour.

Elevated Platforms

All elevated platforms will be surrounded by a standard guardrail, securely fastened to a stationary object, and have a floor capable of withstanding a working load of 75 pounds per square foot.

6.0 ELECTRICAL SAFETY

These procedures are designed to protect NRT staff against injury due to contact with live electricity and to prevent property damage due to the improper use of electricity. The OSHA standards specifically applicable to the use of electricity include in 29 CFR 1910.301 through .399.

6.1 Scope of Applicability

The requirements of this subsection apply to all situations involving electricity. Each NRT staff using electricity or electrically powered equipment is responsible for complying with these requirements and other good safety practice.

6.2 Procedures

The following general procedures for safe use of electricity will be employed:

- The lockout/tagout procedures specified in subsection 3.1 of this Manual will be followed whenever performing maintenance, installation, or removal work on electrical or electrically powered equipment.
- All exposed live parts on electrical equipment will be guarded to prevent accidental contact.
- All electrical or electrically powered equipment will be grounded.
- Ground fault circuit interrupters (GFCIs) will be used in all locations that are wet, damp, or capable of becoming wet during the operation of electrical equipment.
- When performing field work in a host plant, the plant's electrical safety procedures must be followed, in addition to NRT's lockout/tagout procedures.

Use of Extension Cords

Workers using extension cords will observe the following procedures:

- Extension cords will be used in situations where fixed wiring is not feasible.
- Extension cords will be kept in good repair, free from defects in their insulation. They will not be kinked, knotted, abraded, or cut.
- Extension cords will not be buried in soil.
- Extension cords will be kept clean and free of grease, oil, and chemical contamination.
- Extension cords will be placed so that they do not present a tripping or slipping hazard.
- Extension cords will not be placed through doorways having doors that can be closed, and thereby damage the cord(s).
- Extension cords will not be run through water or damp locations unless specifically rated for that use.

- All extension cords will be of the grounding type (three conductor).
- Grounding prongs will not be removed from extension cords. The use of 3 prong-to-2 prong adapters is acceptable only if the ground tab at the 2-prong end is attached to the receptacle or otherwise effectively grounded.
- Only extension cords rated for the voltage and current to be conducted will be used.
- Extension cords will be inspected for defects on a regular basis (e.g., before each field trip; monthly or weekly when in the field).

Hazardous Locations

Work involving the use of electrical or electrically powered equipment in hazardous locations, as defined by the National Electrical Code - Natural Fire Protection Association (NFPA-70) will be conducted according to the following procedures:

- The host plant's "Hot Work Permit" and/or electrical safety will be followed.
- Only wiring and equipment approved for use in the Class, Division, and Group required by the above named reference may be used.

7.0 STORAGE AND USE OF FLAMMABLE AND COMBUSTIBLE LIQUIDS

These procedures are designed to protect NRT staff from injury, and property from damage, due to the improper use of flammable and combustible liquids. The OSHA standards applicable to the use and storage of flammable and combustible liquids 29 CFR 1910.106.

7.1 Scope and Applicability

These procedures apply to all situations involving the storage and/or use of flammable or combustible liquids. The OSHA definition of flammable and combustible liquids (F/CLs) are as follows:

Flammable (Class I):	Any liquid having a flashpoint below 100^0F (37.8^oC).
Combustible (Class II):	Any liquid having a flashpoint at or between: 100^0F (37.8^0C and 140^0F (60^0C).
Combustible (Class III):	Any liquid having a flashpoint at or above: 140^0F (60^0C).

7.2 Procedures

Each NRT staff storing or using materials meeting these definitions will comply with the following procedures:

- F/CLs will be stored per the requirements of 29 CFR 1910.106.
- Ignition sources (e.g., sparking equipment, matches, cigarette lighters, lit cigarettes, etc.) will be kept out of F/CL storage areas and at least 25 feet away from their point of dispensing or use.
- Nozzles/containers dispensed from and containers dispensed into must be bonded (i.e., grounded) to the original container prior to the start of dispensing.
- F/CL storage, dispensing, and use areas must be ventilated with fresh air at flow rates sufficient to prevent the accumulation of flammable vapors in excess of 10% of the liquid's Lower Explosion (or Flammable) Limit (LEL/LFL).
- F/CLs will not be stored in aisle ways or in means of emergency egress.
- F/CL containers will not be stored horizontally.

- F/CL containers will be capped or covered whenever not in use.
- Rags or paper wetted with F/CLs will be placed in closed containers. These containers will be emptied daily.

8.0 EXCAVATION

These procedures are designed to protect NRT staff from injury and/or death due to the hazards associated with excavations. The OSHA standards applicable to excavations include 29 CFR 1926.650, .651, and .652 (Subpart P).

8.1 Scope and Applicability

The procedures specified in this subsection apply to all situations involving any open excavations made in the earth's surface, including trenches.

The responsibility for ensuring that the procedures specified here and in 29 CFR 1926, Subpart P, are followed rests with the highest ranking NRT staff (e.g., Project Director or Field Task Leader) present at the excavation site.

Each NRT staff at the site is responsible for following the procedures specified herein.

8.2 Procedures

The following definitions apply to these procedures:

- ***Competent person:*** One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to staff, and who has the authority to take prompt corrective measures to eliminate them.

- ***Registered professional engineer:*** A person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer registered in any state is deemed to be a "registered professional engineer" within the context of these procedures when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

The following procedures will be observed when any NRT staff works in or around an excavation:

- All surface structures or encumbrances that pose a hazard will be removed or supported, as necessary, to safeguard staff.
- All underground utility or process lines that one may reasonably expect to encounter will have their (at least approximate) locations determined and marked prior to excavation. All contacts with facility and utility company personnel in this regard will be documented.
- Structural ramps used for personnel or equipment access to or egress from excavation will be designed by a competent person.
- A safe means of egress will be located in trench excavations that are 4 feet or more in depth such that no more than 25 feet of lateral travel is required for staff to escape the trench.
- Staff exposed to vehicle traffic will wear warning vests marked with reflectorized or high-visibility materials.
- No staff may be permitted underneath loads handled by digging or lifting equipment. Staff will be required to stand away from any vehicle being loaded or unloaded. Operators may remain in the cabs of vehicles if adequately protected from falling materials.
- If mobile equipment is operated adjacent to an excavation, then barricades, signals or barriers will be used to warn the mobile equipment operator of his or her proximity to the excavation.
- The procedures for permit-required confined space entry specified in Section 6.1 of this Manual will be followed if there is any reason to believe that an excavation contains or could contain a hazardous atmosphere.
- Staff will not work in excavations containing or accumulating water without taking adequate precautions (e.g., special supports or shields, water removal, safety harnesses/lifelines) to protect staff. Water removal equipment and operations will be monitored by a competent person to ensure proper operation.

- Where the stability of adjoining structures is endangered by excavation operations, support systems adequate to protect staff will be employed. Such support systems will be approved by a professional engineer registered in the state where the excavation takes place.
- Adequate protection will be provided to protect staff from loose rocks or soil that could pose a hazard by falling or rolling from an excavation face or from above the excavation. All materials (included removed spoil) and equipment will be placed no closer than 2 feet from the edge of the excavation.
- Daily inspections of the excavation will be conducted by a competent person. Inspections will be conducted at the start of each work shift and as needed during the shift. Inspections will also be made after each rainfall event or at each entry of rainwater runoff into the excavation.
- Where NRT staff are required or permitted to cross over excavations, walkways or bridges with standard guardrails will be provided.
- All wells, pits, shafts, etc., will be barricaded or covered. Upon completion of exploration or similar operations, temporary wells, pits, shafts, etc., will be backfilled.
- Except when excavations are less than 5 feet in depth and examination of the ground by a competent person provides no indication of a potential cave-in, all excavations will be sloped, benched, or supported in accordance with the requirements of 29 CFR 1926.652.

9.0 WORKING WITH ASBESTOS CONTAINING MATERIALS (ACMs)

The procedures specified in this subsection are designed to protect NRT staff from the health effects of exposure to asbestos fibers. Governmental laws and regulations governing work with ACMs include the Asbestos Hazard Emergency Response Act (AHERA, October 22, 1986), 29 CFR 1926.58 and 29 CFR 1910.1001.

9.1 Scope and Applicability

The procedures specified in this subsection apply to all work involving the disturbance or sampling of ACMs. The highest ranking NRT person (e.g., Project Director, Project Manager, Field Task Leader) at the site is responsible for implementing this plan.

Each NRT staff at the site is responsible for following these procedures.

9.2 Procedures

The following procedures will be observed when any NRT staff work with or near ACMs.

- Work involving the disturbance or sampling of ACMs will not be initiated prior to receiving express approval from the EHSM.
- All work involving ACMs will be conducted in accordance with the requirements of 29 CFR 1910.1001 and 1926.58.
- All work involving the sampling and/or disturbance of ACMs will be performed only by persons certified under AHERA regulations for the work they are performing.

10.0 OPERATIONS ON SURFACE WATERS

The procedures specified in this subsection are designed to protect NRT staff when conducting work activities involving water craft vessels on surface waters. Governmental laws and regulations regarding onshore waters are under the jurisdiction of the Unites States Coast Guard (USCG-Great Lakes) and the Wisconsin Department of Natural Resources (WDNR-Wisconsin inland waters). When conducting any surface water work activities out of state (i.e. other than Wisconsin), that state regulatory agency and its regulations will be adhered to.

10.1 Scope and Applicability

The procedures specified in this subsection apply to all work activities involving surface waters. The highest ranking NRT staff member (i.e. Project Manager, Field Task Leader) at the work site is responsible for implementing this plan. The work activities will not be initiated prior to receiving approval from the Environmental Health & Safety Manager (EHSM).

Work activities can be conducted in "open water" or "ice" conditions.

Each NRT staff person at the site is responsible for following these procedures.

10.2 Small Water Craft

The following procedures will be observed when NRT staff conducts work activities in "open water" conditions in a small water craft:

- Work will not be initiated prior to meeting approval from the EHSM;
- All work activities conducted on surface waters will be conducted in accordance with the requirements of the USCG and WDNR (or other appropriate state agency);
- Personal Flotation Devices (PFD) that are USCG approved must be worn at all times when on surface waters. One adult size PFD (wearable style) for every person on the water craft;
- A minimum of two (2) PFDs must be on board on the water craft at all times on Wisconsin waters;
- Have on board a "throwable" flotation device w/attached line;
- Distribute weight evenly across the beam of the watercraft;
- Only allow one person to stand at a time in a small watercraft vessel;
- Do not exceed manufacture's capacity plate load limits;

- Attach a lanyard or safety line which can be tied to the sampling personnel when water surface conditions are rough. This will enable easier retrieval of the person should he/she fall over the side of the water craft;
- Check running condition of the outboard motor prior to launching (i.e. ample supply of fuel/oil mix, fuel line in good condition, integrity of the propeller, **EXTRA SHEER PINS);**
- Equipment to have on board include oars, anchor w/line (100 foot minimum line on inland waters) and mooring lines of adequate length;
- Wear work gloves when using equipment that could injure hands;
- Wear hard hat if overhead hazards exist (e.g. A-Frame, use of long coring devices);
- Secure overboard equipment to vessel; and,
- Use proper lifting techniques when retrieving heavy equipment.

10.3 Shallow Water

Work activities in shallow water along the shore line shall consider the following hazards:

- Use waders to minimize exposure to water, sediment contaminant exposure and heat loss;
- Proceed carefully – water currents and falling can cause the waders to fill creating a very serious condition. In addition to wearing a PFD, a safety line should be tethered to the person walking in water currents.
- Fatigue can occur more rapidly from walking through the water.

Heat Stress-

- Wear thin cotton clothing under Tyvek™ suits;
- Have thirst liquids available; and,
- Stop work if heat exhaustion occurs (i.e. light headedness, profuse sweating).

Ice-

The following procedures will be observed when NRT staff conducts work activities on "ice" conditions:

- Work activities will not be initiated prior to meeting approval from the EHSM;
- Know the ice (i.e. thickness) proceed with extreme caution. Ice thickness at a minimum should be not less than 4 inches. Check ice thickness regularly when traversing across ice to assure adequate support exists. Be especially cautious when approaching pressure cracks, areas of open water or areas of rivers where water velocity may be higher.
- Wear PFDs at all times if ice thickness is less than 4 inches.
- Warm weather causes ice thinning and potential for slipping (drilling holes on thinning ice can cause flooding of ice surface and can accelerate ice thinning and breakage);
- Equipment may be required to be hauled between work stations (use sleds); and,
- Fatigue can occur from walking and drilling holes.

Cold Stress-

- Dress in layers and regulate clothing to activity levels;
- Wear plenty of layer clothing (so layers can be added or removed);

- Cover exposed skin when windy;
- Glove liners can keep hands warm but reduce dexterity;
- Use face masks and helmet liners to keep head warm and,
- Stop work if conditions get too cold.

Always work in pairs – never conduct work activities alone. Due to the location and manner that work activities are conducted, the threat of falling into the water is very high.

Carry retrieval equipment including:

- 50 foot of line at least 3/8 inch diameter.
- Two - six (6) foot 2x4's.

Based on water currents, water temperature and the amount of clothing worn by NRT staff, the threat of being swept down stream or drowning is possible. Extreme caution must be used when conducting these type of work activities. If a NRT staff employee should fall into the water, the employee will be retrieved and all warranted precautions shall be taken to ensure the safety and well being of that individual. All work activities will be immediately suspended and the person brought to shore. All wet clothing shall be removed and the person shall be dried and dressed in a set of dry clothes. **If the possibility of hypothermia exists, seek medical attention immediately.**

Persons sampling contaminated or potentially contaminated materials should wear the same personal protective equipment (PPE) as listed for monitoring well sampling. The required PPE will be carried along on the sediment sampling water craft. PPE can add to heat stress during warm conditions and can cause decreased mobility dexterity.

10.4 Weather Conditions

No work activities will be conducted when there is thunder and lightning in the area. All NRT staff will come to shore during these weather conditions and will remain on shore until all lightning has ceased Other weather conditions (i.e. wave heights, strong winds, snowfall, light rain, etc.) will need to be monitored by NRT staff, and if conditions warrant, work activities will be suspended.

10.5 Subcontractors

It is the responsibility of the PM with the assistance of the EHSM to require any and all subcontractors assisting in the work activities, to adhere to this Water Course-SOP. Any refusal on behalf of the subcontractor regarding this Water Course SOP will mandate shutdown of the project.

ATTACHMENT A4

RESPIRATORY PROTECTION PROGRAM

RESPIRATORY PROTECTION PROGRAM

1.0 PURPOSE

The NRT Respiratory Protection Program has been developed to ensure respirators are properly selected, used, and maintained by NRT staff, and to meet federal regulatory standards (29 CFR 1910.134). The purpose of this program is to ensure the protection of all NRT staff from potential respiratory hazards through the proper selection, use, and care of approved respiratory protective devices. In all cases, staff will be protected by engineering and administrative controls, to the extent feasible, before resorting to respiratory protective equipment.

This program covers all work-related respirators used by NRT staff, both on and off site.

2.0 RESPONSIBILITIES

NRT will provide respirators that are adequate and appropriate for the purpose intended when necessary to protect the staff. The EHSM will have the primary responsibility for implementing this program.

2.1 Environmental Health & Safety Manager (EHSM)

The EHSM will administer the Respiratory Protection Program. The EHSM will determine the need for, and proper selection of, respiratory protection within the office. The EHSM or Project Manager will jointly evaluate those tasks for which respiratory protection is thought to be necessary, determine the degree of hazard posed by the potential exposure, assess whether engineering or administrative controls are feasible, and specify which respiratory protection device is to be used for each task. The EHSM is also responsible for maintaining respiratory protective equipment supplies (facepieces, replacement cartridges, etc.) and for auditing staff compliance with work area or project-specific requirements.

2.2 Project Manager, or Task Leader

The Project Manager, or Task Leader will ensure each staff under his or her supervision using a respirator has received appropriate training and, if appropriate, an annual medical evaluation. The supervisor will ensure the availability of appropriate respirators and accessories, provide adequate storage facilities, and encourage appropriate equipment maintenance. The supervisor must be aware of tasks requiring the use of respiratory protection, and ensure all staff engaged in such work use the appropriate respirators at all times.

2.3 Staff

The staff will use the respirator provided to him or her in accordance with the requirements of this Program. The staff will maintain his or her respirator and report malfunctions to the EHSM.

3.0 WORK PRACTICE

3.1 Respirator Selection

Staff will use approved respiratory protection equipment when it is infeasible to provide engineering or administrative controls to prevent exposures to potentially harmful dusts, fumes, mists, vapors, or gases, or where emergency protection from an occasional and/or relatively brief exposure is needed. Only respiratory protection equipment approved by NIOSH/MSHA (National

Institute for Occupational Safety and Health/Mine Safety and Health Administration) will be used. Respiratory protective devices will be selected by the EHSM, using ANSI Z88.2-1980 and/or the NIOSH Respirator Selection Decision Logic as a guide. The following items will be considered:

- Employee medical evaluation;
- Effectiveness of the device against the substance of concern;
- Estimated maximum concentration of the substance in the work area;
- General environment (open shop or confined space, etc.);
- Known limitations of the respiratory protective device;
- Comfort, fit testing, and worker acceptance; and,
- Other contaminants in the environment or potential for oxygen deficiency.

3.2 Respirator Use

A respirator designed to seal tightly to the face will not be worn if facial hair is present between the face piece and the face in the area of the seal, or if facial hair interferes with valve function.

The user of a full face piece respirator will not wear eyeglasses which adversely affect the face piece-to-face seal. NRT will provide snap-in prescription eyewear when needed.

Each respirator wearer will use only the type, model, and size respirator which has been successfully fit tested for that person. The wearer will only use the respirator that has been approved for that task, process, or potential exposure and then only after he or she has received appropriate training. Key elements to consider when using a respirator include:

- Factors that may prevent a good facial seal;
- The limitations of a respirator;
- Inspections of the respirator before and after use;
- Cleanliness;
- Conditions for which the wearer and respirator have been approved; and
- Assignment of a respirator to each person for individual use.

3.3 Care of Respirators

Respirators must be regularly cleaned, disinfected, and inspected. Those issued for individual use will be cleaned after each day's use (or more often as necessary). Those issued for common use (i.e., one respirator used by more than one worker) will be thoroughly cleaned and disinfected after each use. The respirator will be inspected before and after each use and repaired, cleaned, and disinfected as necessary. Proper storage is also required (e.g., in sealable bags, away from the immediate work area containing dusty conditions, away from heat or sunlight).

3.4 Training

Respirator users and their supervisor will receive training on the contents of this Respiratory Protection Program and their responsibilities under it. They will be trained on the proper selection and use, as well as the limitations of the respirator. Training also covers how to ensure a proper fit before use and how to determine when a respirator is no longer providing the protection intended. A more detailed description of the training requirement is presented in Operating Practice 06-11.

3.5 Medical Evaluation

An occupational health physician will determine a user's physical and psychological fitness to wear a respirator. In making this determination, the physician will consider the type of respirator to be worn, other personal protective equipment to be used, and the anticipated exposures.

3.6 Fit Test

The EHSM will administer a qualitative respirator fit test to determine the ability of each individual respirator wearer to obtain a satisfactory fit with negative-pressure face pieces worn in the course of their work. The test results are the determining factor in selecting the type, model, and size of negative-pressure respirators for use by each individual respirator wearer. This test should be repeated at least annually or when a staff person experiences weight gain or loss or significant dental work that may impact the shape and size of the individual's face.

Fitting

Each staff whose duties require the use of a respirator will be fitted for the respirator by testing the facepiece-to-face seal. Respirators will not be worn when conditions prevent good face piece-to-face seal. Examples of conditions which may interfere with a good facial seal are:

- Sideburns, mustaches, and/or skull caps that project under the face piece;
- Temple bars on eyeglasses;
- The absence of one or both dentures; and,
- Facial hair that covers or infringes on portions of the face that come in contact with the respirator.

Fit Checking

Each time a respirator is donned, the user will perform positive and negative pressure fit checks. These checks are not a substitute for fit testing. Respirator users must be properly trained in the performance of these checks and must understand their limitations.

Negative Pressure Check -- This test is applicable for air-purifying respirators equipped with tight-fitting respirator inlet covers and for atmosphere-supplying respirators.

Procedure: Close off the inlet opening of the respirator's canister(s), cartridge(s), or filer(s) with the palm of the hand, or squeeze the breathing tube or block its inlet so that it will not allow the passage of air. Inhale gently and hold for at least 10 seconds. If the face piece collapses slightly and no inward leakage of air into the face piece is detected, it can be reasonably assumed that the respirator has been properly positioned and the exhalation valve and face piece are not leaking.

Positive Pressure Check -- This test is applicable for air-purifying respirators with exhalation parts and for atmosphere-supplying respirators.

Procedure: Close off the exhalation valve or end of the breathing tube with the palm of the hand. Exhale gently. If the respirator has been properly positioned, a slight positive pressure will build up inside the face piece and no air will be detected leaking outward through the sealing surface between the face piece and the face.

Qualitative Fit Tests

Federal regulations (29 CFR 1910.1001) require qualitative fit tests of respirators and describe step-by-step procedures. These tests test the subject's response to a chemical introduced outside the respirator face piece. This response is either voluntary or involuntary, depending on the chemical used. Several methods may be used. The two most common are the irritant smoke test, and the odorous vapor test.

Irritant Smoke: The irritant smoke test is an involuntary response test. Air purifying respirators must be equipped with a high efficiency particulate air (HEPA) filter for this test. An irritant smoke, usually either stannic chloride or titanium tetrachloride, is directed from a smoke tube toward the respirator. If the test subject does not respond to the irritant smoke, a satisfactory fit is assumed to be achieved. Any response to the smoke indicates an unsatisfactory fit.

The irritant smoke is an irritant to the eyes, skin, and mucous membranes. It should not be introduced directly onto the skin. The test subject must keep his or her eyes closed during the testing if a full face piece mask is not used.

Odorous Vapor: The odorous vapor test is a voluntary response test. It relies on the subject's ability to detect an odorous chemical while wearing the respirator. Air purifying respirators must be equipped with an organic cartridge or canister for this test. Isoamyl acetate (banana oil) is the usual test. An isoamyl acetate-saturated gauze pad is placed near the face piece-to-face seal of the respirator or the test subject's skin. If the test subject is unable to smell the chemical, then a satisfactory fit is assumed to be achieved. If the subject smells the chemical, the fit is unsatisfactory. If the subject cannot smell the chemical, the respirator will be momentarily pulled away from the subject's face. If the subject is then able to smell the chemical, a satisfactory fit is assumed. If the subject cannot smell the chemical with the respirator pulled away from the face, this test is inappropriate for this subject, and a different test will be used. This test is limited by the wide variation of odor thresholds among individuals and the possibility of olfactory fatigue. Since it is a voluntary response test it depends upon an honest response.

ATTACHMENT B

ACTIVITY HAZARD ANALYSES

ATTACHMENT B1

AQUIFER TESTING

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): L

Date prepared: 12 February 2015

Project location: Clove and Maple Avenues Former MGP

Prepared by: Steve Wiskes

Job: Aquifer testing

Reviewed by:

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
1. Hydraulic conductivity testing	1. Exposure to water and air contaminants	Wear appropriate PPE including respirator with appropriate cartridges depending on contaminant concentrations Use PID to monitor breathing zone.	L
2. Pump tests	2. Slip, trip and fall	When working with water the ground can be slippery when wet and icy in the winter	L
			L
			L
			L
			L

EQUIPMENT	TRAINING	INSPECTION
water level	know how to read water level	-battery acceptable

Approval Authority:

ACTIVITY HAZARDS ANALYSIS

EQUIPMENT	TRAINING	INSPECTION
hydraulic conductivity transducer	know operation of transducer read manufacturer manual	check for available storage
groundwater pump	read manufacturers manual	pump and controller operate

Approval Authority: ______________________________

ATTACHMENT B2

LOCKOUT/TAGOUT FOR SERVICE OF DRILL RIG

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): L

Date prepared: 11 March 2015

Project location: Clove and Maple Avenues Former MGP

Prepared by: Steve Wiskes

Job: Lock Out/Tag Out for Service of Drill Rig

Reviewed by:

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
Replace electrical equipment on vehicle or drill rig	- electric shock - accidental restart - non dissipated residual energy - gravitational energy - caught by rotating parts	-Disconnect battery power and tag the battery cable - Put vehicle in gear, tag shifter to indicate work is being performed, and set parking brake. - Put drill rig transmission in neutral and tag shifter to indicate work is being performed - Block wheels to prevent movement - Lock cab to prevent people from entering - Lower the drill rig tower while performing maintenance - Person in charge of the maintenance should collect all keys for the vehicle and drill rig. - Only person in charge of maintenance may remove locks and tags. - Person in charge of maintenance clears works areas before restart	L

Approval Authority:

ACTIVITY HAZARDS ANALYSIS

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
Replace or repair hydraulic or pneumatic hoses	- accidental restart - non dissipated residual energy - gravitational energy	- Disconnect battery power and tag the battery cable - Put vehicle in neutral (if not on flat ground) tag shifter to indicate work is being performed - Put drill rig transmission in gear, tag shifter to indicate work is being performed and set parking brake - Block wheels to prevent movement - Lock cab to prevent people from entering - Lower the drill rig tower while performing maintenance - Ensure that objects operated by the hydraulic or pneumatic hose are at a resting position. - Release pressure from hose by opening the relief valve - Test that all pressure is release by trying to use the equipment - Attach lock to valves that are in the in off position and tag - Person in charge of the maintenance should collect all keys for the vehicle and drill rig - Only person in charge of maintenance may remove locks and tags. - Person in charge of maintenance clears works areas before restart	L
Replace or repair steel cables	- electric shock - accidental restart - non dissipated residual energy - gravitational energy - caught by rotating parts	-Disconnect battery power and tag the battery cable - Put vehicle in gear, tag shifter to indicate work is being performed and set parking brake - Put drill rig transmission in neutral and tag shifter to indicate work is being performed - Block wheels to prevent movement - Lock cab to prevent people from entering - Lower the drill rig tower while performing maintenance - Person in charge of the maintenance should collect all keys for the vehicle and drill rig - Release tension in the cable - Only person in charge of maintenance may remove locks and tags. - Person in charge of maintenance clears works areas before restart	L

Approval Authority: ______________________________

ACTIVITY HAZARDS ANALYSIS

Vehicle maintenance (grease, oil, coolant)	- electric shock - accidental restart - non dissipated residual energy - gravitational energy - caught by rotating parts	-Disconnect battery power and tag the battery cable - Put vehicle in gear, tag shifter to indicate work is being performed and set parking brake - Put drill rig transmission in neutral and tag shifter to indicate work is being performed - Block wheels to prevent movement - Lock cab to prevent people from entering - Lower the drill rig tower while performing maintenance - Person in charge of the maintenance should collect all keys for the vehicle and drill rig - Only person in charge of maintenance may remove locks and tags. - Person in charge of maintenance clears works areas before restart	L

EQUIPMENT	TRAINING	INSPECTION
Locks and tags	Trained in Lock Out /Tag Out procedures	- Person in charge of maintenance must inspect all lock out / tag out procedures, locks and tags in place before the start of maintenance or repair - Only person in charge of maintenance may remove the locks and tags

Approval Authority: ______________________

ATTACHMENT B3

DRILLING AND SOIL AND GROUNDWATER SAMPLING

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): L

Date prepared: 12 February 2015

Project location: Clove and Maple Former MGP

Prepared by: Steve Wiskes

Job: Drilling,Soil and Groundwater Sampling

Reviewed by:

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
Determine location of underground utilities	Shock and explosion to personnel. Damage to underground utilities.	-Contact Dig Safely New York for utility clearance. -Contact a private utility clearance company.	L
Mark boring locations	Underground and overhead utilities	-Keep boring locations a safe distance from underground and overhead utilities	L
Breakup/cut concrete or asphalt to open up the ground	Concrete chips and dust, jagged rebar	-Use qualified personnel. -Use of appropriate equipment and tools. -Use appropriate PPE. -Keep unauthorized personnel out of area. -Daily tailgate safety meeting to discuss Site activities and associated hazards.	L
Inspect equipment (machinery, hand tools)	Injuries from defective tools and equipment	-Do not use defective equipment and tools. -Replace defective tools.	L

Approval Authority:

ACTIVITY HAZARDS ANALYSIS

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
Drill Soil	Rotating hazards Noise Atmospheric hazards Struck-by Overhead falling objects	-Use competent and qualified personnel to operate equipment (certifications and licences). -Use of appropriate PPE (reflective vests, hard hats, hearing protection, safety glasses, steel-toed boots). -Hazwoper training (40-hr with up to date 8-hr refresher) -Screen breathing zone with appropriate instruments (i.e. PID). -Keep unnecessary personnel away from drilling area. -Daily Health and Safety Tailgate Meetings to go over activities and associated hazards. -Site Control	M
Sample soil and water Preserve soil and water	Chemical hazards from contaminants in soil and water	-Use appropriate PPE when handling contaminated soil, water and preaservatives. -Use PID to monitor air quality in breathing zone -Use qualified personnel to run equipment. -Daily Health and Safety Tailgate Meetings to go over activities and associated hazards.	L

EQUIPMENT	TRAINING	INSPECTION
Drill rigs	-Documented competent personnel with required certificates and licenses to operate equipment. -40-hr hazwoper training and 8-hr refresher training	-All equipment working properly (daily). -Safety devices working properly (daily).
Hand tools	none	-Operarting correctly and not defective.
PID (10.6 eV)	Must be able to calibrate PID	-Calibrates to within 10% of true isobutylene value (100 ppm). -Battery life sufficient. -Pump operating.

Approval Authority: ______________________________

ATTACHMENT B4

HYDRAULIC PROBE AND SOIL AND GROUNDWATER SAMPLING

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): L

Date prepared: 12 February 2015

Project location: Clove and Maple Avenues Former MGP

Prepared by: Steve Wiskes

Job: Hydraulic Probe Operation, Soil and Groundwater Sampling

Reviewed by:

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
Determine location of underground utilities	Shock and explosion to personnel. Damage to underground utilities.	-Contact Dig Safely New York for utility clearance. -Contact a private utility clearance company.	L
Obtain access agreements if drilling off site	Trespassing / irate landowner	-Drill only when access agreement is in place	L
Breakup/cut concrete or asphalt to open up the ground.	Concrete chips and dust, jagged rebar	-Use qualified personnel. -Use of appropriate equipment and tools. -Use appropriate PPE. -Keep unauthorized personnel out of area. -Daily tailgate safety meeting to discuss Site activities and associated hazards.	L
Inspect equipment (machinery, hand tools).	Injuries from defective tools and equipment	-Do not use defective equipment and tools. -Replace defective tools.	L

Approval Authority:

ACTIVITY HAZARDS ANALYSIS

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
Hydraulic probe	Hydraulic push hazards Noise Atmospheric hazards Struck-by Overhead falling objects	-Use competent and qualified personnel to operate equipment (certifications and licences). -Use of appropriate PPE (reflective vests, hard hats, hearing protection, safety glasses, steel-toed boots). -Hazwoper training (40-hr with up to date 8-hr refresher) -Screen breathing zone with appropriate instruments (i.e. PID). -Keep unnecessary personnel away from drilling area. -Daily Health and Safety Tailgate Meetings to go over activities and associated hazards. -Site Control	M
Sample soil and groundwater Preserve soil and groundwater samples	Chemical hazards from contaminants in soil and water Chemical hazards from preservatives and methanol	-Use appropriate PPE when handling contaminated soil and groundwater Use of appropriate PPE when handling presrvatives. -Use PID to monitor air quality in breathing zone -Use qualified personnel to run equipment. -Daily Health and Safety Tailgate Meetings to go over activities and associated hazards.	L

EQUIPMENT	TRAINING	INSPECTION
hydraulic probe	-Documented competent personnel with required certificates and licenses to operate equipment. -40-hr hazwoper training and 8-hr refresher training	-All equipment working properly (daily). -Safety devices working properly (daily).
water level, water quality meter, geopump	none	-Operarting correctly and not defective.
PID (10.6 eV)	Must be able to calibrate PID	-Calibrate to within 10% of true isobutylene value (100 ppm). -Battery life sufficient. -Pump operating. -Zeroes appropriately.

Approval Authority: ______________________

ATTACHMENT B5

WELL DRILLING AND ABANDONMENT

ACTIVITY HAZARDS ANALYSIS

Overall Risk Assessment Code (RAC) (Use highest code): L

Date prepared: 12 February 2015

Project location: Clove and Maple Avenues Former MGP

Prepared by: Steve Wiskes

Job: Well Drilling and Abandonment

Reviewed by:

Risk Assessment Code Matrix

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Severity	Probability: Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

JOB STEPS	HAZARDS	ACTIONS TO ELIMINATE OR MINIMIZE HAZARDS	RAC
1. Well drilling with a hollow stem auger rig	1. Struck-by	Be mindful of drill rig movements, stay back while drill rig is moving. Wear hard hat and safety glasses at all times.	L
2. Well abandonment	2. Physical injury from moving parts of machinery, including change out of augers	Avoid moving parts of machinery. Keep fingers, hands, and arms away from rotating drill head near the top (connection to drive) or near the bottom (hole entrance). Keep hands away from hydraulic clamps when activated. Keep fingers away from pinch points.	L
	3. Noise	Wear hearing protection.	L
	4. Exposure to soil or water contaminants	Wear appropriate PPE including dust masks or respirator with particulate cartridges. Use PID to monitor breathing zone.	L
	5. Physical injury from cables under tension that suddenly release	Do not go near when cables are under tension such as lifting Do not stand directly underneath a load suspended by cable.	L
	6. Slip, trip and fall	When drilling wells the ground can be slippery when wet and icy in the winter	L
EQUIPMENT	TRAINING	INSPECTION	

Approval Authority:

ACTIVITY HAZARDS ANALYSIS

EQUIPMENT	TRAINING	INSPECTION
Drill rig	qualified driller and helper	Make sure all kill switches on drill rig are operational. Inspect cables for fraying (replace as necessary). Inspect hooks to be sure spring mechanisms are operational.
		Do not attempt to help the driller or drillers helper. Make eye contact with driller when approaching the rig.

Approval Authority: ______________________________

ATTACHMENT C

CON EDISON'S WORK PLAN GUIDE FOR ELECTRICAL SAFETY

Appendix E
Con Edison's Work Plan Guide for Electrical Safety

Appendix E - Con Edison's Work Plan Guide for Electrical Safety

Overview

Electrical safety is an important component to any safety program. To minimize personal injury from contact with energized sources, workers must be trained in the fundamentals of electrical safety and all electrical hazards on a project must be identified and corrected. Only properly licensed electricians may perform any electrical work on Con Edison projects.

Minimum Electrical Safety Requirements

In order to perform work on any Con Edison facility or project, all contractors must, at least, meet the following requirements. Please note that additional requirements may be necessary based on job-specific activities. It is the responsibility of each contractor to identify these requirements in the job-specific Environmental Health and Safety Plan submitted to Con Edison and include a process to meet these requirements:

- Before work begins, all electric circuits, exposed or concealed, that may be contacted by workers must be posted with warning signs.
- All workers must be notified of the location and hazard involved with nearby electrical circuits and protective measures taken.
- Workers must not work near any part of an electrical circuit unless they are protected against shock by guarding or by de-energizing and grounding the circuit.
- Workspaces, walkways, and similar locations must be kept free of electric cords and tools.
- Equipment must not be stored around electrical cabinets to prevent access.
- Workers must inspect all electrical equipment, including extension cords, for the following hazards:
- Missing ground pins on plugs (except double-insulated);
- Insulation pulled free from plugs or support connections;
- Damaged insulation;
- Exposed wires; and
- Evidence of arcing, sparking, or smoking.
- When any conditions are identified on equipment that make it unsafe to operate, the equipment must be removed from the site until repaired by a qualified person.
- Portable lamps must be covered by a fixed, grounded (if metal) guard and equipped with an insulated handle.
- All underground utilities must be marked prior to any groundbreaking activities.
- Flexible cords must be suitable for the condition and location of use and must be used as appropriate.
- Three-wire extension cords must be used and must be rated for hard or extra-hard use.
- Splices and/or taps are prohibited in extension cords.
- Extension cords must not be fastened with staples, hung on nails, or suspended on wires.
- Workers must be trained in the safety-related work practices that pertain to their job and cannot work near electrical hazards without training to recognize and avoid the hazard.
- Electrical workers must test all equipment to verify if energy is present.
- Only qualified, trained workers may test electrical equipment.
- Workers must properly lockout and tag-out any circuit or equipment being worked on and verify the equipment is de-energized.
- Personal protective equipment used by electrical workers must be appropriate and in good condition.
- Portable metal ladders and ladders with metal reinforcement are prohibited near energized electrical equipment.
- ALL electrical equipment used on a project (hand tools, etc.) must be protected with a ground fault circuit interrupter (GFCI).
- Materials must not be stored in transformer vaults.
- AC and DC wiring systems must be properly grounded.
- Proper clearance from overhead power lines must be maintained at all times.

Regulatory Citations

A complete text of the requirements for Electrical Safety can be found in Title 29 Code of Federal Regulations, Part 1910, Section 147 and Subpart S, and Part 1926, Subpart K. For additional information regarding Electrical Safety requirements or clarification of these requirements, contact the New York regional OSHA office located at 201 Varick Street, Room 670, New York, New York 10014 (212-337-2378). The OSHA website can be found at www.OSHA.gov.

ATTACHMENT D

MATERIAL SAFETY DATA SHEETS

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and GHS

Printing date: 31.12.2013 **Revision:** 31.12.2013

1 Identification of the substance/mixture and of the company/undertaking

· **1.1 Product identifier**

· **Trade name: ALCONOX**
· **1.2 Relevant identified uses of the substance or mixture and uses advised against**
No further relevant information available.

· **Application of the substance / the mixture:** Cleaning material/ Detergent

· **1.3 Details of the supplier of the Safety Data Sheet**
· **Manufacturer/Supplier:**
Alconox, Inc.
30 Glenn St., Suite 309
White Plains, NY 10603
Phone: 914-948-4040
· **Further information obtainable from:** Product Safety Department

· **1.4 Emergency telephone number:**
ChemTel Inc.
(800)255-3924, +1 (813)248-0585

2 Hazards identification

· **2.1 Classification of the substance or mixture**
· **Classification according to Regulation (EC) No 1272/2008**

GHS05 corrosion

Eye Dam. 1; H318: Causes serious eye damage.

GHS07

Skin Irrit. 2; H315: Causes skin irritation.

· **Classification according to Directive 67/548/EEC or Directive 1999/45/EC**

Xi; Irritant

R38-41: Irritating to skin. Risk of serious damage to eyes.
· **Information concerning particular hazards for human and environment:**
The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.
· **Classification system:**
The classification is according to the latest editions of the EU-lists, and extended by company and literature data.
The classification is in accordance with the latest editions of international substances lists, and is supplemented by information from technical literature and by information provided by the company.

· **2.2 Label elements**
· **Labelling according to Regulation (EC) No 1272/2008**
The product is classified and labelled according to the CLP regulation.

(Contd. on page 2)

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and GHS

Printing date: 31.12.2013 **Revision:** 31.12.2013

Trade name: ALCONOX

(Contd. of page 1)

· **Hazard pictograms**

GHS05

· **Signal word:** Danger

· **Hazard-determining components of labelling:**
sodium dodecylbenzene sulfonate
· **Hazard statements**
H315: Causes skin irritation.
H318: Causes serious eye damage.
· **Precautionary statements**
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P264: Wash thoroughly after handling.
P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310: Immediately call a POISON CENTER or doctor/physician.
P321: Specific treatment (see on this label).
P362: Take off contaminated clothing and wash before reuse.
P332+P313: If skin irritation occurs: Get medical advice/attention.
P302+P352: IF ON SKIN: Wash with plenty of soap and water.
· **Hazard description:**
· **WHMIS-symbols:**
D2B - Toxic material causing other toxic effects

· **NFPA ratings (scale 0 - 4)**

Health = 1
Fire = 0
Reactivity = 0

· **HMIS-ratings (scale 0 - 4)**

Health = 1
Fire = 0
Reactivity = 0

· **HMIS Long Term Health Hazard Substances**
None of the ingredients is listed.

· **2.3 Other hazards**
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.

(Contd. on page 3)

(Contd. of page 2)

3 Composition/information on ingredients

· **3.2 Mixtures**
· **Description:** Mixture of substances listed below with nonhazardous additions.

· **Dangerous components:**		
CAS: 68081-81-2	sodium dodecylbenzene sulfonate Xn R22; Xi R36 Acute Tox. 4, H302; Eye Irrit. 2, H319	10-25%
CAS: 497-19-8 EINECS: 207-838-8 Index number: 011-005-00-2	Sodium Carbonate Xi R36 Eye Irrit. 2, H319	2,5-10%
CAS: 7722-88-5 EINECS: 231-767-1	tetrasodium pyrophosphate substance with a Community workplace exposure limit	2,5-10%
CAS: 151-21-3 EINECS: 205-788-1	sodium dodecyl sulphate Xn R21/22; Xi R36/38 Acute Tox. 4, H302; Acute Tox. 4, H312; Skin Irrit. 2, H315; Eye Irrit. 2, H319	2,5-10%

· **Additional information:** For the wording of the listed risk phrases refer to section 16.

4 First aid measures

· **4.1 Description of first aid measures**
· **After inhalation:** Supply fresh air; consult doctor in case of complaints.
· **After skin contact:**
Immediately wash with water and soap and rinse thoroughly.
If skin irritation continues, consult a doctor.
· **After eye contact:**
Remove contact lenses if worn.
Rinse opened eye for several minutes under running water. If symptoms persist, consult a doctor.
· **After swallowing:**
Rinse out mouth and then drink plenty of water.
Do not induce vomiting; call for medical help immediately.
· **4.2 Most important symptoms and effects, both acute and delayed**
No further relevant information available.
· **4.3 Indication of any immediate medical attention and special treatment needed**
No further relevant information available.

5 Firefighting measures

· **5.1 Extinguishing media**
· **Suitable extinguishing agents:**
CO_2, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

(Contd. on page 4)

(Contd. of page 3)

· **5.2 Special hazards arising from the substance or mixture:** No further relevant information available.
· **5.3 Advice for firefighters**
· **Protective equipment:**
Wear self-contained respiratory protective device.
Wear fully protective suit.
· **Additional information:** No further relevant information available.

6 Accidental release measures

· **6.1 Personal precautions, protective equipment and emergency procedures**
Product forms slippery surface when combined with water.
· **6.2 Environmental precautions:** Do not allow to enter sewers/ surface or ground water.
· **6.3 Methods and material for containment and cleaning up:**
Pick up mechanically.
Clean the affected area carefully; suitable cleaners are:
Warm water
· **6.4 Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7 Handling and storage

· **7.1 Precautions for safe handling**
Prevent formation of dust.
Keep receptacles tightly sealed.
· **Information about fire - and explosion protection:** No special measures required.

· **7.2 Conditions for safe storage, including any incompatibilities**
· **Storage:**
· **Requirements to be met by storerooms and receptacles:** No special requirements.
· **Information about storage in one common storage facility:** Not required.
· **Further information about storage conditions:** Protect from humidity and water.
· **7.3 Specific end use(s):** No further relevant information available.

8 Exposure controls/personal protection

· **Additional information about design of technical facilities:** No further data; see item 7.

· **8.1 Control parameters**

· **Ingredients with limit values that require monitoring at the workplace:**	
7722-88-5 tetrasodium pyrophosphate	
REL (USA)	5 mg/m³
TLV (USA)	TLV withdrawn
EV (Canada)	5 mg/m³

(Contd. on page 5)

(Contd. of page 4)

· **Additional information:** The lists valid during the making were used as basis.

· **8.2 Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Avoid contact with the skin.
Avoid contact with the eyes and skin.
· **Respiratory protection:**
Not required under normal conditions of use.
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use self-contained respiratory protective device.
· **Protection of hands:**

Protective gloves

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.
· **Material of gloves**
Butyl rubber, BR
Nitrile rubber, NBR
Natural rubber, NR
Neoprene gloves
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material cannot be calculated in advance and has therefore to be checked prior to the application.
· **Penetration time of glove material**
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.
· **Eye protection:**

Safety glasses

· **Body protection:** Protective work clothing

(Contd. on page 6)

Printing date: 31.12.2013 Revision: 31.12.2013

Trade name: ALCONOX

(Contd. of page 5)

9 Physical and chemical properties

· 9.1 Information on basic physical and chemical properties	
· General Information	
· Appearance:	
Form:	Powder
Colour:	White
· Odour:	Odourless
· Odour threshold:	Not determined.
· pH-value (10 g/l) at 20 °C:	9,5 (- NA for Powder form)
· Change in condition	
Melting point/Melting range:	Not Determined.
Boiling point/Boiling range:	Undetermined.
· Flash point:	Not applicable.
· Flammability (solid, gaseous):	Not determined.
· Ignition temperature:	
Decomposition temperature:	Not determined.
· Self-igniting:	Product is not self-igniting.
· Danger of explosion:	Product does not present an explosion hazard.
· Explosion limits:	
Lower:	Not determined.
Upper:	Not determined.
· Vapour pressure:	Not applicable.
· Density at 20 °C:	1,1 g/cm³
· Relative density	Not determined.
· Vapour density	Not applicable.
· Evaporation rate	Not applicable.
· Solubility in / Miscibility with water:	Soluble.
· Partition coefficient (n-octanol/water):	Not determined.
· Viscosity:	
Dynamic:	Not applicable.
Kinematic:	Not applicable.
· Solvent content:	
Organic solvents:	0,0 %
Solids content:	100 %
· 9.2 Other information	No further relevant information available.

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(Contd. of page 6)

10 Stability and reactivity

- **10.1 Reactivity**
- **10.2 Chemical stability**
- **Thermal decomposition / conditions to be avoided:**
  No decomposition if used according to specifications.
- **10.3 Possibility of hazardous reactions**
  Reacts with acids.
  Reacts with strong alkali.
  Reacts with strong oxidizing agents.
- **10.4 Conditions to avoid:** No further relevant information available.
- **10.5 Incompatible materials:** No further relevant information available.
- **10.6 Hazardous decomposition products:**
  Carbon monoxide and carbon dioxide
  Phosphorus compounds
  Sulphur oxides (SOx)

11 Toxicological information

- **11.1 Information on toxicological effects**
- **Acute toxicity:**
- **Primary irritant effect:**
- **On the skin:** Irritant to skin and mucous membranes.
- **On the eye:** Strong irritant with the danger of severe eye injury.
- **Sensitization:** No sensitizing effects known.
- **Additional toxicological information:**
  The product shows the following dangers according to the calculation method of the General EU Classification Guidelines for Preparations as issued in the latest version:
  Irritant
  Swallowing will lead to a strong caustic effect on mouth and throat and to the danger of perforation of esophagus and stomach.

12 Ecological information

- **12.1 Toxicity**
- **Aquatic toxicity:** No further relevant information available.
- **12.2 Persistence and degradability:** No further relevant information available.
- **12.3 Bioaccumulative potential:** Not worth-mentioning accumulating in organisms
- **12.4 Mobility in soil:** No further relevant information available.
- **Additional ecological information:**
- **General notes:**
  Water hazard class 2 (German Regulation) (Self-assessment): hazardous for water.
  Do not allow product to reach ground water, water course or sewage system.
  Danger to drinking water if even small quantities leak into the ground.
- **12.5 Results of PBT and vPvB assessment**
- **PBT:** Not applicable.

(Contd. on page 8)

(Contd. of page 7)

· **vPvB:** Not applicable.
· **12.6 Other adverse effects:** No further relevant information available.

13 Disposal considerations

· **13.1 Waste treatment methods**
· **Recommendation**
Smaller quantities can be disposed of with household waste.
Small amounts may be diluted with plenty of water and washed away. Dispose of bigger amounts in accordance with Local Authority requirements.
The surfactant used in this product complies with the biodegradability criteria as laid down in Regulation (EC) No. 648/2004 on detergents. Data to support this assertion are held at the disposal of the competent authorities of the Member States and will be made available to them, at their direct request or at the request of a detergent manufacturer.

· **Uncleaned packaging:**
· **Recommendation:** Disposal must be made according to official regulations.
· **Recommended cleansing agents:** Water, if necessary together with cleansing agents.

14 Transport information

· **14.1 UN-Number** · **DOT, ADR, IMDG, IATA, ICAO**	Not Regulated
· **14.2 UN proper shipping name** · **DOT, ADR, IMDG, IATA, ICAO**	Not Regulated
· **14.3 Transport hazard class(es)** · **DOT, ADR, IMDG, IATA, ICAO** · **Class**	Not Regulated
· **14.4 Packing group** · **DOT, ADR, IMDG, IATA, ICAO**	Not Regulated
· **14.5 Environmental hazards:** · **Marine pollutant:**	No
· **14.6 Special precautions for user**	Not applicable.
· **14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.
· **UN "Model Regulation":**	Not Regulated

(Contd. on page 9)

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15 Regulatory information

· **15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture**
· **United States (USA)**
· **SARA**

· **Section 355 (extremely hazardous substances):**
None of the ingredients is listed.

· **Section 313 (Specific toxic chemical listings):**
None of the ingredients is listed.

· **TSCA (Toxic Substances Control Act):**
All ingredients are 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.

· **Carcinogenic Categories**

· **EPA (Environmental Protection Agency)**
None of the ingredients is listed.

· **IARC (International Agency for Research on Cancer)**
None of the ingredients is listed.

· **TLV (Threshold Limit Value established by ACGIH)**
None of the ingredients is listed.

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**
None of the ingredients is listed.

· **OSHA-Ca (Occupational Safety & Health Administration)**
None of the ingredients is listed.

(Contd. on page 10)

Printing date: 31.12.2013 Revision: 31.12.2013

Trade name: ALCONOX

(Contd. of page 9)

· **Canada**

· **Canadian Domestic Substances List (DSL)**

All ingredients are listed.

· **Canadian Ingredient Disclosure list (limit 0.1%)**

None of the ingredients is listed.

· **Canadian Ingredient Disclosure list (limit 1%)**

497-19-8	Sodium Carbonate
7722-88-5	tetrasodium pyrophosphate
151-21-3	sodium dodecyl sulphate

· **15.2 Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Relevant phrases**

H302: Harmful if swallowed.
H312: Harmful in contact with skin.
H315: Causes skin irritation.
H319: Causes serious eye irritation.

R21/22: Harmful in contact with skin and if swallowed.
R22: Harmful if swallowed.
R36: Irritating to eyes.
R36/38: Irritating to eyes and skin.

· **Abbreviations and acronyms:**

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road) IMDG: International Maritime Code for Dangerous Goods 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
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)

Ascent Battery Supply, LLC
925 Walnut Ridge Drive
Hartland, Wisconsin 53029

Material Safety Data Sheet — Alkaline (Manganese Dioxide)

The information and recommendations below are believed to be accurate at the date of preparation. Ascent Battery Supply makes no warranty of merchantability or any other warranty, express or implied, with respect to such information and we assume no liability resulting from its use. This MSDS provides guidelines for safe use and handling of the product. It does not and cannot advise all possible situations. Your specific use of this product should be evaluated to determine if additional precautions must be taken.

Distributed By:	Ascent Battery Supply, LLC	**Emergency Number**	INFOTRAC (800) 535-5053
Address:	925 Walnut Ridge Drive Hartland, Wisconsin 53029	**Overseas Emergency Number**	INFOTRAC (352) 323-3500 (Collect)
Revision Date:	10/07		

SECTION 1 – IDENTITY

Product Name	Manganese Dioxide Battery
Common Synonyms	Alkaline
DOT Description	Dry Battery
Chemical Name	Manganese Dioxide; Primary Battery

SECTION 2 – HAZARDOUS INGREDIENTS

Chemical Name	CAS No.	Percentage %
Manganese Dioxide	1313-13-9	50
Zinc	7440-66-6	18
Graphite	7782-42-5	3
Potassium Hydroxide	1310-58-3	15
Stainless Steel	N/A	12
Plastic	N/A	2

SECTION 3 – PHYSICAL AND CHEMICAL CHARACTERISTICS

Boiling Point	NA	**Melting Point**	NA
Vapor Pressure	NA	**Vapor Density**	NA
Specific Gravity	NA	**Percent Volatile By Volume**	NA
Solubility in Water	NA	**Reactivity in Water**	NA
Appearance and Odor	Geometric, solid object	**Evaporation Rate**	NA

Flash Point	NA	**Flammable Limits in Air % by Volume**	NA
Extinguisher Media	Use Water, foam or dry powder	**Auto-Ignition Temperature**	NA

Special Fire Fighting Procedures	Wear self-contained breathing apparatus to avoid inhalation of hazardous decomposition products.

Unusual Fire and Explosion Hazards	Cells may rupture when exposed to excessive heat. This could result in the release of flammable or corrosive materials.

SECTION 4 – PHYSICAL HAZARDS

Stable or Unstable	Stable	**Conditions to Avoid**	Electrical shorting the cell.
Incompatibility (Materials to Avoid)	NA		
Hazardous Decomposition Products	NA		
Hazardous Polymerization	Will Not Occur		

SECTION 5 – HEALTH HAZARDS

Threshold Limit Value	NA
Signs and Symptoms of Exposure	None (In fire or rupture situation see section 2 and section 4.)
Medical Conditions Generally Caused by Exposure	Chemicals may cause burns to skin, eyes, gastrointestinal tract and mucous membranes.
Routes of Entry	Skin, Eyes, Swallowing
Emergency and First Aid Procedures for	Manganese Dioxide Chemicals
1. Inhalation	Get fresh air. If symptoms persist seek medical attention
2. Eyes and Skin	If a cell ruptures, flush with copious quatities of flowing lukewarm water for a minimum of 15 minutes. Get immediate medical attention for eyes. Wash skin with soap and water.
4. Ingestion	Ingestion of battery chemicals can be harmful. Call The National Battery Ingestion Hotline (202-625-3333) 24 hours a day, for procedures treating ingestion of chemicals. Do not induce vomiting.

SECTION 6 – SPECIAL PROTECTION INFORMATION

Respiratory Protection	NA				
Ventilation	NA	**Local Exhaust**	NA	**Mechanical** (General)	NA
Gloves	Wear gloves if cell ruptures, is corroded or leaking chemicals.	**Safety Glasses**	Always wear safety glasses when working with batteries and cells.		
Other Protective Equipment	NA				

SECTION 7 – SPECIAL PRECAUTIONS – SPILL AND LEAKAGE PROCEDURES

Precautions to be Taken when Handling and Storing	Store in dry place. Storing unpacked cells together could result in cells shorting and heating to the point of rupturing.
Other Precautions	If packaging materials are not available place masking taped on positive and negatives ends of the cells.
Steps to be Taken if chemicals are spilled	If cells are leaking or rupture, prevent skin and eye contact and collect all released material in a plastic lined metal container.
Waste Disposal	Manganese Dioxide (Alkaline) batteries have no hazardous waste characteristics and can be landfilled.
Transportation	These are considered to be "Dry Batteries" and are not considered a "Hazardous Material" per U.S. DOT (Department of Transportation) regulations or "dangerous goods" per IATA (International Air Transport Associtation) regulations.

SAFETY DATA SHEET
HYDROCHLORIC ACID

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY:

PRODUCT NAME: HYDROCHLORIC ACID

PART No.: RM122

SYNONYMS, TRADE NAMES: SPIRIT OF SALTS; HYDROGEN CHLORIDE SOLUTION;

APPLICATIONS: Scope of this safety data sheet covers acid concentration of equal to or greater than 25%.

SUPPLIER:
J M Loveridge plc
Southbrook Road, Southampton
Hampshire
SO15 1BH
Tel: 023 8022 2008
Fax: 023 8022 2117

2. COMPOSITION/INFORMATION ON INGREDIENTS:

EU INDEX No.: 017-002-01-X

EEC (EINECS) No. 231-595-7

CAS No.: 7647-01-1

COMPOSITION COMMENTS: Contains HCl @ 32% w/w

3. HAZARDS IDENTIFICATION:

Causes burns. Irritating to respiratory system.

4. FIRST AID MEASURES:

GENERAL: IN ALL CASES OF DOUBT OR WHEN SYMPTOMS PERSIST, ALWAYS SEEK MEDICAL ATTENTION

INHALATION: Move affected person to fresh air.If recovery not rapid, seek medical attention. If breathing stops, provide artificial respiration.

INGESTION: DO NOT INDUCE VOMITING. In case of spontaneous vomiting, be sure that vomit can freely drain because of danger of suffocation. Only when conscious, rinse mouth with plenty of water and give plenty of water to drink - (approx 500ml). Keep patient at rest and obtain medical attention.

SKIN: Remove contaminated clothing. Wash affected area with plenty of soap and water. Obtain medical attention. Launder clothing before re-use.

EYES: Rinse immediately with plenty of water for at least 5 minutes while lifting the eye lids. Seek medical attention. Continue to rinse.

5. FIRE FIGHTING MEASURES:

EXTINGUISHING MEDIA: Use extinguishing media suitable against surrounding fire or the cause of fire.

HAZARDOUS COMBUSTION PRODUCTS: Toxic or corrosive vapours may be released in fire situation.

PROTECTIVE MEASURES IN FIRE: Fire fighters should wear self-contained breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES:

PERSONAL PRECAUTION IN SPILL: Avoid direct contact with skin, eyes and clothing.
Do not breathe vapour or fumes. Wear appropriate protective clothing.

PRECAUTIONS TO PROTECT ENVIRONMENT: Prevent contamination of soil, drains and surface water.

SPILL CLEANUP METHODS: Small spillage: Dilute to waste with plenty of water.
Larger spill: Neutralise spillage with alkaline material (sodium bicarbonate or soda-ash). Take-up spillage with absorbent, inert material and place in a suitable and closable labelled container for recovery or disposal. Wash the area clean with water and detergent, observing environmental requirements.

7. HANDLING AND STORAGE:

USAGE PRECAUTIONS: HANDLING - Product should be used in accordance with good industrial principles for handling and storing of hazardous chemicals.
Avoid vapour inhalation, skin and eye contact.

STORAGE PRECAUTIONS: Store in a cool, dry, well ventilated place, in securely closed original container.

STORAGE CRITERIA: Corrosive storage.

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION:

INGREDIENT NAME:	CAS No.:	STD	LT EXP 8 Hrs	ST EXP 15 Min
HYDROCHLORIC ACID	7647-01-1	OES	1 ppm	5 ppm

INGREDIENT COMMENTS: Refer to the current edition of HSE Guidance Note EH 40/200* for occupational exposure limits; as Hydrogen chloride (gas and aerosol mist) and not as hydrochloric acid

VENTILATION: Work in a fume cupboard or use local exhaust ventilation. Respiratory protection required in insufficiently ventilated woking areas.

RESPIRATORS: For short periods of work, a suitable RPE fitted with a combination E1 filter cartridge is recommended.

PROTECTIVE GLOVES: Use impervious gloves.

EYE PROTECTION: Where the potential for eye contact exists, splash-proof goggles or face shield must be worn.

OTHER PROTECTION: Wear protective clothing and closed footwear.

	Wear personal protective equipment appropriate to the quantity of material handled.
HYGIENIC WORK PRACTICES:	SKIN PROTECTION - apply barrier cream to hands and exposed skin. Promptly remove contaminated clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES:

APPEARANCE:	Liquid. Fuming.		
COLOUR:	Colourless to pale yellow.		
ODOUR/TASTE:	Pungent. Suffocating.		
DENSITY/SPECIFIC GRAVITY (g/ml):	~1.19	**Temperature (°C):**	20
VAPOUR DENSITY (air=1):	1.27		
pH-VALUE, DILUTED SOLUTION:	1	**Concentration % M:**	
SOLUBILITY DESCRIPTION:	Soluble in water. Miscible with water in all proportions.		
ODOUR THRESHOLD, LOWER:	5		

10. STABILITY AND REACTIVITY:

STABILITY:	Stable under normal conditions of use.
CONDITIONS TO AVOID:	Store away from reactive materials.
MATERIALS TO AVOID:	Sulphuric acid. Strong bases and alkalis - vigorous exothermic reaction. Oxidising agents - reacts to liberate toxic chlorine gas. Can liberate harmful gases from certain chemical salts e.g. cyanides, nitrites, carbides, sulphites.
HAZARDOUS DECOMP. PRODUCTS:	Thermal decomposition may release noxious, toxic or corrosive gases or vapours. CARE - will react with many metals to liberate highly flammable hydrogen gas.

11. TOXICOLOGICAL INFORMATION:

TOXIC DOSE - LD 50:	900 mg/kg (oral-rbt)
INHALATION:	LC 50 - 5mg/l (inhalation-rat). Inhalation of mist or vapour will cause irritation of the upper respiratory tract, high concentrations may cause damage to mucous membranes and lungs.
INGESTION:	May cause burns to mucous membranes, throat and stomach.
SKIN:	Liquid causes severe irritation and burns on prolonged contact. Vapour causes severe irritation, may cause burns at high concentrations.
EYES:	Vapour is irritant at low concentrations. Liquid causes severe burns.
OTHER HEALTH EFFECTS:	Repeated exposure to low levels may cause erosion of teeth and ulceration of the nasal septum and gums.
ROUTE OF ENTRY:	Inhalation.
MEDICAL SYMPTOMS:	Irritation of eyes and mucous membranes. Burning sensation in mouth. Severe skin irritation.

12. ECOLOGICAL INFORMATION:

ECOLOGICAL INFORMATION:	Avoid release to the environment. Prevent contamination of soil, drains or surface water, use appropriate containment method to avoid environmental contamination.
BIO ACCUMULATION:	Not expected to bio-accumulate.
DEGRADABILITY:	Neutralised slowly by natural alkalinity.
ACUTE FISH TOXICITY:	Fatal to aquatic life due to pH shift. Toxic to aquatic forms - 280ppm in fresh water and 100ppm in salt water.

13. DISPOSAL CONSIDERATIONS:

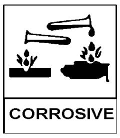
DISPOSAL METHODS:	This material and/or its container must be disposed of as hazardous waste according to Special Waste Regulations 1996 or according to local regulations, in compliance with Duty of Care Regulations and Special Waste Regulations.
WASTE CLASS:	WASTE CODE:0705** HAZARDOUS PROPERTY: H8

14. TRANSPORT INFORMATION:

UN No. ROAD:	1789
UK ROAD PACK GR.:	II
ADR CLASS No.:	8
ADR CLASS:	Class 8: Corrosive substances.
ADR ITEM No.:	5 °(b)
HAZARD No. (ADR):	80 Corrosive or slightly corrosive substance.
ADR MARGINAL:	2801
HAZCHEM CODE:	2R
PROPER SHIPPING NAME I:	HYDROCHLORIC ACID
UN No. SEA:	UN 1789
IMDG CLASS:	8
IMDG PAGE No.:	8174
IMDG PACK GR.:	II
UN No., AIR:	UN-ID 1789
ICAO CLASS:	8
AIR PACK GR.:	II

15. REGULATORY INFORMATION:

LABEL FOR SUPPLY:



RISK PHRASES:

R-34 Causes burns.
R-37 Irritating to respiratory system.

SAFETY PHRASES:

S-1/2 Keep locked up and out of the reach of children.
S-26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S-45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

UK REGULATORY REFERENCES:

Classification, Packaging and Labelling Regulations 1984. Chemicals (Hazard Information & Packaging) Regulations 1993.

16. OTHER INFORMATION:

INFORMATION SOURCES:

This product has been classified in accordance with CHIP3 regulations.

REVISION COMMENTS:

Edition 01; Revised item(s):

ISSUED BY:

MK

SDS No.:

233

DATE:

12/07/02

DISCLAIMER:

The foregoing data has been compiled for safety information only and does not form part of any selling specification. Information contained in this Data Sheet is to the best of JMLs knowledge correct at the time of publication. Customers should always satisfy themselves, that the product which they have selected is entirely suitable for their purpose under their conditions of use and in compliance with current regulations. For any further information, please contact the supplier.

GASCO

MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR

MSDS NO: 248 **Version:3** **Date: August, 2010**

1. Chemical Product and Company Identification

Gasco Affiliates, LLC
320 Scarlett Blvd.
Oldsmar, FL 34677

TELEPHONE NUMBER: (800) 910-0051 **24-HOUR EMERGENCY NUMBER: 1-800-424-9300**
FAX NUMBER: (866) 755-8920
E-MAIL: info@gascogas.com

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR
CHEMICAL NAME: Isobutylene in air
COMMON NAMES/ SYNONYMS: None
TDG (Canada) CLASSIFICATION: 2.2
WHIMIS CLASSIFICATION: A

2. COMPOSITION/ INFORMATION ON INGREDIENTS

INGREDIENT	%VOLUME	PEL-OSHA	TLV-ACGIH	LD_{50} or LC_{50} Route/Species
Isobutylene FORMULA: C_4H_8	0.0001-0.9	N/A	N/A	N/A
Air FORMULA: Mixture	99.0 to 99.9999	N/A	N/A	N/A

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Release of this product may produce oxygen-deficient atmospheres (especially in confined spaces or other poorly ventilated environments); individuals in such atmospheres may be asphyxiated. Isobutylene may cause drowsiness and other central nervous system effects in high concentrations; however, due to the low concentration of this gas mixture, this is unlikely to occur.

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
No	No	No	Yes	No

HEALTH EFFECTS:

Exposure Limits	Irritant	Sensitization	Reproductive Hazard	Mutagen
Yes	No	No	No	No

Carcinogenicity: --NTP: No IARC: No OSHA: No

EYE EFFECTS:
N/A.

SKIN EFFECTS:
N/A.

GASCO

MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR

INGESTION EFFECTS:
Ingestion unlikely. Gas at room temperature.

INHALATION EFFECTS:
Due to the small size of this cylinder, no unusual health effects from over-exposure are anticipated under normal routine use.

NFPA HAZARD CODES		HMIS HAZARD CODES		RATING SYSTEM
Health:	1	Health:	1	0= No Hazard
Flammability:	0	Flammability:	0	1= Slight Hazard
Reactivity:	0	Reactivity:	0	2= Moderate Hazard
				3= Serious Hazard
				4= Severe Hazard

---

4. FIRST AID MEASURES

EYES:
N/A

SKIN:
N/A

INGESTION:
Not required

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASED OF OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED THE SELF-CONTAINED BREATHING APPARATUS. Victims should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. If breathing has stopped administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

---

5. FIRE-FIGHTING MEASURES

These containers hold gas under pressure, with no liquid phase. If involved in a major fire, they should be sprayed with water to avoid pressure increases, otherwise pressures will rise and ultimately they may distort or burst to release the contents. The gases will not add significantly to the fire, but containers or fragments may be projected considerable distances - thereby hampering fire fighting efforts.

---

6. ACCIDENTAL RELEASE MEASURES

In terms of weight, these containers hold very little contents, such that any accidental release by puncturing etc. will be of no practical concern.

---

7. HANDLING AND STORAGE

Suck back of water into the container must be prevented. Do not allow backfeed into the container. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Use only in well-ventilated areas. Do not heat cylinder by any means to increase rate of product from the cylinder. Do not allow the temperature where cylinders are stored to exceed 130°F (54°C).

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Use adequate ventilation for extended use of gas.

GASCO

MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: ISOBUTYLENE (1 PPM – 0.9%) IN AIR

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9. PHYSICAL AND CHEMICAL PROPERTIES

PARAMETER:	VALUE:
Physical state	: Gas
Evaporation point	: N/A
pH	: N/A
Odor and appearance	: Colorless, odorless gas

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10. STABILITY AND REACTIVITY

Stable under normal conditions. Expected shelf life 48 months.

---

11. TOXICOLOGICAL INFORMATION

No toxicological damage caused by this product.

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12. ECOLOGICAL INFORMATION

No ecological damage caused by this product.

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13. DISPOSAL INFORMATION

Do not discharge into any place where its accumulation could be dangerous. Used containers are acceptable for disposal in the normal waste stream as long as the cylinder is empty and valve removed or cylinder wall is punctured; but GASCO encourages the consumer to return cylinders.

---

14. TRANSPORT INFORMATION

	United States DOT	Canada TDG
PROPER SHIPPING NAME:	Compressed Gas N.O.S. (Isobutylene in Air)	Compressed Gas N.O.S. (Isobutylene in Air)
HAZARD CLASS:	2.2	2.2
IDENTIFICATION NUMBER:	UN1956	UN1956
SHIPPING LABEL:	NONFLAMMABLE GAS	NONFLAMMABLE GAS

---

15. REGULATORY INFORMATION

Isobutylene is listed under the accident prevention provisions of section 112(r) of the Clean Air Act (CAA) with a threshold quantity (TQ) of 10,000 pounds.

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16. OTHER INFORMATION

This MSDS has been prepared in accordance with the Chemicals (Hazard Information and Packaging for Supply (Amendment) Regulation 1996. The information is based on the best knowledge of GASCO, and its advisors and is given in good faith, but we cannot guarantee its accuracy, reliability or completeness and therefore disclaim any liability for loss or damage arising out of use of this data. Since conditions of use are outside the control of the Company and its advisors we disclaim any liability for loss or damage when the product is used for other purposes than it is intended.

MSDS/S010/248/ August, 2010

Ascent Battery Supply, LLC
925 Walnut Ridge Drive
Hartland, Wisconsin 53029

Safety Data Sheet (SDS) — Lithium-Ion (Li-Ion) Batteries

The information and recommendations below are believed to be accurate at the date of document preparation. Ascent Battery Supply makes no warranty or merchantability or any other warranty, express or implied, with respect to this information and assumes no liability resulting from its use. This SDS provides guidelines for safe use and handling of product. It does not, and cannot, advise all possible situations. All specific uses of this product must be evaluated by the end user to determine if additional safety precautions should be taken.

SECTION 1 - IDENTIFICATION

Product Name Lithium-Ion Battery
Common Name(s) Li-Ion Battery
Synonyms Lithiated Cobalt Oxide; Li-Ion Secondary Battery; Li-Ion Rechargeable Battery
DOT Description Dry Battery
Chemical Name Lithium-Ion

Distributed By Ascent Battery Supply, LLC
Address 925 Walnut Ridge Drive
Hartland, Wisconsin 53029

Emergency Number INFOTRAC (800) 535-5053
Overseas Emergency Number INFOTRAC (352) 323-3500 (Collect)

SECTION 2 – HAZARD(S)

Unusual Fire and Explosion Hazards Cells or batteries may flame or leak potentially hazardous organic vapors if exposed to excessive heat, fire or short circuit condition. Damaged or opened cells or batteries can result in rapid heating and the release of flammable vapors. Vapors may be heavier than air and may travel along the ground or be moved by ventilation to an ignition source and flash back.

SECTION 3 – COMPOSITION

Chemical Name	CAS No.	Percentage %
Lithium Cobalt Oxide	12190-79-3	25-40
Iron	7439-89-6	15-25
Aluminum	7429-90-5	2-6
Graphite: Natural Graphite: Artificial	7782-42-5 7740-44-0	10-20
Copper	7440-50-8	5-15
Organic Electrolyte		10-20

SECTION 4 – FIRST AID MEASURES

For Li-Ion Chemicals:

Inhalation Get fresh air. If symptoms persist seek medical attention

Eyes and Skin **Skin:** Flush with copious quantities of flowing lukewarm water for a minimum of 15 minutes; wash with soap and water.
Eyes: Flush with copious quantities of flowing lukewarm water for a minimum of 15 minutes; get immediate medical attention.

Ingestion Ingestion of battery chemicals can be harmful. Call The National Battery Ingestion Hotline (202-625-3333) 24 hours a day, for procedures treating ingestion of chemicals. Dilute with plenty of water, do not induce vomiting, and seek immediate medical attention.

SECTION 5 – FIRE-FIGHTING MEASURES

Extinguisher Media Use water, foam or dry powder

Special Fire Fighting Procedures Use a positive pressure self-contained breathing apparatus if batteries are involved in a fire. Full protective clothing is necessary. During water application, caution is advised as burning pieces of flammable particles may be ejected from the fire.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Damaged batteries that are *NOT* hot or burning should be placed in a sealed plastic bag or plastic-lined metal container. Chemical resistance gloves must be used to handle all battery components.
If cells rupture and a thermal event follows: using shovel or broom, cover battery or spilled substances with dry sand or vermiculite, place in approved container (after cooling if necessary) and dispose in accordance with local regulations.

SECTION 7 – HANDLING AND STORAGE

1. Use only approved chargers and charging procedures.
2. Do not disassemble a battery or bypass any safety device.
3. Batteries should be separated from other materials and stored in a non-combustible, well-ventilated, sprinkler-protected structure with sufficient clearance between walls and battery stacks.
4. Do not place batteries near heating equipment; do not expose to direct sunlight for extended periods.
5. Do not store batteries above 60 °C or below -32°C. Store batteries in a cool (below 21°C (70°F)), dry area that is subject to little temperature change. Elevated temperatures can result in reduced battery service life. Battery exposure to temperatures in excess of 130°C will result in the battery venting flammable liquid and gases.
6. Do not store batteries in a manner that allows terminals to short circuit.

SECTION 8 – EXPOSURE/PERSONAL PROTECTION

Respiratory Protection	None required under normal handling conditions; see also *Section 5 – Fire Fighting Measures*.
Gloves	Wear chemical resistant gloves if cell is ruptured, corroded, or leaking materials.
Safety Glasses	Always wear safety glasses with working with battery cells.

SECTION 9 – PHYSICAL/CHEMICAL PROPERTIES

Boiling Point	N/A	**Melting Point**	N/A
Vapor Pressure	N/A	**Vapor Density**	N/A
Specific Gravity	N/A	**Evaporation Rate**	N/A
Solubility in Water	N/A	**Appearance and Odor**	Geometric, solid object

SECTION 10 – STABILITY & REACTIVITY

Reactivity in Water	N/A	**Auto-Ignition Temperature**	N/A
Flash Point	N/A	**Flammable Limits in Air, by vol.**	N/A
Percent Volatile By Volume	N/A		
Stable	Avoid electrically shorting the cell and prolonged exposure to humid conditions. See also *Section 7 – Handling and Storage*.		
Incompatibility (materials to avoid)	N/A		

SECTION 11 – TOXICOLOGICAL INFORMATION

Threshold Limit Value	Exposure limit of $LiCoO_2$ = 0.1mg/m^3 (OSHA)
Signs and Symptoms of Exposure	None. (In fire or rupture situations, refer to sections 4, 5, & 8.)
Medical Conditions Generally Caused by Exposure	Chemicals may cause burns to skin, eyes, gastrointestinal tract and mucous membranes.
Routes of Entry	Skin, Eyes, Ingestion (swallowing), Inhalation (fumes)

SECTION 12 – ECOLOGICAL INFORMATION

Hazardous Decomposition Products	None under normal conditions. During Fire: combustible vapors (including CO), formation of Hydrogen fluoride (HF) and phosphorous oxides. Reaction with Water: may produce irritant Hydrogen fluoride (HF)
Hazardous Polymerization	Will not occur

When properly used and disposed, these batteries are not hazardous to the environment. Do not carelessly discard. Never discard Li-Ion batteries into a fire. Dispose of properly or recycle.

SECTION 13 - DISPOSAL

1. When completely discharged, Li-Ion batteries have no hazardous waste characteristics and can be landfilled.
2. This product does not contain any materials listed by the EPA as requiring specific waste disposal procedures.
3. When disposing of large quantities of Li-Ion batteries or cells, consult local/state/federal guidelines.
4. Fully discharge the battery and tape/cap terminals prior to disposal.

SECTION 14 – TRANSPORT

Product is shipped as:

Ground (DOT)	Air (IATA/ICAO)	Sea (IMDG)
Non-Hazardous by ground UN3480	Lithium ion Batteries – Not restricted UN3480	Lithium ion Batteries – Not restricted

Special Shipping Information: These batteries have been tested to Section 38.3 of the "UN Manual of Test and Criteria"

SECTION 15 – REGULATORY INFORMATION

IATA-DRG	Air transportation – Packing instruction 965 Section II, IATA Dangerous Goods 51st Edition
IMO-IMDG	Sea transportation
DOT	49 Code of Federal Regulations (USA)

SECTION 16 - OTHER

Document Control No:	SDS20004 – Ascent SDS for Lithium-Ion Batteries	**Revision:**	1	**Effective Date:**	07/23/13

Fisher Scientific

Part of Thermo Fisher Scientific

Material Safety Data Sheet

Creation Date 05-May-2014 **Revision Date** 23-Oct-2014 **Revision Number** 1

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name **Methanol**

Cat No. : **A412-1; A412-4; A412-4LC; A412-20; A412-200; A412200-001; A412-200LC; A412-500; A412CU-1300; A412P-4; A412SK-4; A412FB-19; A412FB-50; A412FB-115; A412FB-200; A412POP-19; A412POPB-200; A412RB50; A412RB-115; A412RB-200; A412RS-19; A412RS-28; A412RS-50; A412RS-115; A412RS-200; A412SS-115**

Synonyms Methyl alcohol

Recommended Use Laboratory chemicals

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. HAZARDS IDENTIFICATION

DANGER

Emergency Overview

Flammable liquid and vapor. Poison, may be fatal or cause blindness if swallowed. Cannot be made non-poisonous. Vapor harmful. Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed. Irritating to eyes and skin. WARNING! This product contains a chemical known in the State of California to cause birth defects or other reproductive harm.

Appearance Colorless **Physical State** Liquid **Odor** Alcohol-like

Target Organs Gastrointestinal tract (GI), Central nervous system (CNS), Eyes, Respiratory system, Skin, Optic nerve, Liver, Kidney, spleen, Blood

Potential Health Effects

Acute Effects
Principle Routes of Exposure

Eyes Irritating to eyes.
Skin Toxic in contact with skin. Irritating to skin.
Inhalation Toxic by inhalation. Vapor harmful. May cause irritation of respiratory tract.

Ingestion Poison, may be fatal or cause blindness if swallowed. Cannot be made non-poisonous. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

Chronic Effects
Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed: Experiments have shown reproductive toxicity effects on laboratory animals: May cause adverse liver effects: May cause adverse kidney effects: Component substance is listed on California Proposition 65 as a developmental hazard

Aggravated Medical Conditions Central nervous system disorders. Gastrointestinal tract. Preexisting eye disorders. Skin disorders. Kidney disorders. Liver disorders.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	Weight %
Methyl alcohol	67-56-1	100

4. FIRST AID MEASURES

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. Immediate medical attention is required.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.

Ingestion Do not induce vomiting. Call a physician or Poison Control Center immediately.

Notes to Physician Treat symptomatically

5. FIRE-FIGHTING MEASURES

Flash Point 12 °C / 53.6 °F

Method - No information available

Autoignition Temperature 455 °C / 851 °F

Explosion Limits
Upper 31.00 vol %
Lower 6.0 vol %

Suitable Extinguishing Media CO_2, dry chemical, dry sand, alcohol-resistant foam. Use water spray to cool unopened containers. Cool closed containers exposed to fire with water spray.

Unsuitable Extinguishing Media Water may be ineffective

Hazardous Combustion Products No information available.

Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Flammable. Risk of ignition. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Containers may explode when heated. Vapors may form explosive mixtures with air.

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
	1	3	0	N/A

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Remove all sources of ignition. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Use personal protective equipment. Ensure adequate ventilation. Take precautionary measures against static discharges.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Remove all sources of ignition. Soak up with inert absorbent material. Take precautionary measures against static discharges. Keep in suitable, closed containers for disposal. Use spark-proof tools and explosion-proof equipment.

7. HANDLING AND STORAGE

Handling Wear personal protective equipment. Ensure adequate ventilation. Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharges. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. Use only non-sparking tools. Use explosion-proof equipment.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from open flames, hot surfaces and sources of ignition. Flammables area.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures Use only under a chemical fume hood. Use explosion-proof electrical/ventilating/lighting/equipment. Ensure that eyewash stations and safety showers are close to the workstation location.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Methyl alcohol	TWA: 200 ppm STEL: 250 ppm Skin	(Vacated) TWA: 200 ppm (Vacated) TWA: 260 mg/m³ (Vacated) STEL: 250 ppm (Vacated) STEL: 325 mg/m³ Skin TWA: 200 ppm TWA: 260 mg/m³	IDLH: 6000 ppm TWA: 200 ppm TWA: 260 mg/m³ STEL: 250 ppm STEL: 325 mg/m³
Component	**Quebec**	**Mexico OEL (TWA)**	**Ontario TWAEV**
Methyl alcohol	TWA: 200 ppm TWA: 262 mg/m³ STEL: 250 ppm STEL: 328 mg/m³ Skin	TWA: 200 ppm TWA: 260 mg/m³ STEL: 250 ppm STEL: 310 mg/m³	TWA: 200 ppm STEL: 250 ppm Skin

Legend

NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

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 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.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Colorless
Odor	Alcohol-like
Odor Threshold	No information available
pH	No information available
Vapor Pressure	128 hPa @ 20 °C
Vapor Density	1.11
Viscosity	0.55 cP at 20 °C
Boiling Point/Range	64.7 °C / 148.5 °F @ 760 mmHg
Melting Point/Range	-98 °C / -144.4 °F
Decomposition Temperature	No information available
Flash Point	12 °C / 53.6 °F
Evaporation Rate	5.2 (ether = 1)
Specific Gravity	0.791
Solubility	Miscible with water
log Pow	No data available
Molecular Weight	32.04
Molecular Formula	C H4 O

10. STABILITY AND REACTIVITY

Stability Stable under normal conditions.

Conditions to Avoid Incompatible products. Heat, flames and sparks. Keep away from open flames, hot surfaces and sources of ignition.

Incompatible Materials Strong oxidizing agents, Strong acids, Acid anhydrides, Acid chlorides, Strong bases, Metals, Peroxides

Hazardous Decomposition Products Carbon monoxide (CO), Formaldehyde

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
Methyl alcohol	6200 mg/kg (Rat)	Not listed	22500 ppm (Rat) 8 h

Irritation Irritating to eyes and skin

Toxicologically Synergistic Products Carbon tetrachloride

Chronic Toxicity

Carcinogenicity There are no known carcinogenic chemicals in this product.

Sensitization No information available

Mutagenic Effects Mutagenic effects have occurred in experimental animals.

Reproductive Effects Experiments have shown reproductive toxicity effects on laboratory animals.

Developmental Effects Developmental effects have occurred in experimental animals. Component substance is listed on California Proposition 65 as a developmental hazard.

Teratogenicity Teratogenic effects have occurred in experimental animals.

Other Adverse Effects The toxicological properties have not been fully investigated.

Endocrine Disruptor Information No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

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Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea

Methyl alcohol	Not listed	Pimephales promelas: LC50 > 10000 mg/L 96h	EC50 = 39000 mg/L 25 min EC50 = 40000 mg/L 15 min EC50 = 43000 mg/L 5 min	EC50 > 10000 mg/L 24h

Persistence and Degradability Readily biodegradable.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its volatility.

Component	log Pow
Methyl alcohol	-0.74

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods Should not be released into the environment.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Methyl alcohol - 67-56-1	U154	-

14. TRANSPORT INFORMATION

DOT

UN-No	UN1230
Proper Shipping Name	METHANOL
Hazard Class	3
Packing Group	II

TDG

UN-No	UN1230
Proper Shipping Name	METHANOL
Hazard Class	3
Subsidiary Hazard Class	6.1
Packing Group	II

IATA

UN-No	UN1230
Proper Shipping Name	METHANOL
Hazard Class	3
Subsidiary Hazard Class	6.1
Packing Group	II

IMDG/IMO

UN-No	UN1230
Proper Shipping Name	METHANOL
Hazard Class	3
Subsidiary Hazard Class	6.1
Packing Group	II

15. REGULATORY INFORMATION

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Methyl alcohol	X	X	-	200-659-6	-		X	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 %
Methyl alcohol	67-56-1	100	1.0

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	Yes
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act
Not applicable

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Methyl alcohol 67-56-1 (100)	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
Methyl alcohol	5000 lb	-

California Proposition 65
This product contains the following Proposition 65 chemicals:

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Methyl alcohol	67-56-1	Developmental	-	Developmental

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Methyl alcohol	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.

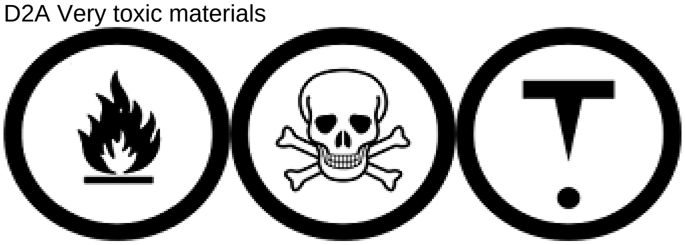
Other International Regulations

Mexico - Grade Serious risk, Grade 3

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
B2 Flammable liquid
D1A Very toxic materials
D2A Very toxic materials



16. OTHER INFORMATION

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 05-May-2014

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Revision Summary
Update to Format (M)SDS sections updated 4 8 11 12 13 15 16

Disclaimer

The information provided on 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 guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as 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 material or in any process, unless specified in the text.

End of MSDS

Safety Data Sheet (SDS)

OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

Printing date 04/24/2013 *Reviewed on 04/24/2013*

1 Product and Company Identification

· **Product identifier**

· **Trade name: 10N Sodium Hydroxide (NaOH)**
· **Article number:** NGT-10N NaOH
· **Relevant identified uses of the substance or mixture and uses advised against**
· **Product description** PC21 Laboratory chemicals

· **Details of the supplier of the safety data sheet**
· **Manufacturer/Supplier:**
NuGeneration Technologies, LLC (dba NuGenTec)
1155 Park Avenue, Emeryville, CA 94608
info@nugentec.com www.nugentec.com
888-996-8436 or 707-820-4080 for product information
· **Emergency telephone number:** Contact Infotrac: 1-800-535-5053

2 Hazard(s) identification

· **Classification of the substance or mixture**


GHS05 Corrosion

H314 Causes severe skin burns and eye damage.

· **Label elements**
· **GHS label elements**
The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**

GHS05

· **Signal word** Danger

· **Hazard-determining components of labeling:**
sodium hydroxide
· **Hazard statements**
H314 Causes severe skin burns and eye damage.
· **Precautionary statements**
Precautionary statements

P101	If medical advice is needed, have product container or label at hand.
P102	Keep out of reach of children.
P103	Read label before use.
P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P303+P361+P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.

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Safety Data Sheet (SDS)

OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

Printing date 04/24/2013 *Reviewed on 04/24/2013*

Trade name: 10N Sodium Hydroxide (NaOH)

(Contd. of page 1)

P405	*Store locked up.*
P501	*Dispose of contents/container in accordance with local/regional/national/ international regulations.*

· ***Classification system:*** *NFPA/HMIS Definitions: 0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme*

· ***NFPA ratings (scale 0 - 4)***

Health = 3
Fire = 0
Reactivity = 1

· ***HMIS-ratings (scale 0 - 4)***

HEALTH	3
FIRE	0
REACTIVITY	1

Health = 3
Fire = 0
Reactivity = 1

· ***Other hazards***
· ***Results of PBT and vPvB assessment***
· ***PBT:*** *Not applicable.*
· ***vPvB:*** *Not applicable.*

3 Composition/information on ingredients

7732-18-5	*water, distilled, conductivity or of similar purity*	*60%*

· ***Chemical characterization: Mixtures***
· ***Description:*** *Mixture of the substances listed below with nonhazardous additions.*

· ***Dangerous components:***

1310-73-2	*sodium hydroxide*	*H314*	*40%*

4 First-aid measures

· ***Description of first aid measures***
· ***General information:*** *Immediately remove any clothing soiled by the product.*
· ***After inhalation:*** *In case of unconsciousness place patient stably in side position for transportation.*
· ***After skin contact:*** *Immediately wash with water and soap and rinse thoroughly.*
· ***After eye contact:*** *Rinse opened eye for several minutes under running water. Then consult a doctor.*
· ***After swallowing:*** *Drink copious amounts of water and provide fresh air. Immediately call a doctor.*
· ***Information for doctor:***
· ***Most important symptoms and effects, both acute and delayed***
No further relevant information available.
· ***Indication of any immediate medical attention and special treatment needed***
No further relevant information available.

(Contd. on page 3)

(Contd. of page 2)

5 Fire-fighting measures

· **Extinguishing media**
· **Suitable extinguishing agents:**
CO2, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
· **Special hazards arising from the substance or mixture** No further relevant information available.
· **Advice for firefighters**
· **Protective equipment:** No special measures required.

6 Accidental release measures

· **Personal precautions, protective equipment and emergency procedures**
Wear protective equipment. Keep unprotected persons away.
· **Environmental precautions:**
Dilute with plenty of water.
Do not allow to enter sewers/ surface or ground water.
· **Methods and material for containment and cleaning up:**
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
Use neutralizing agent.
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
· **Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7 Handling and storage

· **Handling:**
· **Precautions for safe handling**
Ensure good ventilation/exhaustion at the workplace.
Prevent formation of aerosols.
· **Information about protection against explosions and fires:** No special measures required.

· **Conditions for safe storage, including any incompatibilities**
· **Storage:**
· **Requirements to be met by storerooms and receptacles:** No special requirements.
· **Information about storage in one common storage facility:** Not required.
· **Further information about storage conditions:** Keep receptacle tightly sealed.
· **Specific end use(s)** No further relevant information available.

8 Exposure controls/personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

(Contd. on page 4)

Safety Data Sheet (SDS)

OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

Printing date 04/24/2013 *Reviewed on 04/24/2013*

Trade name: 10N Sodium Hydroxide (NaOH)

(Contd. of page 3)

· **Control parameters**

· **Components with limit values that require monitoring at the workplace:**	
1310-73-2 sodium hydroxide	
PEL	2 mg/m³
REL	Short-term value: C 2 mg/m³
TLV	Short-term value: C 2 mg/m³

· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Avoid contact with the eyes and skin.
· **Breathing equipment:**
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use respiratory protective device that is independent of circulating air.
· **Protection of hands:**

Protective gloves

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation
· **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.
· **Penetration time of glove material**
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.
· **Eye protection:**

Tightly sealed goggles

USA

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Safety Data Sheet (SDS)

OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

Printing date 04/24/2013 Reviewed on 04/24/2013

Trade name: 10N Sodium Hydroxide (NaOH)

(Contd. of page 4)

9 Physical and chemical properties

· Information on basic physical and chemical properties	
· General Information	
· Appearance:	
Form:	Liquid
Color:	Colorless
· Odor:	Odorless
· Odour threshold:	Not determined.
· pH-value at 20 °C (68 °F):	>13.7
· Change in condition	
Melting point/Melting range:	~32 C
Boiling point/Boiling range:	> 100 °C (> 212 °F)
· Flash point:	Not applicable.
· Flammability (solid, gaseous):	Not applicable.
· Ignition temperature:	
Decomposition temperature:	Not determined.
· Auto igniting:	Product is not selfigniting.
· Danger of explosion:	Product does not present an explosion hazard.
· Explosion limits:	
Lower:	Not determined.
Upper:	Not determined.
· Vapor pressure at 20 °C (68 °F):	23 hPa (17 mm Hg)
· Density at 20 °C (68 °F):	1.452 g/cm³ (12.117 lbs/gal)
· Relative density	Not determined.
· Vapour density	Not determined.
· Evaporation rate	Not determined.
· Solubility in / Miscibility with	
Water:	Fully miscible.
· Partition coefficient (n-octanol/water):	Not determined.
· Viscosity:	
Dynamic at 20 °C (68 °F):	1 mPas
Kinematic:	Not determined.
· Solvent content:	
Organic solvents:	0.0 %
Water:	60.0 %
Solids content:	40.0 %

(Contd. on page 6)

Safety Data Sheet (SDS)
OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

(Contd. of page 5)

· **Other information** No further relevant information available.

10 Stability and reactivity

· **Reactivity**
· **Chemical stability**
· **Thermal decomposition / conditions to be avoided:**
No decomposition if used according to specifications.
· **Possibility of hazardous reactions** No dangerous reactions known.
· **Conditions to avoid** No further relevant information available.
· **Incompatible materials:** No further relevant information available.
· **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

· **Information on toxicological effects**
· **Acute toxicity:**

· **LD/LC50 values that are relevant for classification:**		
1310-73-2 sodium hydroxide		
Oral	LD50	2000 mg/kg (rat)

· **Primary irritant effect:**
· **on the skin:** Strong caustic effect on skin and mucous membranes.
· **on the eye:** Strong caustic effect.
· **Sensitization:** No sensitizing effects known.
· **Additional toxicological information:**
The product shows the following dangers according to internally approved calculation methods for preparations:
Corrosive
Swallowing will lead to a strong caustic effect on mouth and throat and to the danger of perforation of esophagus and stomach.

· **Carcinogenic categories**

· **IARC (International Agency for Research on Cancer)**
None of the ingredients is listed.

· **NTP (National Toxicology Program)**
None of the ingredients is listed.

12 Ecological information

· **Toxicity**
· **Aquatic toxicity:** No further relevant information available.
· **Persistence and degradability** No further relevant information available.
· **Behavior in environmental systems:**
· **Bioaccumulative potential** No further relevant information available.

(Contd. on page 7)

(Contd. of page 6)

· ***Mobility in soil*** *No further relevant information available.*
· ***Additional ecological information:***
· ***General notes:***
Water hazard class 1 (Self-assessment): slightly hazardous for water
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
Must not reach bodies of water or drainage ditch undiluted or unneutralized.
Rinse off of bigger amounts into drains or the aquatic environment may lead to increased pH-values. A high pH-value harms aquatic organisms. In the dilution of the use-level the pH-value is considerably reduced, so that after the use of the product the aqueous waste, emptied into drains, is only low water-dangerous.
· ***Results of PBT and vPvB assessment***
· ***PBT:*** *Not applicable.*
· ***vPvB:*** *Not applicable.*
· ***Other adverse effects*** *No further relevant information available.*

13 Disposal considerations

· ***Waste treatment methods***
· ***Recommendation:***
Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

· ***Uncleaned packagings:***
· ***Recommendation:*** *Disposal must be made according to official regulations.*
· ***Recommended cleansing agent:*** *Water, if necessary with cleansing agents.*

14 Transport information

· ***UN-Number***	
· ***DOT, ADR, IMDG, IATA***	*UN1824*
· ***UN proper shipping name***	*None*
· ***DOT, IMDG, IATA***	*SODIUM HYDROXIDE SOLUTION*
· ***ADR***	*1824 SODIUM HYDROXIDE SOLUTION*
· ***Transport hazard class(es)***	

· ***DOT***

· ***Class*** *8 Corrosive substances.*

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Safety Data Sheet (SDS)

OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

Printing date 04/24/2013 Reviewed on 04/24/2013

Trade name: 10N Sodium Hydroxide (NaOH)

(Contd. of page 7)

· **Label** 8

· **ADR, IMDG, IATA**

· **Class**	8 Corrosive substances
· **Label**	8
· **Packing group**	
· **DOT, ADR, IMDG, IATA**	II
· **Environmental hazards:**	
· **Marine pollutant:**	No
· **Special precautions for user**	Warning: Corrosive substances
· **Danger code (Kemler):**	80
· **EMS Number:**	F-A,S-B
· **Segregation groups**	Alkalis
· **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.
· **UN "Model Regulation":**	UN1824, SODIUM HYDROXIDE SOLUTION, 8, II

15 Regulatory information

· **Safety, health and environmental regulations/legislation specific for the substance or mixture**

· **Sara**

· **Section 355 (extremely hazardous substances):**

None of the ingredients is listed.

· **Section 313 (Specific toxic chemical listings):**

None of the ingredients is listed.

· **TSCA (Toxic Substances Control Act):**

All ingredients are listed.

· **Proposition 65**

· **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.

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Safety Data Sheet (SDS)

OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

Printing date 04/24/2013 *Reviewed on 04/24/2013*

Trade name: 10N Sodium Hydroxide (NaOH)

(Contd. of page 8)

· ***Carcinogenic categories***

· ***EPA (Environmental Protection Agency)***

None of the ingredients is listed.

· ***TLV (Threshold Limit Value established by ACGIH)***

None of the ingredients is listed.

· ***NIOSH-Ca (National Institute for Occupational Safety and Health)***

None of the ingredients is listed.

· ***OSHA-Ca (Occupational Safety & Health Administration)***

None of the ingredients is listed.

· ***GHS label elements***

The product is classified and labeled according to the Globally Harmonized System (GHS).

· ***Hazard pictograms***

GHS05

· ***Signal word*** *Danger*

· ***Hazard-determining components of labeling:***

sodium hydroxide

· ***Hazard statements***

H314 Causes severe skin burns and eye damage.

· ***Precautionary statements***

P101	*If medical advice is needed, have product container or label at hand.*
P102	*Keep out of reach of children.*
P103	*Read label before use.*
P260	*Do not breathe dust/fume/gas/mist/vapours/spray.*
P303+P361+P353	*IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.*
P305+P351+P338	*IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.*
P310	*Immediately call a POISON CENTER or doctor/physician.*
P405	*Store locked up.*
P501	*Dispose of contents/container in accordance with local/regional/national/ international regulations.*

· ***Chemical safety assessment:*** *A Chemical Safety Assessment has not been carried out.*

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· ***Abbreviations and acronyms:***

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)

(Contd. on page 10)

Safety Data Sheet (SDS)

OSHA Hazard Communication Standard 29 CFR 1910.1200. Prepared to GHS Rev03.

Printing date 04/24/2013 Reviewed on 04/24/2013

Trade name: 10N Sodium Hydroxide (NaOH)

(Contd. of page 9)

IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent

GHS Safety Data Sheet

Revision Issued: 12/03/2012   Supercedes: 1/28/2011   First Issued: 12/01/1985

Section 1 - Identification of the Product and Manufacturer

Product Identifier: Nitric Acid
Synonyms/Common Names: Aqua Fortis; Hydrogen Nitrate; HNO_3
Product Use & Restrictions: Refer to label or call

CAS Number: 7697-37-2   HBCC MSDS No. CN03300

Hill Brothers Chemical Company
1675 No. Main Street, Orange, California 92867
Telephone No: 714-998-8800 | Outside CA: 800-821-7234
Emergency: Chemtrec: 800-424-9300

Section 2 - Hazard Identification

Classifications of this Product
Acute Toxicity: Category 1
Skin Corrosion: Category 1
Eye: Category 1
Labels | Signal Word: Danger

Hazard Statements
H272: May Intensify fire; oxidizer category 2
H290: Corrosive to Metals
H300: Acute Toxicity, Oral, Category 1
H304: Aspiration Hazard, Category 1
H312: Acute Toxicity, Dermal, Category 4
H314: Skin/Corrosion/Irritation, Category 1
H332: Acute Toxicity, Inhalation, Category 4

Precautionary Statements
P210: Keep away from heat
P220: Keep/store away from combustibles
P221: Take precautions to avoid mixing with combustibles
P280: Wear protective gloves/eye/face protection.
P370 & P378: In case of fire, Use water in flooding quantities as fog on adjacent fires
P501: Dispose of contents/containers in accordance with local/regional national and international regulations

Section 3 – Composition/Information on Ingredients

Chemical Name: Nitric Acid
Synonyms/Common Names: Aqua Fortis; Hydrogen Nitrate; HNO_3
CAS#7697-37-2, 30-71%

Section 4 - First Aid Measures

Ingestion: DO NOT INDUCE VOMITING. Drink large amounts of water to dilute acid. GET PROMPT MEDICAL ATTENTION.
Inhalation: If inhaled, will cause difficult breathing or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. GET PROMPT MEDICAL ATTENTION.
Skin: Promptly flush with plenty of soap and water for at least 15 minutes. Remove contaminated clothing. Wash clothing before reuse. GET PROMPT MEDICAL ATTENTION.
Eyes: Wash eyes immediately with large amounts of water, for at least 30 minutes, lifting the lower and upper lids. Contact lenses should not be worn when working with this material. Do not allow victim to rub or keep eyes closed. GET PROMPT MEDICAL ATTENTION.
Medical Conditions Generally Aggravated by Exposure: Skin disorders and respiratory (asthma-like) disorders.
Effects of Overexposure: Possible acute pulmonary edema, chronic obstructive pulmonary disease, or chronic bronchitis from inhalation. The vapor and mist may erode the exposed teeth. On the skin or through ingestion, the liquid may cause pain and severe and penetrating burns. In contact with the eyes, the liquid produces severe burns which may lead to visual impairment or blindness.
Summary of Acute Health Hazards
Ingestion: Can cause irritation and severe corrosive burns to mouth, throat, and stomach, and may be fatal if swallowed.
Inhalation: Gases or acid mist can cause severe irritation or corrosive burns to the upper respiratory system, including nose, mouth, and throat. Lung irritation, nitrogen oxide poisoning, and pulmonary edema can also occur. May cause severe breathing difficulties which may be delayed in onset.
Skin: Can cause severe corrosive burns or irritation. May stain the skin bright yellow.
Eyes: Can cause irritation, corneal burns, conjunctivitis, and may cause blindness. Contact lenses should not be worn when working with this material.
Summary of Chronic Health Hazards: Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Note to Physicians: Nitric Acid vapors contain nitrogen oxides. Acute overexposure by inhalation can result in delayed pulmonary edema. Observe affected patients for delayed effects up to 48 hours after exposure. Screen patients with chest x-ray, arterial blood gas, methemoglobinemia level, and pulmonary function tests. Bronchiolitis obliterans may develop weeks after exposure.

Section 5 - Fire Fighting Measures

Extinguishing Media: Use water in flooding quantities as fog on adjacent fires. Water spray may be useful in minimizing or dispersing vapors and cooling equipment exposed to heat and flame.
Unusual Fire and Explosion Hazards: Will accelerate the burning of combustible materials and can cause ignition by contact with combustible materials. Contact with common materials may generate hydrogen gas, which can form flammable mixtures with air.

Special Protective Equipment for Firefighters: In danger area, wear bunker gear and self-contained breathing apparatus for fires beyond the incipient range (29CFR

1910.156)
NFPA Rating: Health - 3; Flammability - 0; Instability - 0; Other - (Oxidizer)
0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

Section 6 - Accidental Release Measures

Personal Precautions: Adequate ventilation is required to eliminate any nitrogen oxides released and, if soda ash or limestone is used, CO_2.
For personal protective equipment, please see Section VIII.
Protective Equipment: Impervious clothing should be used to prevent any possibility of physical contact with liquid nitric acid. Clothing may include a rubber acid suit, hood, boots and gloves, and an air mask and chemical goggles.
Eye Protection: Splash-proof safety goggles should be used if the possibility of liquid nitric acid contacting the eyes exists. Do not wear contact lenses. Eight-inch minimum face shields should be used.
Emergency Procedures: Stay upwind and away from spill. Spills may need to be reported to the National Response Center (800/424-8802)
Methods of Containment and Clean-Up: Build dikes using inert material (i.e. dry sand or earth) to contain flow as necessary. Dilute spills or leaks with plenty of water. Neutralize residue with sodium bicarbonate, then place into a chemical waste container. A vapor suppressing foam may be used to reduce vapors.

Section 7 - Handling and Storage

Safe Handling: Avoid inhalation of vapors or mists and all bodily contact. Keep away from incompatible substances. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Do not get in eyes, on skin, or on clothing. Remove contaminated clothing and wash before reuse.
Storage: Store in a cool, well-ventilated, properly drained area out of the sun. Avoid storage on wood floors or near wooden walls, etc. Diking of storage tanks is recommended. Protect from physical damage. Keep containers tightly closed.
Work/Hygienic Practices: Facilities for quick drenching of the body, in addition to an eye-wash fountain, should be provided within the immediate work area for emergency use. Employees who handle nitric acid should wash their hands before eating, smoking, or using toilet facilities. Do NOT place food, coffee or other drinks in the area where dusting or splashing of solutions is possible.
Ventilation: Ventilation sufficient to reduce mists and nitrogen oxide concentrations below permissible TLV levels. Mechanical exhaust systems or closed ventilated systems may be required. Always keep the nitric acid vapor concentration levels below 2 ppm (5 mg/m^3).

Section 8 - Exposure Controls/Personal Protection

			Exposure Limits (TWAs) in Air		
Chemical Name	CAS Number	%	ACGIH TLV	OSHA PEL	STEL
Nitric Acid	7697-37-2	30-71	2 ppm (2mg/l)	2 ppm (2mg/l)	4 ppm (4mg/l)

Engineering Controls: See Section VI: Ventilation
Respiratory Protection: Only respirators approved by MSHA or NIOSH are permissible. Only non-oxidizable sorbents are allowed. A chemical cartridge

respirator is not recommended due to the potential for exposure limits being exceeded prior to odor breakthrough.

Respirator Selection

100 ppm or less (250 mg/m³ or less): GMOVS/SAF/SCBAF/SA:PD,PP,CF
100 ppm or greater (250 mg/m³ or greater), or entry and escape from unknown concentrations: GMS/SCBA

Section 9 - Physical and Chemical Properties

Appearance: Watery liquid, colorless, yellow, or red fuming liquid	
Odor: Suffocating, acrid odor	**Odor Threshold:** N/A
pH: 1-2	**Melting Point/Range:** See table below
Initial Boiling Point/Range: 244-251°F @ 68%	**Flash Point:** Not Flammable
Evaporation Rate (N-Butyl Acetate=1): < 1	**Flammability:** N/A
Upper/Lower Explosive Limits: N/A	**Vapor pressure:** See table below
Vapor Density: See table below	**Relative Density:** N/A
Solubility in Water: 100%	**Partition Coefficient:** N/A
Autoignition Temperature: N/A	**Decomposition Temperature:** N/A
Viscosity: N/A	

% Acid in Solution:	30	40	56-71
Melting/Freezing Range:	-42°C@68%	-44°F	31°F
Vapor Pressure(mmHg)	5-10	<3@70°F	2.9@68°F
Vapor Density(Air=1)	> 1	< 3	1.5-1.7
Specific Gravity(Water=1)	1.18-1.19	1.2-1.41	1.41
Weight/Gallon (Lbs.)	9.8-9.9	10-11	11.7

Section 10 - Stability and Reactivity

Reactivity: Reacts with water to produce heat, and toxic, corrosive fumes of nitrogen oxides.
Chemical Stability: Stable
Possibility of Hazardous Reactions or Polymerization: N/A
Conditions to Avoid: Avoid exposure to direct sunlight.
Incompatible Materials: Most metals, metallic powders, alcohol, charcoal, turpentine, hydrogen sulfide, wood excelsior, paper, cotton and similar organic materials. Alkalies, carbon, carbonates, cyanides, diborane organic chemicals, fluorine, phosphine, sulfides, thiocyanates. Nitric Acid is corrosive or incompatible with many common materials including mild steel, PVC, Viton®, and rubber. Viton® is a registered trademark of DuPont Dow Elastomers.
Hazardous Decomposition Products: When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.

Section 11 - Toxicological Information

Routes of Exposure: Nitric acid vapor or mist is an irritant of the eyes, mucous membranes, and skin.
Symptoms related to physical, chemical, and toxicological characteristics: When nitric acid is exposed to air or comes in contact with organic matter, it decomposes to yield a mixture of toxic oxides of nitrogen, including nitric oxide and nitrogen dioxide. Exposure to high concentrations of nitric acid vapor or mist causes pneumonitis and pulmonary edema which may be fatal.
Acute and Chronic effects: Onset of symptoms may be delayed for 4 to 30 hours. In contact with the eyes, the liquid produces severe burns which may result in permanent damage and visual impairment. On the skin, the liquid or concentrated vapor produces immediate, severe and penetrating burns; concentrated solutions cause deep ulcers and stain the skin a bright yellow or yellowish brown color. The vapor and mist may erode the exposed teeth. Ingestion of the liquid will cause immediate pain and burns of the mouth, esophagus, and gastrointestinal tract.
LD50/LC50:
CAS# 7697-37-2:
- Inhalation, rat: LC50 = 260 mg/m3/30M;
- Inhalation, rat: LC50 = 130 mg/m3/4H;
- Inhalation, rat: LC50 = 67 ppm(NO_2)/4H

Carcinogenicity Lists:
National Toxicology Program (NTP): No
International Agency for Research on Cancer (IARC) Monograph: No
Occupational Safety & Health Administration (OSHA) Regulated: Yes

Section 12 - Ecological Information

Ecotoxicity: Nitric acid has moderate volatility. Harmful to aquatic organisms. Large discharges may contribute to the acidification of water and be fatal to fish and other aquatic life, due low pH and decomposition of nitric acid into nitrates. If discharged into an effluent treatment system, nitric acid can contribute to acidification of the system and injure sewage treatment organisms. Can cause damage to vegetation due to corrosive action.
Persistence and degradability: Expected to be readily biodegradable.
Bioaccumulative Potential: Nitric acid has low potential for bioaccumulation.
Mobility in Soil: Nitric acid is soluble in water and has high mobility in soil. During transport through the soil, nitric acid will dissolve some of the soil material; in particular, the carbonate based materials. The acid will be neutralized to some degree with adsorption of the proton also occurring on clay materials. However, significant amounts of acid are expected to remain for transport down towards the ground water table. Upon reaching the ground water table, the acid will continue to move, now in the direction of the ground water flow. Lime addition may be required to rectify low pH resulting from nitric acid spillages.
Environmental Precautions: Keep all ignition sources and hot metal surfaces away from spill/release. Keep material out of water sources and sewers.

Section 13 - Disposal Considerations

Nitric acid may be disposed of by neutralizing with water and alkaline material (such as soda ash, lime, etc.) and disposing in a secured sanitary landfill. Disposal of nitric acid may be subject to federal, state, and local regulations. Users of this product should review their operations in terms of applicable federal, state, and local laws and regulations, then consult with the appropriate regulatory agencies before discharging or disposing of waste material.

Section 14 - Transport Information

UN #: UN2031
UN/DOT Proper Shipping Name: NITRIC ACID
Transport Hazard Class: 8 (with less than 65% Nitric Acid) 8, 5.1(with at least 65% Nitric Acid)
Packing Group: II (not more than 70 percent nitric acid); I (with more than 70% Nitric Acid)
Marine Pollutant: No
Transport in Bulk: N/A
Special Precautions: N/A
DOT Reportable Quantity (RQ) is 1000 pounds

Section 15 - Regulatory Information

This product contains the following toxic chemical(s) subject to the reporting requirements of SARA TITLE III of the Emergency Planning and Community Right-To Know Act (EPCRA) of 1986 and of 40 CFR 372:
Section 302 Extremely Hazardous Substance (EHS): CAS # 7697-37-2
1000 Lbs. (454 Kilograms) (85 Gals.) Threshold Planning Quantity (TPQ)
Section 304 Extremely Hazardous Substance (EHS): CAS # 7697-37-2
1000 Lbs. (454 Kilograms) (85 Gals.) Reportable Quantity (RQ)
CERCLA Hazardous Substance: CAS #7697-37-2
1000 Lbs. (454 Kilograms) (85 Gals.) Reportable Quantity (RQ)
Section 313 Supplier Notification: CAS # 7697-37-2, % by Weight: 30-71%

Section 16 - Other Information

Sections changed since last revision: XIV, all other changes made as per SDS Conversion

IMPORTANT! Read this MSDS before use or disposal of this product. Pass along the information to employees and any other persons who could be exposed to the product to be sure that they are aware of the information before use or other exposure. This MSDS has been prepared according to the OSHA Hazard Communication Standard [29 CFR 1910.1200]. The MSDS information is based on sources believed to be reliable. However, since data, safety standards, and government regulations are subject to change and the conditions of handling and use, or misuse are beyond our control, **Hill Brothers Chemical Company** makes no warranty, either expressed or implied, with respect to the completeness or continuing accuracy of the information contained herein and disclaims all liability for reliance thereon. Also, additional information may be necessary or helpful for specific conditions and circumstances of use. It is the user's responsibility to determine the suitability of this product and to evaluate risks prior to use, and then to exercise appropriate precautions for protection of employees and others.

Material Safety Data Sheet

according to ANSI Z400.1- 2004 and 29 CFR 1910.1200

OFF!® DEEP WOODS® PUMP SPRAY INSECT REPELLENT FOR SPORTSMEN (REG NO 28340 P.C.P. ACT)

Version 2.0	Print Date 06/08/2012
Revision Date 03/12/2012	MSDS Number 350000012371 SITE_FORM Number 30000000000000009857.001

1. PRODUCT AND COMPANY IDENTIFICATION

Product information

Trade name	:	OFF!® DEEP WOODS® PUMP SPRAY INSECT REPELLENT FOR SPORTSMEN (REG NO 28340 P.C.P. ACT)
Use of the Substance/Mixture	:	Insect Repellent
Company	:	S.C. Johnson and Son, Limited 1 Webster Street Brantford ON N3T 5R1
Emergency telephone number	:	24 Hour Transport & Medical Emergency Phone (866) 231-5406 24 Hour International Emergency Phone (952) 852-4647 24 Hour Canadian Transport Emergency Phone (CANUTEC) (613) 996-6666

2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance / Odor	:	yellow / liquid / pleasant
Immediate Concerns	:	Caution FLAMMABLE: CAUSES EYE IRRITATION. Keep away from heat, sparks and flame. Avoid contact with eyes and lips.

Potential Health Effects

Exposure routes	:	Eye, Skin, Inhalation, Ingestion.
Eyes	:	Causes: Moderate eye irritation
Skin	:	May cause skin reactions in rare cases. Prolonged or repeated contact may dry skin and cause irritation.
Inhalation	:	May cause nose, throat, and lung irritation. Inhalation may cause central nervous system effects.
Ingestion	:	May cause irritation to mouth, throat and stomach. May cause abdominal discomfort. Causes headache, drowsiness or other effects to the central

nervous system.

Aggravated Medical Condition : Persons with pre-existing skin disorders may be more susceptible to irritating effects.
Individuals with chronic respiratory disorders such as asthma, chronic bronchitis, emphysema, etc. may be more susceptible to irritating effects
Do not apply to cuts or irritated skin.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous chemicals present at or above reportable levels as defined by OSHA 29 CFR 1910.1200 or the Canadian Controlled Products Regulations are listed in this table:

Chemical Name	CAS-No.	Weight percent
Ethyl alcohol	64-17-5	30.00 - 60.00
N,N-Diethyl-m-toluamide	134-62-3	10.00 - 30.00

For additional information on product ingredients, see www.whatsinsidescjohnson.com.

4. FIRST AID MEASURES

Eye contact : Remove contact lenses. Flush immediately with plenty of water for at least 15 to 20 minutes. Get medical attention if irritation develops and persists.

Skin contact : Wash off immediately with plenty of water. Get medical attention if irritation develops and persists. If you suspect a reaction to this product, discontinue use and remove contaminated clothing.

Inhalation : Remove to fresh air.

Ingestion : If swallowed, DO NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

5. FIREFIGHTING MEASURES

Suitable extinguishing media : Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Specific hazards during firefighting	:	Flammable liquid. Vapors are heavier than air and may travel to a source of ignition and flash back. Liquid run-off to sewers may create fire/explosion hazard. Burns with colourless flame. Container may melt and leak in heat of fire. Do not allow run-off from fire fighting to enter drains or water courses.
Further information	:	Fight fire from maximum distance or protected area. Cool and use caution when approaching or handling fire-exposed containers. For large quantities of flammable liquids, consider containment to prevent the spread of fire. Wear full protective clothing and positive pressure self-contained breathing apparatus. In case of fire and/or explosion do not breathe fumes.
Flash point	:	25 °C 77 °F Method: Tag Closed Cup (TCC)
Lower explosion limit	:	Note: no data available
Upper explosion limit	:	Note: no data available

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Remove all sources of ignition. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas. Wear personal protective equipment.
Environmental precautions	:	Do not flush into surface water or sanitary sewer system. Use appropriate containment to avoid environmental contamination. Outside of normal use, avoid release to the environment.
Methods for cleaning up	:	Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13). Use only non-sparking equipment. Dike large spills. Clean residue from spill site.

7. HANDLING AND STORAGE

Handling

Advice on safe handling : Avoid contact with eyes and lips.
Avoid breathing vapors, mist or gas.
For personal protection see section 8.
Use only as directed.
KEEP OUT OF REACH OF CHILDREN AND PETS.

Advice on protection against fire and explosion : Keep away from heat and sources of ignition.
Take measures to prevent the build up of electrostatic charge.

Storage

Requirements for storage areas and containers : Keep away from food, drink and animal feedingstuffs.
Keep container closed when not in use.
Keep in a dry, cool and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits

Components	CAS-No.	mg/m3	ppm	Non-standard units	Basis
Ethyl alcohol	64-17-5	-	1,000 ppm	-	ACGIH STEL

Personal protective equipment

Respiratory protection Use only with adequate ventilation.
Do not spray in enclosed areas.

Hand protection : No special requirements.

Eye protection Safety glasses with side-shields

Skin and body protection : No special requirements.

Hygiene measures : Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling.

9. PHYSICAL AND CHEMICAL PROPERTIES

Form : liquid

Color	:	yellow
Odor	:	pleasant
pH	:	7.5
Boiling point	:	75 °C
Boiling point	:	167 °F
Freezing point	:	no data available
Flash point	:	25 °C 77 °F Method: Tag Closed Cup (TCC)
Evaporation rate	:	no data available
Autoignition temperature	:	no data available
Lower explosion limit	:	no data available
Upper explosion limit	:	no data available
Vapour pressure	:	no data available
Density	:	0.930 g/cm3 at 21 °C
Water solubility	:	dispersible
Partition coefficient: n-octanol/water	:	no data available

10. STABILITY AND REACTIVITY

Conditions to avoid	:	Heat, flames and sparks.
Materials to avoid	:	Do not mix with oxidizing agents. Avoid contact with: Oxidizing agents Natural Rubber Plastic Aluminium
Hazardous decomposition products	:	Thermal decomposition can lead to release of irritating gases and vapours.

Hazardous reactions	:	Stable under recommended storage conditions.

11. TOXICOLOGICAL INFORMATION

Acute oral toxicity	:	LD50 estimated > 2,000 mg/kg
Acute inhalation toxicity	:	LC50 estimated > 2.07 mg/l
Acute dermal toxicity	:	LD50 estimated > 5,000 mg/kg
Chronic effects		
Carcinogenicity	:	no data available
Mutagenicity	:	no data available
Reproductive effects	:	no data available
Teratogenicity	:	no data available
Sensitisation	:	Substances is not a sensitizer.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects	:	no data available

13. DISPOSAL CONSIDERATIONS

PESTICIDAL WASTE:
Observe all applicable Federal, Provincial and State regulations and Local/Municipal ordinances regarding disposal.
Consumer may discard empty container in trash, or recycle where facilities exist.

RCRA waste class : D001 (Ignitable Waste)

14. TRANSPORT INFORMATION

Land transport

- **U.S. DOT and Canadian TDG Surface Transportation:**

Proper shipping name	UN 1993 Flammable liquids, n.o.s.
Class:	3
UN number	1993
Packaging group:	II
Note:	Limited quantities derogation may be applicable to this product, please check transport documents.

Sea transport

- *IMDG:*

Proper shipping name	UN 1993 Flammable liquids, n.o.s.
Class:	3
UN number:	1993
Packaging group:	II
EmS:	F-E, S-E
Note:	Limited quantities derogation may be applicable to this product, please check transport documents.

Air transport

- *ICAO/IATA:*

Proper shipping name	UN 1993 Flammable liquids, n.o.s.
Class:	3
UN/ID No.:	UN 1993
Packaging group:	II
Note:	SC Johnson typically does not ship products via air. Refer to IATA/ICAO Dangerous Goods Regulations for detailed instructions when shipping this item by air.

15. REGULATORY INFORMATION

Notification status	:	All ingredients of this product comply with the New Substances Notification requirements under the Canadian Environmental Protection Act (CEPA).
California Prop. 65	:	This product is not subject to the reporting requirements under California's Proposition 65.
Canada Regulations	:	This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

16. OTHER INFORMATION

HMIS Ratings

Health	2
Flammability	3
Reactivity	0

NFPA Ratings

Health	2
Fire	3
Reactivity	0
Special	-

Further information
This document has been prepared using data from sources considered to be technically reliable. It does not constitute a warranty, expressed or implied, as to the accuracy of the information contained herein. Actual conditions of use are beyond the seller's control. User is responsible to evaluate all available information when using product for any particular use and to comply with all Federal, State, Provincial and Local laws and regulations.

Prepared by:	SC Johnson Global Safety Assessment & Regulatory Affairs (GSARA)

Material Safety Data Sheet

according to ANSI Z400.1- 2004 and 29 CFR 1910.1226

OFF!® SKINTASTIC® INSECT REPELLENT - CLEAN FEEL

Version 2.0

Print Date 01/11/2011

Revision Date 12/01/2010

MSDS Number 350000003999
SITE_FORM Number
300000000000000003330.002
GEN_SOF Number 41042

1. PRODUCT AND COMPANY IDENTIFICATION

Product information

Trade name	:	OFF!® SKINTASTIC® INSECT REPELLENT - CLEAN FEEL
Use of the Substance/Mixture	:	Insect Repellent
Company	:	S.C. Johnson & Son, Inc. 1525 Howe Street Racine WI 53403-2236
Emergency telephone number	:	24 Hour Transport & Medical Emergency Phone (866) 231-5406 24 Hour International Emergency Phone (952) 852-4647

2. HAZARDS IDENTIFICATION

Emergency Overview

Appearance / Odor	:	clear / liquid / Alcohol Odor
Immediate Concerns	:	Warning FLAMMABLE: CAUSES EYE IRRITATION. Keep away from heat, sparks and flame. Avoid contact with eyes and lips.

Potential Health Effects

Exposure routes	:	Eye, Skin, Inhalation, Ingestion.
Eyes	:	Causes: Moderate eye irritation
Skin	:	May cause skin reactions in rare cases.
Inhalation	:	No adverse effects expected when used as directed.
Ingestion	:	Causes headache, drowsiness or other effects to the central nervous system.
Aggravated Medical Condition	:	Do not apply to cuts or irritated skin.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous chemicals present at or above reportable levels as defined by OSHA 29 CFR 1910.1200 or the Canadian Controlled Products Regulations are listed in this table:

Chemical Name	CAS-No.	Weight percent
Ethyl alcohol	64-17-5	30.00 - 60.00
Icaridine	119515-38-7	5.00 - 10.00

For additional information on product ingredients, see www.whatsinsidescjohnson.com.

4. FIRST AID MEASURES

Eye contact : Remove contact lenses. Flush immediately with plenty of water for at least 15 to 20 minutes. Get medical attention if irritation develops and persists.

Skin contact : Wash off immediately with plenty of water. Get medical attention if irritation develops and persists. If you suspect a reaction to this product, discontinue use and remove contaminated clothing.

Inhalation : No special requirements

Ingestion : If swallowed, DO NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Specific hazards during fire fighting : Flammable liquid. Vapors are heavier than air and may travel to a source of ignition and flash back. Liquid run-off to sewers may create fire/explosion hazard. Container may melt and leak in heat of fire. Do not allow run-off from fire fighting to enter drains or water courses. Burns with colourless flame.

Further information : Fight fire from maximum distance or protected area. Cool and use caution when approaching or handling fire-exposed containers. For large quantities of flammable liquids, consider containment to prevent the spread of fire. Wear full protective

		clothing and positive pressure self-contained breathing apparatus. In case of fire and/or explosion do not breathe fumes.
Flash point	:	30 °C 86 °F Method: Tag Closed Cup (TCC)
Lower explosion limit	:	Note: no data available
Upper explosion limit	:	Note: no data available

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Remove all sources of ignition. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas. Wear personal protective equipment.
Environmental precautions	:	Do not flush into surface water or sanitary sewer system. Use appropriate containment to avoid environmental contamination. Outside of normal use, avoid release to the environment.
Methods for cleaning up	:	Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13). Use only non-sparking equipment. Dike large spills. Clean residue from spill site.

7. HANDLING AND STORAGE

Handling

Advice on safe handling	:	Avoid contact with eyes and lips. For personal protection see section 8. Use only as directed. KEEP OUT OF REACH OF CHILDREN AND PETS.
Advice on protection against fire and explosion	:	Keep away from heat and sources of ignition. Take measures to prevent the build up of electrostatic charge.

Storage

Requirements for storage areas and containers : Keep away from food, drink and animal feedingstuffs.
Keep container closed when not in use.
Keep in a dry, cool and well-ventilated place.

Other data : Stable under recommended storage conditions.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits

Components	CAS-No.	mg/m3	ppm	Non-standard units	Basis
Ethyl alcohol	64-17-5	1,900 mg/m3	1,000 ppm	-	OSHA TWA
Ethyl alcohol	64-17-5	-	1,000 ppm	-	ACGIH STEL

Personal protective equipment

Respiratory protection

Industrial setting : Do not spray in enclosed areas.

Household setting : Use only with adequate ventilation.

Hand protection : No special requirements.

Eye protection

Industrial setting : Safety glasses with side-shields

Household setting : Avoid contact with eyes.

Skin and body protection : No special requirements.

Hygiene measures : Handle in accordance with good industrial hygiene and safety practice. Wash thoroughly after handling.

9. PHYSICAL AND CHEMICAL PROPERTIES

Form : liquid

Color : clear

Odor	:	Alcohol Odor
pH	:	8.5
Boiling point	:	no data available
Freezing point	:	no data available
Flash point	:	30 °C 86 °F Method: Tag Closed Cup (TCC)
Evaporation rate	:	no data available
Flammability (solid, gas)	:	Sustains combustion
Autoignition temperature	:	no data available
Lower explosion limit	:	no data available
Upper explosion limit	:	no data available
Vapour pressure	:	no data available
Density	:	0.95 - 0.96 g/cm3
Water solubility	:	soluble
Partition coefficient: n-octanol/water	:	no data available
Viscosity, dynamic	:	no data available
Viscosity, kinematic	:	no data available
Volatile Organic Compounds (California Air Resource Board – CARB) Total VOC (wt. %)	:	31 % - does not include any applicable regulatory exemptions

10. STABILITY AND REACTIVITY

Conditions to avoid	:	Heat, flames and sparks.
Materials to avoid	:	Strong oxidizing agents Strong acids

Hazardous decomposition products	:	Thermal decomposition can lead to release of irritating gases and vapours.
Hazardous reactions	:	Stable under recommended storage conditions.

11. TOXICOLOGICAL INFORMATION

Acute oral toxicity	:	LD50 estimated > 5,050 mg/kg
Acute inhalation toxicity	:	no data available
Acute dermal toxicity	:	LD50 estimated > 5,020 mg/kg

Chronic effects

Carcinogenicity	:	no data available
Mutagenicity	:	no data available
Reproductive effects	:	no data available
Teratogenicity	:	no data available
Sensitisation	:	Substance is not a sensitizer.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects : no data available

13. DISPOSAL CONSIDERATIONS

PESTICIDAL WASTE:
Observe all applicable Federal, Provincial and State regulations and Local/Municipal ordinances regarding disposal.

		Consumer may discard empty container in trash, or recycle where facilities exist.
RCRA waste class	:	D001 (Ignitable Waste)

14. TRANSPORT INFORMATION

Land transport

- **U.S. DOT and Canadian TDG Surface Transportation:**

Proper shipping name	UN 1993 FLAMMABLE LIQUID N.O.S. (ethanol), 3, III
Class:	3
UN number	1993
Packaging group:	III
Note:	SC Johnson ships this product as Consumer Commodity ORM-D (non-bulk packages)

Sea transport

- *IMDG:*

Proper shipping name	UN 1993 FLAMMABLE LIQUID N.O.S. (ethanol), 3, III
Class:	3
UN number:	1993
Packaging group:	III
EmS:	F-E, S-E
Note:	Limited quantities derogation may be applicable to this product, please check transport documents.

Air transport

- *ICAO/IATA:*

Proper shipping name	UN 1993 FLAMMABLE LIQUID N.O.S. (ethanol), 3, III
Class:	3
UN/ID No.:	UN 1993
Packaging group:	III
Note:	SC Johnson typically does not ship products via air, therefore it has not been determined if the product container meets current IATA/ICAO package criteria. Refer to IATA/ICAO Dangerous Goods Regulations for detailed instructions when shipping this item by air.

15. REGULATORY INFORMATION

Notification status	:	All ingredients of this product are listed or are excluded from listing on the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory.

California Prop. 65 : This product is not subject to the reporting requirements under California's Proposition 65.

Registration # / Agency
4822-536/EPA

16. OTHER INFORMATION

HMIS Ratings

Health	2
Flammability	3
Reactivity	0

NFPA Ratings

Health	2
Fire	3
Reactivity	0
Special	

Further information
This document has been prepared using data from sources considered to be technically reliable. It does not constitute a warranty, expressed or implied, as to the accuracy of the information contained herein. Actual conditions of use are beyond the seller's control. User is responsible to evaluate all available information when using product for any particular use and to comply with all Federal, State, Provincial and Local laws and regulations.

Prepared by:	SC Johnson Global Safety Assessment & Regulatory Affairs (GSARA)

Ascent Battery Supply, LLC
1325 Walnut Ridge Drive
Hartland, Wisconsin 53029

Safety Data Sheet (SDS) — Nickel Cadmium (NiCd) Batteries

SECTION 1 - IDENTIFICATION

Product Name	Nickel Cadmium Battery		
Common Name(s)	NiCd, NiCad, Nickel Cadmium		
Synonyms	Nickel Cadmium Rechargeable Battery		
DOT Description	Dry Battery		
Chemical Name	Nickel Cadmium Secondary Battery		
Distributed By	Ascent Battery Supply, LLC	**Emergency Number**	INFOTRAC (800) 535-5053
Address	1325 Walnut Ridge Drive Hartland, Wisconsin 53029	**International Emergency Number**	INFOTRAC (352) 323-3500 (Collect)

SECTION 2 – HAZARD(S)

Unusual Fire and Explosion Hazards — Cells may rupture when exposed to excessive heat. This could result in the release of flammable or corrosive materials.

SECTION 3 – COMPOSITION

Chemical Name	CAS No.	Wt. Percentage %
Nickel	7440-02-0	15-22%
Potassium Hydroxide	1310-58-3	1.5-3%
Mercury	7439-79-6	≤5 ppm
Lead	7439-92-1	≤10 ppm
Cadmium	7440-43-9	18-26%
Other/Housing	n/a	balance

SECTION 4 – FIRST AID MEASURES

Inhalation — Get fresh air. If symptoms persist seek medical attention

Eyes and Skin — **Skin:** Flush with copious quantities of flowing lukewarm water for a minimum of 15 minutes; wash with soap and water

Eyes: Flush with copious quantities of flowing lukewarm water for a minimum of 15 minutes; get immediate medical attention.

Ingestion — Ingestion of battery chemicals can be harmful. Call The National Battery Ingestion Hotline (202-625-3333) 24 hours a day, for procedures treating ingestion of chemicals. Do not induce vomiting.

SECTION 5 – FIRE-FIGHTING MEASURES

Extinguisher Media — Use CO_2, foam or dry chemical extinguishers. Sand may also be used.

Special Fire Fighting Procedures — Wear self-contained breathing apparatus to avoid inhalation of hazardous decomposition products.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

In case of accidental rupture or release: prevent skin and eye contact and collect all released material in a plastic lined metal container. Leaking batteries should be handled with gloves. Wear protective clothing. Use a self-contained breathing apparatus if in the presence of chemical vapor. See also: sections 4, 5, and 8.

SECTION 7 – HANDLING AND STORAGE

1. Store in a dry place with ambient temperature between -20°C(-4°F) and 35°C(95°F).
2. Do not store unpacked cells together: avoid cells shorting to one another – especially in a charged state.
3. Do not mix new and used batteries.
4. Do not disassemble.
5. Do not store with conductive objects.
6. Store away from flame or spark hazards.

SECTION 8 – EXPOSURE/PERSONAL PROTECTION

Respiratory Protection	None required under normal handling conditions
Gloves	Wear gloves if cell is ruptured, corroded, or leaking materials
Safety Glasses	Always wear safety glasses with working with battery cells

SECTION 9 – PHYSICAL/CHEMICAL PROPERTIES

Boiling Point	N/A	**Melting Point**	N/A
Vapor Pressure	N/A	**Vapor Density**	N/A
Specific Gravity	N/A	**Evaporation Rate**	N/A
Solubility in Water	N/A	**Appearance and Odor**	Cylindrical, solid object, odorless

SECTION 10 – STABILITY & REACTIVITY

Reactivity in Water	N/A	**Auto-Ignition Temperature**	N/A
Flash Point	N/A	**Flammable Limits in Air, by vol.**	N/A
Percent Volatile By Volume	N/A		
Stable	Avoid electrically shorting the cell. Under normal conditions this product is stable and will not decompose.		
Incompatibility (materials to avoid)	N/A		

SECTION 11 – TOXICOLOGICAL INFORMATION

Threshold Limit Value	N/A
Signs and Symptoms of Exposure	None. (In fire or rupture situations, refer to sections 4, 5, & 8.)
Medical Conditions Generally Caused by Exposure	Chemicals may cause burns to skin, eyes, gastrointestinal tract and mucous membranes. Inhalation of electrolyte vapors may cause irritation of the upper respiratory tract and lungs.
Routes of Entry	Skin, Eyes, Ingestion (swallowing)

SECTION 12 – ECOLOGICAL INFORMATION

Hazardous Decomposition Products	N/A
Hazardous Polymerization	Will not occur

Under normal use these batteries do not release internal ingredients into the environment. Damaged or abused batteries may release small amounts of cadmium, nickel or carbon oxides. Do not carelessly discard, as small amounts of cadmium may be released into storm or surface water. Do not discard batteries into a fire. Dispose of properly or recycle.

SECTION 13 - DISPOSAL

Dispose of batteries according to all Federal, State and local laws and regulations.

SECTION 14 – TRANSPORT

These batteries must be packaged in a way that prevents the dangerous evolution of heat and protects the terminals from short circuit. When properly packaged and labeled, these dry batteries are not subject to dangerous goods regulation for the purpose of transportation and fall under special provision of the agencies listed in Section 15.

SECTION 15 – REGULATORY INFORMATION

IATA	Not considered to be 'dangerous goods' when packaged properly
DOT	Not considered to be a 'hazardous material' when packaged properly
ICAO	Not subject when packaged properly
IMDG	Not subject when packaged properly
UN2800	Exempted when packaged properly

SECTION 16 - OTHER

Document Control No:	SDS20008 – Ascent SDS for Nickel Cadmium (NiCd) Batteries	**Revision:**	1	**Effective Date:**	01-02-2015

SAFETY DATA SHEET (SDS)

PRODUCT IDENTITY (as indicated on label)	PRODUCT CODE
Sun X SPF 30 Sunscreen Broad Spectrum Spray	**COR10**

SECTION 1. COMPANY IDENTIFICATION:

DISTRIBUTOR'S NAME: CoreTex Products, Inc.	EMERGENCY TELEPHONE NUMBER: 1-800-255-3924 - 24 HOURS
ADDRESS: 1850 Sunnyside Court Bakersfield, Ca 93308	TELEPHONE NUMBER FOR INFO: 877-684-5774
Revision Number: A3	DATE PREPARED: 8/28/2014

SECTION 2. HAZARDOUS INGREDIENTS/IDENTITY INFORMATION:

The identity of individual components of this mixture is proprietary information and regarded to be a trade secret. However, based on the health hazard determination of contained ingredients present at a concentration greater than one percent, this mixture presents the following hazard:

HAZARDOUS COMPONENTS	% (RANGE)	CAS NO.	OSHA PEL	ACGIH TLV
N/A	N/A	N/A	N/A	N/A

SECTION 3. HAZARDS IDENTIFICATION:

I. EMERGENCY OVERVIEW

TYPE OF HAZARD: Eye irritant, spilled material can cause a slip hazard

APPEARANCE: None known

II. POTENTIAL HEALTH EFFECTS

INHALATION: May irritate

SKIN CONTACT: Not irritating

EYE CONTACT: May irritate eye

INGESTION: May be harmful if ingested

CHRONIC EFFECTS AD MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:

Not established

SECTION 4. FIRST AID MEASURES:

SKIN: Wash with soap and water if irritation should appear. See a doctor if irritation persists.

EYES: Wash eye with copious amounts of water. See doctor if irritation persists.

INGESTION: If swallowed, give victim a glass of water or milk. Seek medical help. Never give anything by mouth to an unconscious person. Do not induce vomiting.

INHALATION: Move person into fresh air. If breathing stops, qualified personnel should administer artificial respiration.

Distributor's Name: CoreTex Products, Inc.
Emergency Telephone Number: 1-800-255-3924
Product Identity: **Sun X SPF 30 Sunscreen Broad Spectrum**

SECTION 5. FIRE FIGHTING MEASURES:

FLAMMABILITY CLASSIFICATION: N/A **FLASHPOINT:** N/A

EXTINGUISHING MEDIA: Will not support combustion. All recognized methods acceptable

UNUSUAL FIRE AND EXPLOSION HAZARDS: Will not support combustion.

SPECIAL FIRE FIGHTING PROCEDURES: Keep containers cool and vapors down with water spray. Prevent runoff from entering sewers and public waterways. Wear SCBA in chemical fires.

SECTION 6. ACCIDENTAL RELEASE MEASURES:

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:
Caution, slip hazard. Wipe up small spills with an absorbent material. For large spills, pick up with vacuum or an absorbent material. Place waste in appropriate container for disposal.

WASTE DISPOSAL METHOD: Consult local, state, and federal regulations. Do not reuse empty container.

SECTION 7. HANDLING AND STORAGE:

HANDLING AND STORAGE PRECAUTIONS: In the event of acciden contact with eyes, irrigate with copious amounts of water to exposed area promptly. Store in a cool (under 120° F) dry location away from heat. Use with adequate ventilation.

OTHER PRECAUTIONS: Follow label directions carefully. Keep out of reach of childern. Keep container tightly seald when not in use. Do not contaminate water, food or feed by use or storage. Do not swallow. Avoid inhaling mist and vapors.

SECTION 8. EXPOSURE CONTROLS AND PERSONAL PROTECTION:

RESPIRATORY PROTECTION (specify type): Not usually necessary. Use with adequate ventilation Use NIOSH/MSHA approved respirator if PELs or TLVs are exceeded.

VENTILATION: Normal ventilation

PROTECTIVE GLOVES: N.A.

EYE PROTECTION: Keep out of eyes. Wear protective glasses when applicable

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES:

BOILING RANGE: N.A. **VAPOR DENSITY (Air = 1):** N.A. **VAPOR PRESSURE:** N.A.

EVAPORATION RATE (Butyl Acetate = 1): N.A.

SPECIFIC GRAVITY AT 25/25 C 0.95 -1.05

APPEARANCE AND ODOR: Off-white to Light Yellow. Characteristic odor.

SOLUBILITY IN WATER: In-soluble

ph (RANGE): 7.5-9.5

VISCOSITY: 1,500 - 2,500cps.

SAFETY DATA SHEET (SDS)

Distributor's Name: CoreTex Products, Inc.
Emergency Telephone Number: 1-800-255-3924
Product Identity: **Sun X SPF 30 Sunscreen Broad Spectrum**

SECTION 10. STABILITY AND REACTIVITY:

STABILITY: Stable
INCOMPATIBILITY (materials to avoid): None known
HAZARDOUS DECOMPOSITION PRODUCTS: None known
HAZARDOUS POLMERIZATION: Will Not Occur
CONDITIONS TO AVOID: None known

SECTION 11. TOXICOLOGICAL INFORMATION:

HEALTH WARNING: No Data Available.
CARCINOGENICITY: No Data Available.

SECTION 12. ECOLOGICAL INFORMATION:

Not established

SECTION 13. DISPOSAL CONSIDERATIONS:

Dispose of in accordance with local, state and federal regulations regarding health, air and water pollution.

SECTION 14. TRANSPORT INFORMATION:

DOT CLASSIFICATION: Not classified **SHIPPING NAME:** N.A.
HAZARD CLASS: N.A. **OTHER PERTINENT INFORMATION:** N.A.

This material is not subject to the transportation regulations of DOT, ICAO, IMO and the ADR.

SECTION 15. REGULATORY INFORMATION:

TSCA: N.A.
SARA, Title III, Section 313 (40CFR 372): N.A.
CALIFORNIA PROPOSITION 65: N.A.

SECTION 16. OTHER INFORMATION:

SUPERCEDES: Revision # A2

N.A.- Not applicable

Material Safety Data Sheet

Product Name:	AMCO CLEAR® Turbidity Standard	**Manufacturer:**	APS Analytical Standards
MSDS Number:	A002-01	**Address:**	123 Saginaw Drive, Redwood City, CA 94063
CAS Number:	9003-70-7	**Phone Number:**	(650) 366-2626
Date Prepared:	10/04/93	**Fax Number:**	(650) 368-4470
Date Revised:	01/02/01		
Prepared By:	Safety Manager		

Note: Blank spaces are not permitted. If any item is not applicable, the space must be marked to indicate that.

Section 1 - MATERIAL IDENTIFICATION AND INFORMATION

Components - Chemical Name & Common Names	%
Styrene Divinyl Benzene Copolymer Bead	<1%
Deionized/Reverse Osmosis Water	>99%
Total	100%

Section 2 - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	100° Celsius	**Specific Gravity (H_2O = 1.0)**	1.0
Vapor Pressure	760 mm Hg	**Melting Point**	N/A
Vapor Density (Air=1)	N/A	**Evaporation Rate**	N/A
Solubility in Water	N/A	**Water Reactive**	1.0
Appearance/Odor	Clear to Opaque Liquid/No Odor	**pH**	6.7

Section 3 - FIRE AND EXPLOSION DATA

Flash Point and Method Used	N/A	**Auto Ignition Temperature**	N/A
Flammability Limits in Air % by Volume	N/A	**Extinguisher Media**	N/A
Special Fire Fighting Procedures	N/A	**Unusual Fire Explosion Hazards**	None

Section 4 - REACTIVITY HAZARD DATA

Stability:	Stable	**Hazardous Decomposition Products:**	None
Conditions to avoid:	None	**Hazardous Polymerization:**	Will not occur
Incompatibility:	Organics		

Section 5 -HEALTH HAZARD DATA

Primary Routes of Entry: Ingestion **Carcinogen Listed In:** Not Listed

Health Hazards: None **Signs and Symptoms of Exposure:** N/A

Medical Conditions Generally Aggravated by Exposure: None

Emergency First Aid Procedures - Seek medical assistance for further treatment, observation and support if necessary.

Eye Contact:	Flush with water several times	**Inhalation:**	N/A
Skin Contact:	Wash hands / use moisturizer if dryness develops	**Ingestion:**	Not Hazardous

Section 6 - CONTROL AND PROTECTIVE MEASURES

Respiratory Protection: N/A **Protective Gloves:** N/A **Eye Protection:** N/A

Ventilation to be used: Regular Ventilation **Other Protective Equipment:** N/A

Hygienic Work Practices: N/A

Section 7 - PRECAUTIONS FOR SAFE HANDLING / LEAK PROCEDURES

Steps to be taken if material is spilled:	Use absorbent towel(s) / wash residual into drain.
Waste Disposal Methods:	Standard non-toxic disposal methods (trash, wash into drain).
Precautions to be taken in handling and storage:	Prevent from freezing and Contamination
Other Precautions and/or Special Hazards:	N/A

NFPA Rating: Health _0_ Flammability_0_ Reactivity_0_ Special_0_

HMIS Rating: Health_0_ Flammability_0_ Reactivity_0_ Personal Protection_0_

ATTACHMENT E

MATERIAL SAFETY DATA SHEETS – POTENTIAL CONSTITUENTS OF CONCERN

Complying with 1907/2006/EEC Regulation of 18 December 2006 ("REACH Regulation") and REGULATION (EC) No 1272/2008 (CLP)

Section 1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/ UNDERTAKING

Identification of the substance/preparation

Substance Name: BENZENE

Trade names: BENZENE

Synonyms: Benzol; Cyclohexatriene; Phenyl hydride

CAS #: 71-43-2

EC #: 200-753-7

Common/important uses of the substance/preparation: Benzene is used as an intermediate in synthesis and manufacture of organic aromatic substances. Benzene is defined as "transported isolated intermediate" (Article 3 (15) of REACH) and should be used under "Strictly Controlled Conditions" (Article 18 (4) for Intermediates under REACH.

Company/undertaking identification

Supplier/Manufacturer: GADIV PETROCHEMICAL INDUSTRIES Ltd.
P.O.B 32 HAIFA
Tel: +972-4-8788020
Fax: +972-4-8788018
E-mail: Gadiv@orl.co.il

E-mail address of person responsible for this SDS: gamiram@orl.co.il

Emergency telephone number (including hours of operation): +972-4-8788643

Section 2. HAZARDS IDENTIFICATION

According to EC Directive 2001/59/EC
Most Important Hazards

Physical / Chemical Hazards:
R11: Highly flammable.

Health Hazards:
R45: May cause cancer.
R46: May cause heritable genetic damage.
R36/38: Irritant; Irritating to eyes and skin.
R48/23/24/25: Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with the skin and if swallowed.
R65: Harmful: may cause lung damage if swallowed.

Environmentally Hazards:
Not Classified.

Classification

F – Highly flammable
T-Toxic

GHS-Classification

Physical / Chemical Hazard Statements:
H225: Highly flammable liquid and vapour.

Health Hazard Statements:
H350: May cause cancer.
H340: May cause genetic defects.
H372: Causes damage to organs through prolonged or repeated exposure.
H304: May be fatal if swallowed and enters airways.
H319: Causes serious eye irritation.
H315: Causes skin irritation.

Signal Word

Danger

See section 11 for more detailed information on health effects and symptoms.

Section 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance/preparation

Formula: C_6H_6

Molecular weigth: 78.11 g/mol

Ingredient name	CAS number	EC number	%	EU Classification	GHS Classification
Benzene	71-43-2	200-753-7	100	F; R11 Carc. Cat. 1; R45 Muta. Cat. 2; R46 T; R48/23/24/25 Xn; R65 Xi; R36/38	Flam. Liq. 2 H225 Carc. 1A H350 Muta. 1B H340 STOT RE 1 H372 Asp. Tox. 1 H304 Eye Irrit. 2 H319 Skin Irrit. 2 H315
See section 16 for the full text of the R-phrases declared above					

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

Eyes contact: In case of contact with eyes rinse thoroughly with plenty of water and seek medical advice.

Skin contact: In case of contact with skin wash off immediately with soap and plenty of water, and seek medical advice.

Inhalation: Remove from exposure, lie down. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.

Ingestion: Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Get medical attention immediately.

Expected delayed effects: N/A

See section 11 for more detailed information on health effects and symptoms.

Section 5: FIRE-FIGHTING MEASURES

Extinguishing media

Suitable: For small (incipient) fires, use media such as "alcohol" foam, dry chemical, or carbon dioxide. For large fires, apply water from as far as possible. Use very large quantities (flooding) of water applied as a mist or spray. Cool all affected containers with flooding quantities of water.

Not suitable: Solid streams of water may be ineffective.

Special exposure hazards arising from the substance/preparation including combustion products and gases: Thermal decomposition can lead to release of irritating gases and vapors. Highly flammable material. Flash back possible over considerable distance. Container explosion may occur under fire conditions.

Special protective equipment for fire fighters: Fire fighters should wear full protective clothing and self-contained breathing apparatus in positive pressure mode.

Further information: Move containers from fire area if possible to do so without risk. Use water spray to cool unopened containers.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal precautions: Wear protective clothing. Avoid contact with skin eyes. Avoid breathing vapors, mist or gas. Remove all sources of ignition. Ventilate area of spill. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.

Environmental precautions: Prevent entry into waterways, sewers, basements or confined areas.

Methods for cleaning up

Absorb the chemical onto sand, vermiculite, or any other non-combustible absorbent, and scoop into containers for later disposal.

Section 7: HANDLING AND STORAGE

Handling: Avoid contact with eyes, skin and clothing. Avoid inhalation of vapour or mist. Do not permit eating/drinking/smoking near the material. Keep away from heat, sparks and open flame. Take measures to prevent the build up of electrostatic charge.

Storage: Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Keep away from incompatible materials.

Section 8: EXPOSURE CONTROL / PERSONAL PROTECTION

Exposure limit values:

Ingredient name	Occupational exposure limits
Benzene	TLV-ACGIH 0.5 ppm (TWA), 2.5 ppm (STEL) REL-NIOSH 0.1 ppm (TWA), 1 ppm (CEIL)* *15 Minutes

Exposure controls

Occupational exposure controls:

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

Respiratory protection: Suitable respirator. Be sure to use an approved/certified or equivalent. Wear appropriate respirator when ventilation is inadequate.

Hand protection: Chemically compatible gloves.

Eye protection: Wear protective safety glasses.

Skin protection: Wear appropriate long-sleeved clothing to minimize skin contact.

Hygiene measures: Handle in accordance with good industrial hygiene and safety practice.

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 may be necessary to reduce emissions to acceptable levels.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

General information

Physical state: Liquid
Colour: Colourless
Odour: Aromatic

Safety data

pH: Not available
Boiling point/boiling range: 80˚C
Flash point: -11˚C
Flammability: Not applicable
Explosive properties: Not applicable
Oxidizing properties: Not applicable
Vapor pressure: 10 hPa at 20˚C and 100hPa at 79.7˚C
Water solubility: 1.88 g/l at 23.5˚C
Relative density (15.6°C): 0.8765 g/cm^3
Solubility: Not available
Log Octanol/Water partition coefficient: 2.13
Viscosity: 0.604 mPa at 25°C
Vapor density: Not available
Evaporation rate (butyl acetate=1): Not available

Other information:

Melting point/melting range: 5.5 °C
Auto-ignition temperature: 498°C

Section 10: STABILITY AND REACTIVITY

Stability: Stable under normal conditions.

Conditions to avoid: Heat, flames and sparks.

Materials to avoid: Acids, Bases, Halogens, Strong oxidizing agents, Metallic salts.

Hazardous Decomposition products: Carbon oxides.

Hazard polymerization: Not available.

Section 11: TOXICOLOGICAL INFORMATION

Potential acute health effects

Acute toxicity:

Product/ingredient name	Test	Species	Dose
Benzene	LD_{50}, Oral LD_{50}, Oral LC_{50}, Inhalation LC_{50}, Dermal	Rat Mouse Rat	1800 mg/kg 4700 mg/kg 10000 ppm/7H >5000 mg/kg

Inhalation: Toxic if inhaled. May cause respiratory tract irritation.

Ingestion: Toxic if swallowed. Aspiration hazard if swallowed - can enter lungs and cause damage.

Skin contact: Toxic if absorbed through skin. Causes skin irritation.

Eyes contact: Causes eye irritation.

Irritation and corrosivity: Irritating.

Skin Sensitization: Not sensitizing.

Toxicokinetics:
At low exposure levels, benzene is rapidly metabolized and excreted predominantly as conjugated urinary metabolites. At higher exposure levels, metabolic pathways appear to become saturated and a large portion of an absorbed dose of benzene is excreted as parent compound in exhaled air.

CMR Effects:

Carcinogenicity:
IARC-GROUP 1 – Carcinogenic to humans.
EPA-GROUP A – Human carcinogen.
NTP1 – Known to be carcinogenic.
Carcinogenic by OSHA.
Carcinogenic by NIOSH.
ACGIH A1: Confirmed Human Carcinogen.

Mutagenicity: Genotoxic.

Reproductive toxicity: No evidence of reproductive or developmental effects.

Repeated dose toxicity:
Inhalation: May cause bone marrow toxicity and depression of red and white blood cells.

Chronic/Other Effects
Carcinogen and an aspiration hazard (kinematic viscosity below 20.5 mm^2/s at 40°C).

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity: Experimental data from reliable studies are available for acute aquatic ecotoxicity endpoints. Data are not available for sediment or soil toxicity.

Substance name	Toxicity to fish	Toxicity to crustaceans	Toxicity to algae / terrestrial plants	Toxicity to other aquatic plants	Other toxicity data (birds, bees, plants etc.)
Benzene	LC_{50}/96H: 5.3 mg/l Long-term: (32 day NOEC) 0.8 mg/l	EC_{50}/48H (Daphnia): 10 mg/l Long term (7 day NOEC): 3 mg/l	Not available	EC_{50}/72H: 100 mg/l	Not available

Activated sludge respiration inhibition testing (24 hour IC_{50} - nitrification): 13 mg/l

Mobility: Not expected to adsorb to soil or sediment due to the low log Kow < 3.

Persistence and Degradability
Biotic - Readily biodegradable.
Abiotic - Will not undergo hydrolysis. Will not undergo photolysis. Expected to rapidly degrade by indirect photolysis in air.

Bioaccumulative potential: Not expected to bioaccumulate due to the low log Kow < 3.

Result of PBT / vPvB assessment (if CSR is required): Does not meet the criteria.

Other adverse effects:

Substances which have an unfavorable influence on the oxygen balance and can be measured using parameters such as BOD, COD, etc.: Not available.

Substances, which contribute to eutrophication: Not available

Remarks: Not available.

Section 13: DISPOSAL CONSIDERATIONS

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

Hazardous waste: Not available.

Section 14: TRANSPORT INFORMATION

International transport regulations

Regulatory Information	UN number	Proper shipping name	Class	Packing group	Label	Additional information	Marine pollutant
ADR/RID Class	1114	BENZENE	3	II			-
IMDG class	1114	BENZENE	3	II		EMS-No: F-E, S-D	No
IATA class	1114	BENZENE	3	II			-

National Fire Protection Association Hazard Ratings- NFPA (R):

Health Hazard - 2
Flammability - 3
Stability - 0

Section 15: REGULATORY INFORMATION

Chemical Safety Assessment has been performed for Benzene.

Classification and labeling according to EU Directives 67/548/EEC and 1999/45/EC (including amendments) and take into account the intended product use:

F – Highly flammable

T-Toxic

Risk phrases:
R11: Highly flammable.
R45: May cause cancer.
R46: May cause heritable genetic damage.
R36/38: Irritating to eyes and skin.
R48/23/24/25: Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with the skin and if swallowed.
R65: Harmful: may cause lung damage if swallowed.

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

Classification and labeling according to EU Regulation (EC) 1272/2008 (CLP Regulation) and Globally Harmonized System (GHS):

Signal Word **Danger**

<u>Dangerous as defined by the EU CLP 2008:</u>

Physical/Chemical Properties:

Flammable liquids: Flam. Liquid cat. 2	H225: Highly flammable liquid and vapour.

Health Hazards:

Carcinogenicity: Carc. cat. 1A	H350: May cause cancer.
Germ cell mutagenicity: Muta. cat. 1B	H340: May cause genetic defects.
Specific target organ toxicity - repeated exposure: STOT RE 1	H372: Causes damage to organs through prolonged or repeated exposure.
Aspiration hazard: Asp. Tox. cat. 1	H304: May be fatal if swallowed and enters airways.
Eye irritation: Eye Irrit. cat. 2	H319: Causes serious eye irritation.
Skin corrosion / irritation: Skin Irrit. cat. 2	H315: Causes skin irritation.

Precautionary Statements
P202: Do not handle until all safety precautions have been read and understood.
P210: Keep away from heat, sparks, open flame, hot surfaces - no smoking.
P243: Take precautionary measures against static discharges.
P280: Wear protective gloves/clothing/eye protection/face protection.
P303+P361+P353: if on skin (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P331: Do NOT induce vomiting.

National Paint & Coating Hazardous Materials Identification System – HMIS (R):

Health Hazard Rating -2
Flammability Rating - 3
Instability Rating - 0
Personal Protection - H

Section 16: OTHER INFORMATION

Full text of R-phrases referred to in sections 2 and 3:
R11: Highly flammable.
R45: May cause cancer.
R46: May cause heritable genetic damage.
R36/38: Irritating to eyes and skin.
R48/23/24/25: Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with the skin and if swallowed.
R65: Harmful: may cause lung damage if swallowed.

Full text of Hazards Statements referred to in sections 2 and 3:
H225: Highly flammable liquid and vapour.
H350: May cause cancer.
H340: May cause genetic defects.
H372: Causes damage to organs through prolonged or repeated exposure.
H304: May be fatal if swallowed and enters airways.
H319: Causes serious eye irritation.
H315: Causes skin irritation.

Training advice: Before using / handling the product one must read carefully present MSDS.

Recommended restriction on use: *Should be used under Strictly Controlled Conditions (Article 18 (4)) for Intermediates under REACH.*

Key Legend Information:

ACGIH- American Conference of Govermental Industrial Hygienists

OSHA- Occupational Safety and Health Administration

NTP- National Toxicology program

IARC- International Agency for Research on Cancer

ND- Not Determined

N/A- Not available

R-phrases- Risk phrases

S-phrases- Safety phrases

Date of printing: 2.12.2010

Version no. 1

According to Regulation (EC) No. 1907/2006 (REACH), Annex II, Commission Directive 2001/59/EC and REGULATION (EC) No 1272/2008 (CLP).

Ethylbenzene

Version 1.4 Revision Date 2011-08-24

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

Product information

Trade name	:	Ethylbenzene
Material	:	1037350, 1036462, 1015418

Company : Chevron Phillips Chemical Company LP
10001 Six Pines Drive
The Woodlands, TX 77380

Emergency telephone:

Health:
866.442.9628 (North America)
1.832.813.4984 (International)
Transport:
North America: CHEMTREC 800.424.9300 or 703.527.3887
Asia: +800 CHEMCALL (+800 2436 2255) China: 0532.8388.9090
EUROPE: BIG +32.14.584545 (phone) or +32.14583516 (telefax)
Chemcare Asia: Tel: +65 6848 9048 - Mob: +65 8382 9188 - Fax: +65 6848
South America SOS-Cotec Inside Brazil: 0800.111.767 Outside Brazil: +55.19.3467.1600

Responsible Department	:	Product Safety and Toxicology Group
E-mail address	:	MSDS@CPChem.com
Website	:	www.CPChem.com

2. HAZARDS IDENTIFICATION

Emergency Overview

Physical state: Liquid **Color**: Colorless **Odor**: Aromatic

OSHA Hazards : Flammable Liquid, Moderate skin irritant, Moderate eye irritant

GHS Classification

: Flammable liquids, Category 2
Skin irritation, Category 2
Acute toxicity, Category 5, Oral
Acute toxicity, Category 4, Inhalation
Eye irritation, Category 2A
Specific target organ systemic toxicity - single exposure, Category 3, Inhalation
Aspiration hazard, Category 1
Acute aquatic toxicity, Category 2
Specific target organ systemic toxicity - repeated exposure, Category 2, OralInhalation, Auditory organs

GHS-Labeling

Symbol(s) :

Signal Word : Danger

Hazard Statements :
H225: Highly flammable liquid and vapor.
H303: May be harmful if swallowed.
H304: May be fatal if swallowed and enters airways.
H315: Causes skin irritation.
H319: Causes serious eye irritation.
H332: Harmful if inhaled.
H335: May cause respiratory irritation.
H401: Toxic to aquatic life.
H373: May cause damage to organs through prolonged or repeated exposure if inhaled.
H373: May cause damage to organs through prolonged or repeated exposure if swallowed.

Precautionary Statements :
Prevention:
P210: Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233: Keep container tightly closed.
P240: Ground/bond container and receiving equipment.
P241: Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242: Use only non-sparking tools.
P243: Take precautionary measures against static discharge.
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/ protective clothing/ eye protection/ face protection.
Response:
P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P303 + P361 + P353: IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P312: Call a POISON CENTER or doctor/ physician if you feel unwell.
P321: Specific treatment (see supplemental first aid instructions on this label).
P331: Do NOT induce vomiting.
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.
P370 + P378: In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
Storage:
P403 + P233: Store in a well-ventilated place. Keep container tightly closed.

P403 + P235: Store in a well-ventilated place. Keep cool.
P405: Store locked up.
Disposal:
P501: Dispose of contents/ container to an approved waste disposal plant.

Carcinogenicity:

IARC
Group 2B: Possibly carcinogenic to humans
Ethylbenzene 100-41-4

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.

ACGIH
Confirmed animal carcinogen with unknown relevance to humans: The agent is carcinogenic in experimental animals at a relatively high dose, by route(s) of administration, at site(s), of histologic type(s), or by mechanism(s) that may not be relevant to worker exposure. Available epidemiologic studies do not confirm an increased risk of cancer in exposed humans. Available evidence does not suggest that the agent is likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure.
Ethylbenzene 100-41-4

3. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms : Ethylbenzol
EB
Phenylethane

Molecular formula : C_8H_{10}
Index-No. : 601-023-00-4
EINECS-No. : 202-849-4

Component	CAS-No.	Weight %
Ethylbenzene	100-41-4	99.00

4. FIRST AID MEASURES

General advice : Move out of dangerous area. Show this material safety data sheet to the doctor in attendance. Symptoms of poisoning may only appear several hours later. Do not leave the victim unattended.

If inhaled : Consult a physician after significant exposure. If unconscious place in recovery position and seek medical advice.

In case of skin contact : If skin irritation persists, call a physician. If on skin, rinse well with water. If on clothes, remove clothes.

In case of eye contact : Immediately flush eye(s) with plenty of water. Remove contact lenses. Protect unharmed eye. Keep eye wide open while rinsing. If eye irritation persists, consult a specialist.

If swallowed	:	Keep respiratory tract clear. Do NOT induce vomiting. Do not give milk or alcoholic beverages. Never give anything by mouth to an unconscious person. If symptoms persist, call a physician. Take victim immediately to hospital.

5. FIRE-FIGHTING MEASURES

Flash point	:	15 °C (59 °F) Method: closed cup
Autoignition temperature	:	432.22 °C (810.00 °F) Typical
Suitable extinguishing media	:	Alcohol-resistant foam. Carbon dioxide (CO_2). Dry chemical.
Unsuitable extinguishing media	:	High volume water jet.
Specific hazards during fire fighting	:	Do not allow run-off from fire fighting to enter drains or water courses.
Special protective equipment for fire-fighters	:	Wear self contained breathing apparatus for fire fighting if necessary.
Further information	:	Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. For safety reasons in case of fire, cans should be stored separately in closed containments. Use a water spray to cool fully closed containers.
Fire and explosion protection	:	Do not spray on an open flame or any other incandescent material. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapors). Use only explosion-proof equipment. Keep away from open flames, hot surfaces and sources of ignition.
Hazardous decomposition products	:	Carbon Dioxide. Carbon oxides.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Use personal protective equipment. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas.
Environmental precautions	:	Prevent product from entering drains. Prevent further leakage or spillage if safe to do so. If the product contaminates rivers and lakes or drains inform respective authorities.
Methods for cleaning up	:	Contain spillage, and then collect with non-combustible

absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

7. HANDLING AND STORAGE

Handling

Advice on safe handling : Avoid formation of aerosol. Do not breathe vapors/dust. Avoid exposure - obtain special instructions before use. Avoid contact with skin and eyes. For personal protection see section 8. Smoking, eating and drinking should be prohibited in the application area. Take precautionary measures against static discharges. Provide sufficient air exchange and/or exhaust in work rooms. Open drum carefully as content may be under pressure. Dispose of rinse water in accordance with local and national regulations.
Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary, but may not by themselves be sufficient. Review all operations, which have the potential to generating and accumulation of electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106 "Flammable and Combustible Liquids"; National Fire Protection Association (NFPA 77), "Recommended Practice on Static Electricity"; and/or the American Petroleum Institute (API) Recommended Practice 2003, "Protection Against Ignitions Arising Out of Static, Lightning, and stray Currents".

Advice on protection against fire and explosion : Do not spray on an open flame or any other incandescent material. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapors). Use only explosion-proof equipment. Keep away from open flames, hot surfaces and sources of ignition.

Storage

Requirements for storage areas and containers : No smoking. Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Observe label precautions. Electrical installations / working materials must comply with the technological safety standards.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

US

Ingredients	Basis	Value	Control parameters	Note
Ethylbenzene	ACGIH	TWA	100 ppm,	(), BEI, A3,
	ACGIH	STEL	125 ppm,	(), BEI, A3,
	OSHA Z-1	TWA	100 ppm, 435 mg/m3	(b),
	OSHA Z-1-A	TWA	100 ppm, 435 mg/m3	
	OSHA Z-1-A	STEL	125 ppm, 545 mg/m3	
	NIOSH REL	TWA	100 ppm, 435 mg/m3	

	NIOSH REL	ST	125 ppm, 545 mg/m3	

() Adopted values or notations enclosed are those for which changes are proposed in the NIC
(b) The value in mg/m3 is approximate.
A3 Confirmed animal carcinogen with unknown relevance to humans: The agent is carcinogenic in experimental animals at a relatively high dose, by route(s) of administration, at site(s), of histologic type(s), or by mechanism(s) that may not be relevant to worker exposure. Available epidemiologic studies do not confirm an increased risk of cancer in exposed humans. Available evidence does not suggest that the agent is likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure.
BEI Substances for which there is a Biological Exposure Index or Indices (see BEI® section)

Personal protective equipment

Respiratory protection : In the case of vapor formation use a respirator with an approved filter.

Hand protection : The suitability for a specific workplace should be discussed with the producers of the protective gloves.

Eye protection : Eye wash bottle with pure water. Tightly fitting safety goggles. Wear face-shield and protective suit for abnormal processing problems.

Skin and body protection : Impervious clothing. Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures : When using do not eat or drink. When using do not smoke. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance

Physical state : Liquid
Color : Colorless
Odor : Aromatic

Safety data

Flash point : 15 °C (59 °F)
Method: closed cup
Lower explosion limit : 1 %(V)

Upper explosion limit : 6.7 %(V)

Oxidizing properties : No

Autoignition temperature : 432.22 °C (810.00 °F)
Typical

Molecular formula : C8H10

Molecular Weight : No data available

pH : Not applicable

Pour point : No data available

Boiling point/boiling range : 136 °C (277 °F)

Vapor pressure	:	9.00 MMHG at 25 °C (77 °F)
Relative density	:	0.87, 15.6 °C(60.1 °F)
Water solubility	:	Slightly soluble in water (14mg/100ml). Miscible with alcohol and ether.
Partition coefficient: n-octanol/water	:	No data available
Viscosity, kinematic	:	< 1.138 cSt at 37.8 °C (100.0 °F)
Relative vapor density	:	3.7 (Air = 1.0)
Evaporation rate	:	No data available

Other information

Conductivity	:	123 pSm

10. STABILITY AND REACTIVITY

Possibility of hazardous reactions

Conditions to avoid	:	Heat, flames and sparks.
Materials to avoid	:	May react with oxygen and strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
Other data	:	This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. No decomposition if stored and applied as directed.

11. TOXICOLOGICAL INFORMATION

Ethylbenzene
Acute oral toxicity : Acute toxicity estimate: 2,525.25 mg/kg
Method: Calculation method

Ethylbenzene
Acute inhalation toxicity : Acute toxicity estimate: 17.58 mg/l
Method: Calculation method

Acute dermal toxicity

Ethylbenzene	:	LD50: 15,415 mg/kg Species: rabbit

Ethylbenzene

Skin irritation : May cause skin irritation in susceptible persons.

Ethylbenzene
Eye irritation : Eye irritation.

Sensitization

Ethylbenzene : Did not cause sensitization on laboratory animals.

Ethylbenzene
Aspiration toxicity : May be fatal if swallowed and enters airways.
Substances known to cause human aspiration toxicity hazards or to be regarded as if they cause human aspiration toxicity hazard.

CMR effects

Ethylbenzene : Carcinogenicity: Carcinogenicity classification not possible from current data.
Mutagenicity: In vivo tests did not show mutagenic effects
Teratogenicity: Did not show teratogenic effects in animal experiments.
Reproductive toxicity: No toxicity to reproduction

Ethylbenzene
Further information : Solvents may degrease the skin.

12. ECOLOGICAL INFORMATION

Toxicity to fish

Ethylbenzene : LC50: 4.3 mg/l
Exposure time: 96 HR
Species: Marone saxatilis (striped bass)

Toxicity to daphnia and other aquatic invertebrates.

Ethylbenzene : LC50: 2.6 mg/l
Exposure time: 96 HR
Species: Mysidopsis bahia (mysid shrimp)

EC50: 2.2 mg/l
Exposure time: 48 HR
Species: Daphnia magna (Water flea)
Method: OECD Test Guideline 202

Toxicity to algae

Ethylbenzene : ErC50: 5.0 mg/l
Exposure time: 96 HR
Species: Selenastrum capricornutum (algae)

ErC50: 7.7 mg/l
Exposure time: 72 HR
Species: Skeletonema costatum (Marine Algae)

Elimination information (persistence and degradability)

Biodegradability : This material is expected to be readily biodegradable.

Further information on ecology

Results of PBT assessment

Ethylbenzene : This substance is not considered to be persistent, bioaccumulating nor toxic (PBT)., This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

Additional ecological information : An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

The information in this MSDS pertains only to the product as shipped.

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by US EPA under RCRA (40 CFR 261) or other State and local regulations. Measurement of certain physical properties and analysis for regulated components may be necessary to make a correct determination. If this material is classified as a hazardous waste, federal law requires disposal at a licensed hazardous waste disposal facility.

Product : The product should not be allowed to enter drains, water courses or the soil. Do not contaminate ponds, waterways or ditches with chemical or used container. Send to a licensed waste management company.

Contaminated packaging : Empty remaining contents. Dispose of as unused product.
Do not re-use empty containers. Do not burn, or use a cutting torch on, the empty drum.

14. TRANSPORT INFORMATION

The shipping descriptions shown here are for bulk shipments only, and may not apply to shipments in non-bulk packages (see regulatory definition).

Consult the appropriate domestic or international mode-specific and quantity-specific Dangerous Goods Regulations for additional shipping description requirements (e.g., technical name or names, etc.) Therefore, the information shown here, may not always agree with the bill of lading shipping description for the material. Flashpoints for the material may vary slightly between the MSDS and the bill of lading.

US DOT (United States Department of Transportation)
UN1175, ETHYLBENZENE, 3, II, RQ (ETHYLBENZENE)

IMO / IMDG (International Maritime Dangerous Goods)
UN1175, ETHYLBENZENE, 3, II, (15 °C)

IATA (International Air Transport Association)
UN1175, ETHYLBENZENE, 3, II

ADR (Agreement on Dangerous Goods by Road (Europe))
UN1175, ETHYLBENZENE, 3, II, (D/E)

RID (Regulations concerning the International Transport of Dangerous Goods (Europe))
UN1175, ETHYLBENZENE, 3, II

ADN (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways)
UN1175, ETHYLBENZENE, 3, II

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

15. REGULATORY INFORMATION

National legislation

SARA 311/312 Hazards : Fire Hazard
Acute Health Hazard
Chronic Health Hazard

CERCLA Reportable Quantity : 1010 lbs
Ethylbenzene

SARA 302 Threshold Planning Quantity : 1000 lbs
CERCLA hazardous substances. 40 cfr part 302. May be subject to emergency release notification under sara title III.

SARA 313 Ingredients : The following components are subject to reporting levels established by SARA Title III, Section 313:
: Ethylbenzene 100-41-4

Clean Air Act

Ozone-Depletion Potential : This product neither contains, nor was manufactured with a Class I or Class II ODS as defined by the U.S. Clean Air Act Section 602 (40 CFR 82, Subpt. A, App.A + B).

US State Regulations

Pennsylvania Right To Know
: Ethylbenzene 100-41-4

New Jersey Right To Know : Ethylbenzene 100-41-4

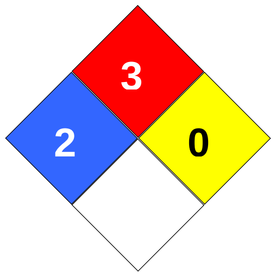
California Prop. 65 Ingredients : WARNING! This product contains a chemical known in the State of California to cause cancer.

Notification status

Europe REACH	: Not in compliance with the inventory
United States of America US.TSCA	: On the inventory, or in compliance with the inventory
Canada DSL	: On the inventory, or in compliance with the inventory
Australia AICS	: On the inventory, or in compliance with the inventory
New Zealand NZIoC	: On the inventory, or in compliance with the inventory
Japan ENCS	: On the inventory, or in compliance with the inventory
Korea KECI	: On the inventory, or in compliance with the inventory
Philippines PICCS	: On the inventory, or in compliance with the inventory
China IECSC	: On the inventory, or in compliance with the inventory

16. OTHER INFORMATION

NFPA Classification : Health Hazard: 2
Fire Hazard: 3
Reactivity Hazard: 0



Further information

Legacy MSDS Number : 790

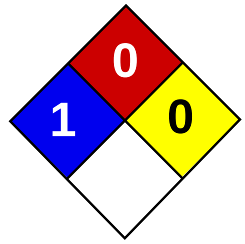
Significant changes since the last version are highlighted in the margin. This version replaces all previous versions.

The information in this MSDS pertains only to the product as shipped.

The information provided in this Material 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.

Key or legend to abbreviations and acronyms used in the safety data sheet			
ACGIH	American Conference of Government Industrial Hygienists	LD50	Lethal Dose 50%
AICS	Australia, Inventory of Chemical Substances	LOAEL	Lowest Observed Adverse Effect Level
DSL	Canada, Domestic Substances List	NFPA	National Fire Protection Agency
NDSL	Canada, Non-Domestic Substances List	NIOSH	National Institute for Occupational Safety & Health
CNS	Central Nervous System	NTP	National Toxicology Program

CAS	Chemical Abstract Service	NZIoC	New Zealand Inventory of Chemicals
EC50	Effective Concentration	NOAEL	No Observable Adverse Effect Level
EC50	Effective Concentration 50%	NOEC	No Observed Effect Concentration
EGEST	EOSCA Generic Exposure Scenario Tool	OSHA	Occupational Safety & Health Administration
EOSCA	European Oilfield Specialty Chemicals Association	PEL	Permissible Exposure Limit
EINECS	European Inventory of Existing Chemical Substances	PICCS	Philipines Inventory of Commercial Chemical Substances
MAK	Germany Maximum Concentration Values	PRNT	Presumed Not Toxic
GHS	Globally Harmonized System	RCRA	Resource Conservation Recovery Act
>=	Greater Than or Equal To	STEL	Short-term Exposure Limit
IC50	Inhibition Concentration 50%	SARA	Superfund Amendments and Reauthorization Act.
IARC	International Agency for Research on Cancer	TLV	Threshold Limit Value
IECSC	Inventory of Existing Chemical Substances in China	TWA	Time Weighted Average
ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Compositon, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System
LC50	Lethal Concentration 50%		



Health	1
Fire	0
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Lead MSDS

Section 1: Chemical Product and Company Identification

Product Name: Lead

Catalog Codes: SLL1291, SLL1669, SLL1081, SLL1459, SLL1834

CAS#: 7439-92-1

RTECS: OF7525000

TSCA: TSCA 8(b) inventory: Lead

CI#: Not available.

Synonym: Lead Metal, granular; Lead Metal, foil; Lead Metal, sheet; Lead Metal, shot

Chemical Name: Lead

Chemical Formula: Pb

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
Lead	7439-92-1	100

Toxicological Data on Ingredients: Lead LD50: Not available. LC50: Not available.

Section 3: Hazards Identification

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

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (permeator). CARCINOGENIC EFFECTS: Classified A3 (Proven for animal.) by ACGIH, 2B (Possible for human.) by IARC. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to blood, kidneys, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:

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

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

Serious Skin Contact: Not available.

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

Serious Inhalation: Not available.

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: May be combustible at high temperature.

Auto-Ignition Temperature: Not available.

Flash Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Some metallic oxides.

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

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

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: When heated to decomposition it emits highly toxic fumes of lead.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. 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 away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable

protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

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

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

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

Exposure Limits:
TWA: 0.05 (mg/m3) from ACGIH (TLV) [United States] TWA: 0.05 (mg/m3) from OSHA (PEL) [United States] TWA: 0.03 (mg/m3) from NIOSH [United States] TWA: 0.05 (mg/m3) [Canada]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Metal solid.)

Odor: Not available.

Taste: Not available.

Molecular Weight: 207.21 g/mole

Color: Bluish-white. Silvery. Gray

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

Boiling Point: 1740°C (3164°F)

Melting Point: 327.43°C (621.4°F)

Critical Temperature: Not available.

Specific Gravity: 11.3 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: Not available.

Solubility: Insoluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, excess heat

Incompatibility with various substances: Reactive with oxidizing agents.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Can react vigorously with oxidizing materials. Incompatible with sodium carbide, chlorine trifluoride, trioxane + hydrogen peroxide, ammonium nitrate, sodium azide, disodium acetylide, sodium acetylide, hot concentrated nitric acid, hot concentrated hydrochloric acid, hot concentrated sulfuric acid, zirconium.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Inhalation. Ingestion.

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified A3 (Proven for animal.) by ACGIH, 2B (Possible for human.) by IARC. May cause damage to the following organs: blood, kidneys, central nervous system (CNS).

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

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans:
Acute Potential: Skin: Lead metal granules or dust: May cause skin irritation by mechanical action. Lead metal foil, shot or sheets: Not likely to cause skin irritation Eyes: Lead metal granules or dust: Can irritate eyes by mechanical action. Lead metal foil, shot or sheets: No hazard. Will not cause eye irritation. Inhalation: In an industrial setting, exposure to lead mainly occurs from inhalation of dust or fumes. Lead dust or fumes: Can irritate the upper respiratory tract (nose, throat) as well as the bronchi and lungsby mechanical action. Lead dust can be absorbed through the respiratory system. However, inhaled lead does not accumulate in the lungs. All of an inhaled dose is eventually abssorbed or transferred to the gastrointestinal tract. Inhalation effects of exposure to fumes or dust of inorganic lead may not develop quickly. Symptoms may include metallic taste, chest pain, decreased physical fitness, fatigue, sleep disturbance, headache, irritability, reduces memory, mood and personality changes, aching bones and muscles, constipation, abdominal pains, decreasing appetite. Inhalation of large amounts may lead to ataxia, deliriuim, convulsions/seizures, coma, and death. Lead metal foil, shot, or sheets: Not an inhalation hazard unless metal is heated. If metal is heated, fumes will be released. Inhalation of these fumes may cause "fume metal fever", which is characterized by flu-like symptoms. Symptoms may include metallic taste, fever, nausea, vomiting, chills, cough, weakness, chest pain, generalized muscle pain/aches, and increased white blood cell count. Ingestion: Lead metal granules or dust: The symptoms of lead poisoning include abdominal pain or cramps (lead cholic), spasms, nausea, vomiting, headache, muscle weakness, hallucinations, distorted perceptions, "lead line" on the gums, metallic taste, loss of appetite, insomnia, dizziness and other symptoms similar to that of inhalation. Acute poisoning may result in high lead levels in the blood and urine, shock, coma and death in extreme cases. Lead metal foil, shot or sheets: Not an ingestion hazard for usual industrial handling.

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: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

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: Lead California prop. 65: This product contains the following ingredients for which the State of California has found to cause reproductive harm (female) which would require a warning under the statute: Lead California prop. 65: This product contains the following ingredients for which the State of California has found to cause reproductive harm (male) which would require a warning under the statute: Lead California prop. 65 (no significant risk level): Lead: 0.0005 mg/day (value) California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Lead California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: Lead Connecticut hazardous material survey.: Lead Illinois toxic substances disclosure to employee act: Lead Illinois chemical safety act: Lead New York release reporting list: Lead Rhode Island RTK hazardous substances: Lead Pennsylvania RTK: Lead

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-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R20/22- Harmful by inhalation and if swallowed. R33- Danger of cumulative effects. R61- May cause harm to the unborn child. R62- Possible risk of impaired fertility. S36/37- Wear suitable protective clothing and gloves. S44- If you feel unwell, seek medical advice (show the label when possible). S53- Avoid exposure - obtain special instructions before use.

HMIS (U.S.A.):

Health Hazard: 1

Fire Hazard: 0

Reactivity: 0

Personal Protection: E

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

Health: 1

Flammability: 0

Reactivity: 0

Specific hazard:

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

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:21 PM

Last Updated: 05/21/2013 12:00 PM

* * *Section 1 - IDENTIFICATION* * *

Product Identifier: NAPHTHALENE

Synonyms

NAPHTHALENE CRUDE 78 DEGREE; NAPHTHALENE INTERMEDIATE 79 DEGREE; NAPHTHALENE REFINED 80 DEGREE

Chemical Family

polynuclear aromatic hydrocarbons

Recommended Use

process chemical

Restrictions on Use

None known.

Manufacturer Information

KOPPERS INC.
436 Seventh Avenue
Pittsburgh, PA 15219-1800
Mfg Contact: 412-227-2001 (SDS Requests: 866-852-5239)

CHEMTREC: 800-424-9300 (Outside USA: +1 703-527-3887)
Emergencies: (Medical in USA): 877-737-9047
Emergencies: (Medical Outside of USA): 651-632-9269
Email: naorgmsds@koppers.com

* * *Section 2 - HAZARD(S) IDENTIFICATION* * *

Classification in accordance with 29 CFR 1910.1200

Flammable Liquids, Category 4
Acute Toxicity (Oral), Category 4 (2% unknown)
Carcinogenicity, Category 2
Specific Target Organ Toxicity - Repeated Exposure, Category 1 (blood)
Hazardous to the Aquatic Environment - Acute Hazard, Category 1 (4 % unknown)
Hazardous to the Aquatic Environment - Chronic Hazard, Category 1 (2 % unknown)

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

DANGER

Hazard Statement(s)

Combustible liquid
Harmful if swallowed
Suspected of causing cancer
Causes damage to blood through prolonged or repeated exposure.
Very toxic to aquatic life with long lasting effects

Precautionary Statement(s)

Prevention

Keep away from flames and hot surfaces. - No smoking. Do not breathe vapor or mist. Wear protective gloves/clothing and eye/face protection. Wash thoroughly after handling. Do not eat, drink, or smoke when using this product. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Avoid release to the environment.

Response

In case of fire, use media appropriate for extinction. IF exposed or concerned: Get medical advice/attention. IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. Rinse mouth. Collect spillage.

Storage

Store in a well-ventilated place. Keep cool. Store locked up.

Disposal

Dispose in accordance with all applicable regulations.

Hazard(s) Not Otherwise Classified

May cause thermal burns from heated material.

* * *Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS* * *

CAS	Component	Percent (weight)
91-20-3	NAPHTHALENE	95-100
95-15-8	BENZO(B)THIOPHENE	1-2
91-57-6	2-METHYLNAPHTHALENE	<1
1319-77-3	CRESOL	<1
92-52-4	DIPHENYL	<1
90-12-0	1-METHYLNAPHTHALENE	<1

* * *Section 4 - FIRST-AID MEASURES* * *

Description of Necessary Measures

Inhalation

If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

Skin

Wash skin with soap and water or use a waterless handcleaner while removing contaminated clothing and shoes. For thermal burns, cool affected areas as quickly as possible by drenching or immersing in water. Get immediate medical attention.

Eyes

Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Then get immediate medical attention.

Ingestion

Not a likely route of exposure. If burns occur, treat as thermal burns. DO NOT induce vomiting. If a large amount is swallowed, get medical attention. Do not give anything by mouth to unconscious or convulsive person. If vomiting occurs, keep head lower than hips to help prevent aspiration. Rinse mouth.

Most Important Symptoms/Effects

Acute

harmful if swallowed

Delayed

blood damage, nasal cancer, lung tumors

Indication of Immediate Medical Attention and Special Treatment Needed, if Necessary

Treat symptomatically and supportively.

* * *Section 5 - FIRE-FIGHTING MEASURES* * *

Suitable Extinguishing Media

regular dry chemical, carbon dioxide, dry sand, earth, water spray, regular foam
Large fires: Use water spray, fog or regular foam.

Unsuitable Extinguishing Media

Do not use water jets.

Specific Hazards Arising from the Chemical

Moderate fire hazard. Vapor/air mixtures are explosive above flash point. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back.

Hazardous Combustion Products

Combustion Products: oxides of carbon

Fire Fighting Measures

Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Directly spraying water or foam onto hot burning product may cause frothing. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. Keep unnecessary people away, isolate hazard area and deny entry. Avoid inhalation of material or combustion by-products. Stay upwind and keep out of low areas. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire.

Special Protective Equipment and Precautions for Firefighters

Wear full protective fire fighting gear including self contained breathing apparatus (SCBA) for protection against possible exposure.

Sensitivity to Mechanical Impact

No

Sensitivity to Static Discharge

Yes (dust)

* * *Section 6 - ACCIDENTAL RELEASE MEASURES* * *

Personal Precautions, Protective Equipment and Emergency Procedures

Avoid inhalation or contact. Provide adequate ventilation. Wear personal protective clothing and equipment, see Section 8. Avoid release to the environment. Collect spillage.

Methods and Materials for Containment and Cleaning Up

Eliminate all ignition sources if safe to do so. Do not touch or walk through spilled material. Stop leak if possible without personal risk. **Small spills:** Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. **Large spills:** Dike for later disposal. Prevent entry into waterways, sewers, basements, or confined areas. In Canada, report releases to provincial authorities, municipal authorities, or both, as required. If this product is spilled or leaked into the environment, the CERCLA (40 CFR 302.4) reportable quantity is 100 pounds, and requires National Response Center notification.

* * *Section 7 - HANDLING AND STORAGE* * *

Precautions for Safe Handling

Keep away from flames and hot surfaces. - No smoking. Do not breathe vapor or mist. Avoid breathing vapors of heated materials. Avoid contact with eyes, skin and clothing. Use only in well ventilated areas. Wash exposed areas thoroughly with soap and water, or a waterless handcleaner, after skin contact and before eating, drinking, using tobacco products, or restrooms. Contaminated clothing should be removed and laundered before reuse. Wear protective gloves/clothing and eye/face protection. Do not eat, drink, or smoke when using this product. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood.

Conditions for Safe Storage, including any Incompatibilities

Store and handle in accordance with all current regulations and standards. Label all containers. Keep away from heat, sparks and flame. Store in a cool, dry place. Keep container in a well-ventilated place. Protect from physical damage. Store locked up. Keep separated from incompatible substances.

Incompatibilities: oxidizing materials

* * *Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION* * *

Component Exposure Limits

NAPHTHALENE (91-20-3)

OSHA (US): 10 ppm TWA; 50 mg/m3 TWA

ACGIH: 10 ppm TWA
Skin - potential significant contribution to overall exposure by the cutaneous route

Biological Limit Values

NAPHTHALENE (91-20-3)

ACGIH: Time: end of shift Parameter: 1-Naphthol with hydrolysis plus 2-Naphthol with hydrolysis (nonquantitative, nonspecific)

Appropriate Engineering Controls

Ensure adequate ventilation. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Ensure compliance with applicable exposure limits.

Individual Protection Measures, such as Personal Protective Equipment

Eyes/Face Protection

ANSI Z87.1-1989 approved safety glasses with side shields. Provide an emergency eye wash fountain and quick drench shower in the immediate work area. For the molten form: A faceshield is recommended.

Skin Protection

Wear protective clothing to prevent contact. Contaminated clothing should be removed and laundered before reuse. In the molten form: Wear appropriate heat resistant clothing.

Glove Recommendations

Wear appropriate gloves. In the molten form: Wear appropriate heat resistant gloves.

Protective Materials

chemical resistant material, heat resistant material

Respiratory Protection

If the applicable TLVs and/or PELs are exceeded, use canister or cartridge respirators, which are MSHA/NIOSH-approved, with organic vapor cartridges and high-efficiency particulate filters.

* * *Section 9 - PHYSICAL AND CHEMICAL PROPERTIES* * *

Physical State:	Liquid	**Appearance:**	forms crystals during cooling
Physical Form:	liquid when loaded, solid at room temperature, changes from solid to liquid as temperature increases	**Odor:**	mothball odor
Odor Threshold:	0.003 ppm	**pH:**	Not available
Freezing / Melting Point:	77 - 80 °C	**Boiling Point:**	218 °C
Flash Point:	>80 °C	**Decomposition Temperature:**	Not available
Evaporation Rate:	<1 ether=1	**Lower Explosive Limit:**	0.9 % by volume
Upper Explosive Limit:	5.9 % by volume	**Vapor Pressure:**	0.187 mmHg @ 20 °C
Vapor Density:	4.42	**Density:**	1.162 g/cc @ 4 °C
Specific Gravity (water=1):	1.028 @ 4 °C	**Water Solubility:**	0.003 % by weight
Log Kow:	3.7 @ 25 °C	**Autoignition Temp.:**	526 °C
Viscosity:	Not available	**Volatility:**	Not available
Volatility by Volume:	>99 %	**Flammability (solid, gas):**	Not applicable

Other Property Information

No additional information is available.

* * *Section 10 - STABILITY AND REACTIVITY* * *

Reactivity

No reactivity hazard is expected.

Chemical Stability

Stable at normal temperatures and pressure.

Possibility of Hazardous Reactions

Will not polymerize.

Conditions to Avoid

Avoid heat, flames, sparks and other sources of ignition.

Incompatible Materials

oxidizing materials

Hazardous Decomposition

Combustion Products: oxides of carbon

* * *Section 11 - TOXICOLOGICAL INFORMATION* * *

Acute Toxicity (Component)

Component Analysis - LD50/LC50

The components of this material have been reviewed in various sources and the following selected endpoints are published:

NAPHTHALENE (91-20-3)

Dermal LD50 Rabbit 1120 mg/kg; Inhalation LC50 Rat >340 mg/m3 1 h; Oral LD50 Rat 1110 mg/kg

Information on Likely Routes of Exposure

Inhalation

blood damage, nasal cancer, lung tumors

Ingestion

harmful if swallowed, blood damage

Skin Contact

thermal burns from heated material

Eye Contact

temporary irritation, thermal burns from heated material

Immediate Effects

harmful if swallowed

Delayed Effects

blood damage, nasal cancer, lung tumors

Medical Conditions Aggravated by Exposure

respiratory disorders, skin disorders, eye disorders, blood system disorders

Irritation/Corrosivity Data

The material was found to be non-irritating.

Respiratory Sensitization

No data available.

Dermal Sensitization

Not sensitizing.

Germ Cell Mutagenicity

Negative

Carcinogenicity (Product)

See applicable component information.

Component Carcinogenicity

NAPHTHALENE (91-20-3)

ACGIH:	A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
NTP:	Reasonably Anticipated To Be A Human Carcinogen (Possible Select Carcinogen)
IARC:	Monograph 82 [2002] (Group 2B (possibly carcinogenic to humans))

Reproductive Toxicity

No data available for the mixture.

Specific Target Organ Toxicity - Single Exposure

No data available.

Specific Target Organ Toxicity - Repeated Exposure

blood

Aspiration Hazard

No data available.

* * *Section 12 - ECOLOGICAL INFORMATION* * *

Ecotoxicity

Very toxic to aquatic life with long lasting effects.

Component Analysis - Aquatic Toxicity

NAPHTHALENE (91-20-3)

Fish:	96 Hr LC50 Pimephales promelas: 5.74 - 6.44 mg/L [flow-through]; 96 Hr LC50 Oncorhynchus mykiss: 1.6 mg/L [flow-through]; 96 Hr LC50 Oncorhynchus mykiss: 0.91 - 2.82 mg/L [static]; 96 Hr LC50 Pimephales promelas: 1.99 mg/L [static]; 96 Hr LC50 Lepomis macrochirus: 31.0265 mg/L [static]
Invertebrate:	48 Hr LC50 Daphnia magna: 2.16 mg/L; 48 Hr EC50 Daphnia magna: 1.96 mg/L [Flow through]; 48 Hr EC50 Daphnia magna: 1.09 - 3.4 mg/L [Static]

Algal Toxicity

Naphthalene: 0.4 mg/L 72 hours EC50 Skeletonema costatum

Persistence and Degradability

Biodegradable.

Bioaccumulation Potential

This material is believed not to bioaccumulate due to low water solubility. BCF for fish is 168.

Mobility

The product has poor water-solubility.

Other Adverse Effects

No data available.

* * *Section 13 - DISPOSAL CONSIDERATIONS* * *

Disposal Methods

Dispose in accordance with all applicable regulations.

Component Waste Numbers

NAPHTHALENE (91-20-3)

RCRA: waste number U165

Disposal of Contaminated Packaging

Dispose in accordance with all applicable regulations.

* * *Section 14 - TRANSPORT INFORMATION* * *

US DOT Information

Shipping Name: Naphthalene, molten, RQ

UN/NA #: UN2304 **Hazard Class:** 4.1 **Packing Group:** III

Required Label(s): 4.1

This material contains reportable quantity (RQ) Hazardous Substances. Applicable shipping classification depends on temperature of product.

US DOT Reportable Quantities

NAPHTHALENE (91-20-3)

100 lbs RQ; 45.4 kg RQ

Component Marine Pollutants

This material does not contain any chemicals listed on the Hazardous Materials Table required by US DOT to be identified as a marine pollutant.

TDG Information

Shipping Name: Naphthalene, molten

UN #: UN2304 **Hazard Class:** 4.1 **Packing Group:** III

Required Label(s): 4.1

IATA Information

Air shipment is prohibited.

Marine Pollutant(s) based on 2.9.3 of the UN Model Regulations

NAPTHALENE

* * *Section 15 - REGULATORY INFORMATION* * *

U.S. Federal Regulations

This material contains one or more of the following chemicals required to be identified under SARA Sections 302/304 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65), CERCLA (40 CFR 302.4), TSCA 12(b), and/or require an OSHA process safety plan.

NAPHTHALENE (91-20-3)

SARA 313: 0.1 % de minimis concentration
CERCLA: 100 lb final RQ; 45.4 kg final RQ

SARA 311/312 Hazardous Categories (40 CFR 370 Subparts B and C)

Acute Health: Yes **Chronic Health:** Yes **Fire:** Yes **Pressure:** No **Reactive:** No

U.S. State Regulations

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS#	CA	MA	MN	NJ	PA
NAPHTHALENE	91-20-3	Yes	Yes	Yes	Yes	Yes

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.

WHMIS Classification

B3, D2A.

WHMIS Ingredient Disclosure List

The following components are identified under the Canadian Hazardous Products Act Ingredient Disclosure List:

NAPHTHALENE (91-20-3)

1 %

Component Analysis - Inventory

Component	CAS	US	DSL	NDSL
NAPHTHALENE	91-20-3	Yes	Yes	No

U.S. Inventory (TSCA)

Listed on inventory.

Canada Inventory

Listed on DSL.

* * *Section 16 - OTHER INFORMATION* * *

NFPA Ratings: Health= 1 **Fire=** 2 **Reactivity=** 0

Hazard Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

Review date

1/22/2015

Summary of Changes

Updated: 1/22/2015

Multiple changes due to format (GHS) update.

Key / Legend

ACGIH - American Conference of Governmental Industrial Hygienists; ANSI - American National Standards Institute; BOD - Biochemical Oxygen Demand; C - Celsius; CA - Canada; CAS - Chemical Abstracts Service; CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act; CPR - Controlled Products Regulations; DOT - Department of Transportation; DSL - Domestic Substances List; EPA - Environmental Protection Agency; F - Fahrenheit; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; ICAO - International Civil Aviation Organization; IDL - Ingredient Disclosure List; IDLH - Immediately Dangerous to Life and Health; IMDG - International Maritime Dangerous Goods; Kow - Octanol/water partition coefficient; LC50 - Lethal Concentration, 50%; LD50 - Lethal Dose, 50%; LEL - Lower Explosive Limit; LMPE-CT - Maximum Permissible Short Time Exposure Limit (Mexico); LMPE-PPT - Maximum Permissible Time-Weighted Average Exposure Limit (Mexico); LOLI - List Of LIsts™ - ChemADVISOR's Regulatory Database; NDSL - Non-Domestic Substances List; NFPA - National Fire Protection Agency; NIOSH - National Institute for Occupational Safety and Health; NJTSR - New Jersey Trade Secret Registry; NTP - National Toxicology Program; OSHA - Occupational Safety and Health Administration; PEL - Permissible Exposure Limit; RCRA - Resource Conservation and Recovery Act; RTECS - Registry of Toxic Effects of Chemical Substances®; SARA - Superfund Amendments and Reauthorization Act; STEL - Short-term Exposure Limit; TDG - Transportation of Dangerous Goods; TLV - Threshold Limit Value; TSCA - Toxic Substances Control Act; TWA - Time Weighted Average; UEL - Upper Explosive Limit; US - United States; WHMIS - Workplace Hazardous Materials Information System

Other Information

The information set forth in this Safety Data Sheet does not purport to be all-inclusive and should be used only as a guide. While the information and recommendations set forth herein are believed to be accurate, the company makes no warranty regarding such information and recommendations and disclaims all liability from reliance thereon.

End of Sheet 00228306

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME **UNIAROM® SX 250 IF**

SYNONYM Aromatic Solvent Bottoms

CAS REGISTRY NUMBER 68477-30-5

CHEMICAL FAMILY Aromatic Hydrocarbon

COMPANY IDENTIFICATION
UniSource Energy, Inc.
40 Shuman Blvd, Suite 290
Naperville, IL 60563
Phone: 630-470-6030 Fax: 630-470-6031

EMERGENCY TELEPHONE NUMBERS
UniSource Energy, Inc. 1-800-444-5510
CHEMTREC 1-800-424-9300

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

CAS Number	Material or Component	% By Weight
68477-30-5	INTERMEDIATE-BOILING PETROLEUM DISTILLATES, CATALYTIC REFORMER FRACTIONATOR RESIDUE	100
	POLYCYCLIC AROMATIC HYDROCARBONS (PNAs or PAHs)	< 3
91-20-3	NAPHTHALENE	< 0.4

SECTION 3 HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

CONTAINS MATERIAL WHICH MAY CAUSE DAMAGE TO RESPIRATORY TRACT, EYES, SKIN, LUNGS, CENTRAL NERVOUS SYSTEM, DIGESTIVE SYSTEM.
MAY CAUSE IRRITATION TO EYES, SKIN OR RESPIRATORY TRACT.

ROUTES OF ENTRY: Absorbed through dermal contact, eye contact, inhalation, ingestion

POTENTIAL ACUTE HEALTH EFFECTS

Eyes: Liquid and vapor may cause eye irritation.
Skin: May cause skin irritation characterized by itching, scaling, reddening or blistering.
Inhalation: May cause respiratory tract irritation, dizziness, agitation, headaches and fatigue. May cause nausea, damage to kidney and liver, and CNS effects.
Ingestion: May cause irritation of mouth, throat, and gastrointestinal tract. If swallowed, aspiration into lungs may result in chemical pneumonitis and severe pulmonary injury.

POTENTIAL CHRONIC HEALTH EFFECTS

The substance is harmful to the nervous system, digestive system, skin, eyes. Signs and symptoms of chronic exposure are similar to those of acute exposure.

Carcinogenic Effects

This product as a whole is not listed as a carcinogen by OSHA, NTP or IARC.
However, this product contains a material which may cause cancer:
Naphthalene: Classified 2 (Reasonably anticipated to be human carcinogens) by NTP
This product may contain polycyclic aromatic hydrocarbons (PAHs) or polynuclear aromatics (PNAs), some of which are known to cause skin cancer in humans under conditions of poor personal hygiene and prolonged, repeated contact.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE

Repeated or prolonged contact with spray mist may produce chronic eye irritation, severe skin irritation or respiratory tract irritation leading to frequent attacks of bronchial infection.

OVEREXPOSURE/SIGNS/SYMPTOMS

Overexposure may cause central nervous system effects and irritation to eyes, skin and respiratory tract.

(See Toxicological Information – Section 11)

SECTION 4 FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water while holding eyelids open. Remove contact lenses, if worn, after initial flushing, and continue flushing for at least 15 minutes. If irritation occurs, get immediate medical attention.

SKIN CONTACT: Wash contact areas immediately with soap and water. Remove contaminated clothing and place in closed container for storage until laundered or discarded. Thoroughly clean contaminated clothing before reuse.

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

INGESTION: DO NOT induce vomiting; aspiration into lungs may cause chemical pneumonia and severe lung damage. If spontaneous vomiting occurs, keep head below hips to prevent aspiration and monitor for breathing difficulty. Seek immediate medical attention.

NOTES TO PHYSICIAN: Not available

SECTION 5 FIRE FIGHTING MEASURES

FLAMMABILITY CLASS: IIIB – May be combustible at high temperatures

FLASH POINT: Closed Cup: > 121.1ºC (> 250ºF) (Tagliabue)

PRODUCTS OF COMBUSTION: Carbon oxides (COx)

FIRE HAZARDS IN PRESENCE OF VARIOUS SUBSTANCES

Flammable in presence of open flames, sparks and heat

EXPLOSION HAZARDS IN PRESENCE OF VARIOUS SUBSTANCES:

Risks of explosion of the product in presence of mechanical impact: Not expected
Risks of explosion of the product in presence of static discharge: Possible

FIRE FIGHTING MEDIA AND INSTRUCTIONS:

SMALL FIRE: Use DRY chemical powder, halon and CO2.
LARGE FIRE: Use water spray, fog or foam. DO NOT use water jet.

PROTECTIVE CLOTHING (FIRE):

Wear MSHA/NIOSH approved self-contained breathing apparatus or equivalent and full protective gear (Bunker gear).

NFPA HAZARD ID

Health: 3	Fire Hazard: 1	Reactivity: 0	Special Notice: COR

HMIS HAZARD ID

Health: 3	Flammability: 1	Physical Hazard : 0	Personal Protection: None

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

U.S. regulations may require reporting releases of this material to the environment which exceed the reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. Report spills to local authorities and/or the National Response Center at (800) 424-8802 as appropriate or required.

PROTECTIVE MEASURES

Avoid contact with spilled material. Warn or evacuate occupants in surrounding area. Eliminate all (potential) sources of ignition in the vicinity of the spill or released vapor. Handling equipment must be grounded to prevent sparking.

SPILL MANAGEMENT

Land Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if it can be done without risk. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Prevent entry into waterways, sewers, basements or confined areas. A vapor-suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
Water Spill: Stop leak if it can be done without risk. Confine the spill immediately with booms. Warn other vessels. Remove from the surface by skimming or with suitable absorbents. Report spills as required to appropriate authorities. Seek the advice of a specialist before using dispersants.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Contain spill and safely stop the flow, warning personnel to stay away. Eliminate all sources of ignition and ventilate. Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas. Water spray may reduce vapor, but may not prevent ignition in closed spaces. Recover with appropriate pumping equipment or with suitable absorbent.
Small Spills: Absorb with an inert material such as clay or sand. Place in appropriate non-leaking container. Seal tightly for proper disposal.

Note: Local regulations may prescribe or limit action to be taken.

SECTION 7 HANDLING AND STORAGE

HANDLING

Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Ground lines and equipment used during transfer to reduce the possibility of static spark-initiated fire or explosion. Use non-sparking tools. Keep away from incompatibles such as oxidizing agents.
DO NOT ingest. Do not breathe gas, fumes, vapor or spray. Do not eat, drink or smoke in areas of use or storage. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately, showing them the container or the label. Avoid contact with skin and eyes.
Use good personal hygiene practices. Do not eat, drink or smoke in areas of use or storage.
ALWAYS WASH THOROUGHLY WITH SOAP AND WATER AFTER HANDLING THIS PRODUCT.

STORAGE

Combustible materials should be stored in a separate labeled safety storage cabinet or room. Keep away from heat and all possible sources of ignition. Keep container tightly closed and dry. Keep in a cool and well-ventilated area. Ground all equipment containing material. Empty containers may contain material residue; do not reuse without adequate precautions.
All efforts should be made to prevent any leaks or spills. Storage tanks containing this product should be engineered to prevent contact with water resources, as this material could contaminate the water resources. Surface spills can reach groundwater through porous soil or cracked surfaces. The storage tanks should be monitored regularly for leaks. Where spills or leaks are possible, a comprehensive response plan should be developed and implemented.

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

Eyes: Safety glasses with side shields
Body: Coveralls
Respiratory: Use a MSHA/NIOSH approved respirator or equivalent at high concentrations.
Hands: Chemical resistant gloves if contact is possible. Discard contaminated gloves.
Feet: Boots

PROTECTIVE CLOTHING

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.

THRESHOLD LIMIT VALUE: No Threshold Limit Value (TLV) or Permissible Exposure Limit (PEL) has been published for this material. Some specific components may have established exposure limits (see below).

The best practice is to maintain concentrations of all atmospheric contaminants as low as practical using engineering controls and work rules. Appropriate personal protective equipment may be used for additional protection of the worker from exposure. For application of TLV's or PEL's consult an industrial hygienist.

Material or Component	Exposure Limits
INTERMEDIATE-BOILING PETROLEUM DISTILLATES, CATALYTIC REFORMER FRACTIONATOR RESIDUE	Not established
POLYCYCLIC AROMATIC HYDROCARBONS (PNAs or PAHs)	**OSHA PEL (US, 6/93) & ACGIH TLV (US, 1/08)** TWA: 0.2 mg/m³ (Benzene Soluble) 8 hours
NAPHTHALENE	**ACGIH TLV (U.S. 1/08) & NIOSH REL (US, 6/08)** STEL: 15 ppm 15 minutes TWA: 10 ppm 8 hrs-ACGIH, 10 hrs-NIOSH **OSHA PEL** (U.S. 11/06) TWA: 50 mg/m³ (10 ppm) 8 hours

Consult local authorities for acceptable exposure limits.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE AND APPEARANCE: Liquid
ODOR: Aromatic
COLOR: Straw to amber
BOILING/CONDENSATION PT: 271 to 399ºC (520 to 750ºF)
SPECIFIC GRAVITY: 1.02 (Water = 1)
VAPOR PRESSURE: < 1 Reid Vapor Pressure
VAPOR DENSITY: 4.5 (Air = 1)
VOLATILITY: 100% (v/v)
EVAPORATION RATE: Not available
VOC: 100%
SOLUBILITY IN WATER: Negligible

SECTION 10 STABILITY AND REACTIVITY

STABILITY AND REACTIVITY: The product is stable.
CONDITIONS OF INSTABILITY: No additional remark
INCOMPATIBILITY WITH VARIOUS SUBSTANCES: Extremely reactive/ incompatible with strong oxidizing agents.
HAZARDOUS DECOMPOSITION PRODUCTS: Carbon Monoxide & Carbon Dioxide
HAZARDOUS POLYMERIZATION: No

SECTION 11 TOXICOLOGICAL INFORMATION

TOXICITY TO ANIMALS: Not available
CHRONIC EFFECTS ON HUMANS:

The substance is toxic to the nervous system, digestive system, skin, eyes and lungs.

Carcinogenic Effects

This product as a whole is not listed as a carcinogen by OSHA, NTP or IARC.
However, this product contains a material which may cause cancer:
Naphthalene: Classified 2 (Reasonably anticipated to be human carcinogens) by NTP
This product may contain polycyclic aromatic hydrocarbons (PAHs) or polynuclear aromatics (PNAs), some of which are known to cause skin cancer in humans under conditions of poor personal hygiene and prolonged, repeated contact.

OTHER TOXIC EFFECTS ON HUMANS:

Very hazardous in case of inhalation.
Hazardous in case of skin or eye contact (irritant) or ingestion

SPECIAL REMARKS ON TOXICITY TO ANIMALS:

This product contains low levels of polynuclear aromatics (PNAs) which have been shown to cause skin cancer in mouse painting studies. Because the component was repeatedly applied and never washed from the animals' skin, the significance of these findings to human health is uncertain. Several studies have shown that washing the animals' skin with soap and water between applications greatly reduces tumor formation.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY: Not available
BOD5 and COD: Not available
BIODEGRADABLE/OECD: Not available
MOBILITY: Not available
TOXICITY OF THE PRODUCTS OF BIODEGRADATION: No information available
SPECIAL REMARKS ON THE PRODUCTS OF BIODEGRADATION: No additional remark

SECTION 13 DISPOSAL CONSIDERATIONS

WASTE DISPOSAL

Recover free liquid. Transfer to a safe disposal area in accordance with federal, state, and local regulations.

Consult your local or regional authorities.

SECTION 14 TRANSPORT INFORMATION

U.S. DOT CLASSIFICATION FOR BULK SHIPMENTS
Proper Shipping Name: UN 3082, Environmentally Hazardous Substances, liquid, n.o.s. (aromatic hydrocarbon), 9, III RQ (contains naphthalene)
Hazard Class & Division: DOT Class 9: Miscellaneous Hazardous Material
UN/NA Number: UN 3082
Packing Group: III

USCG PROPER SHIPPING NAME: Naphtha: Aromatic
MARINE POLLUTANT: Not listed in Appendix B of 49 CFR 172.101
HAZARDOUS SUBSTANCES REPORTABLE QUANTITY: Not listed in Appendix A of 49 CFR 172.101

SECTION 15 REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

TSCA: All components are listed.

SARA 302/304

Extremely Hazardous Substances: No products were found.
Emergency Planning and Notification: No products were found.
Hazardous Chemicals: INTERMEDIATE-BOILING PETROLEUM DISTILLATES, CATALYTIC REFORMER FRACTIONATOR RESIDUE

SARA 311/312

The following chemicals in this product require reporting under the requirements of 40 CFR 370, Hazardous Chemical Reporting: Community Right-To-Know. The hazard category for each chemical is also listed.

Chemical Name	Immediate Hazard	Delayed Hazard	Fire Hazard	Pressure Hazard	Reactivity Hazard
INTERMEDIATE-BOILING PETROLEUM DISTILLATES, CATALYTIC REFORMER FRACTIONATOR RESIDUE	X	X	-	-	-

SARA 313 SUPPLIER NOTIFICATION

This product contains the following EPCRA Section 313 chemicals subject to the reporting requirements of 40 CFR 372 – Table 372.65:

Product Name	CAS #	Concentration (%)
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs, PNAs)	-	< 3
NAPHTHALENE	91-20-3	< 0.4

CLEAN WATER ACT (CWA)

CWA 307: NAPHTHALENE
CWA 311: NAPHTHALENE

CLEAN AIR ACT (CAA) 112

Accidental Release Prevention: No products were found.
Regulated Flammable Substances: No products were found.
Regulated Toxic Substances: No products were found.

INTERNATIONAL REGULATIONS

CANADA

WHMIS: Class D-2A: Material causing other toxic effects (Very toxic)
CEPA Toxic Substances: None of the components are listed.
Canadian ARET: None of the components are listed.
Canadian NPRI: None of the components are listed.
Alberta Designated Substances: None of the components are listed.
Ontario Designated Substances: None of the components are listed.
Quebec Designated Substances: None of the components are listed.

EUROPE

EINECS: Not available
DSCL (EEC): R45 – May cause cancer

INTERNATIONAL INVENTORY LISTS

Australia Inventory (AICS): All components are listed or exempted.
China Inventory (IECSC): All components are listed or exempted.
Japan Inventory (ENCS/ISHL): Not determined
Korea Inventory (KECI): All components are listed or exempted.
New Zealand Inventory (NZIoC): Not determined
Philippines Inventory (PICCS): Not determined

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: NAPHTHALENE, POLYCYCLIC AROMATIC HYDROCARBONS (PAHs or PNAs)

The following components are listed as hazardous substances by some states in the U.S.:
NAPHTHALENE, POLYCYCLIC AROMATIC HYDROCARBONS (PAHs or PNAs)

Please consult with local state agencies for regulatory compliance.
Additional information is available upon request.

SECTION 16 OTHER INFORMATION

REVISIONS

This Material Safety Data Sheet (MSDS) has been created to fully comply with the guidance contained in the ANSI MSDS standard (ANSI Z400.1-1998).

LABEL REQUIREMENTS

CONTAINS MATERIAL WHICH MAY CAUSE DAMAGE TO RESPIRATORY TRACT, EYES, SKIN, LUNGS, CENTRAL NERVOUS SYSTEM, DIGESTIVE SYSTEM.
MAY CAUSE IRRITATION TO EYES, SKIN OR RESPIRATORY TRACT.

DATE PREPARED: MARCH 2011 **UNIAROM® SX 250 IF**

SIGMA-ALDRICH

sigma-aldrich.com

SAFETY DATA SHEET

Version 4.7
Revision Date 10/07/2014
Print Date 02/26/2015

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : Xylenes

Product Number : 247642
Brand : Sigma-Aldrich

CAS-No. : 1330-20-7

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
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 3), H226
Acute toxicity, Inhalation (Category 4), H332
Acute toxicity, Dermal (Category 4), H312
Skin irritation (Category 2), H315
Acute aquatic toxicity (Category 2), H401
Chronic aquatic toxicity (Category 2), H411

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)

H226	Flammable liquid and vapour.
H312 + H332	Harmful in contact with skin or if inhaled
H315	Causes skin irritation.
H411	Toxic to aquatic life with long lasting effects.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.

P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ 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/ protective clothing/ eye protection/ face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P312	Call a POISON CENTER or doctor/ physician if you feel unwell.
P322	Specific measures (see supplemental first aid instructions on this label).
P332 + P313	If skin irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
P391	Collect spillage.
P403 + P235	Store in a well-ventilated place. Keep cool.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.2 Mixtures

Synonyms : Xylene mixture of isomers

Formula : C_8H_{10}

Molecular weight : 106.17 g/mol

Hazardous components

Component		Classification	Concentration
Xylene			
CAS-No. EC-No. Index-No.	1330-20-7 215-535-7 601-022-00-9	Flam. Liq. 3; Acute Tox. 4; Skin Irrit. 2; Aquatic Acute 2; Aquatic Chronic 2; H226, H312 + H332, H315, H411	>= 90 - <= 100 %
Ethylbenzene			
CAS-No. EC-No. Index-No.	100-41-4 202-849-4 601-023-00-4	Flam. Liq. 2; Acute Tox. 4; Aquatic Acute 2; Aquatic Chronic 2; H225, H332, H411	>= 20 - < 30 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

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.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. Consult a physician.

In case of eye contact

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. 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
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

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
Carbon oxides

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

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
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).

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 inhalation of vapour or mist.
Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Xylene	1330-20-7	TWA	100 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Eye & Upper Respiratory Tract irritation Central Nervous System impairment Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen		
		STEL	150 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Eye & Upper Respiratory Tract irritation Central Nervous System impairment Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen		
		STEL	150 ppm 655 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	100 ppm 435 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	100 ppm 435 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
Ethylbenzene	100-41-4	TWA	20 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Cochlear impair Kidney damage (nephropathy) Upper Respiratory Tract irritation Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Confirmed animal carcinogen with unknown relevance to humans		
		TWA	100 ppm 435 mg/m3	USA. NIOSH Recommended Exposure Limits
		ST	125 ppm 545 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	100 ppm 435 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		TWA	100 ppm 435 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		STEL	125 ppm 545 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Xylene	1330-20-7	Methylhippuri c acids	1,500.000 0 mg/g	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			
		Methylhippuri c acids	1,500.000 0 mg/g	Urine	ACGIH - Biological Exposure Indices (BEI)
		End of shift (As soon as possible after exposure ceases)			
Ethylbenzene	100-41-4	Ethylbenzene		In end-exhaled air	ACGIH - Biological Exposure Indices (BEI)

		Not critical

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Tightly fitting safety goggles. Faceshield (8-inch minimum). 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.

Full contact
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: 480 min
Material tested:Vitoject® (KCL 890 / Aldrich Z677698, Size M)

Splash contact
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: 480 min
Material tested:Vitoject® (KCL 890 / Aldrich Z677698, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, 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 and safety officer 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, 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.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose 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).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: clear, liquid Colour: colourless
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	< 0 °C (< 32 °F)
f)	Initial boiling point and	137 - 140 °C (279 - 284 °F) - lit.

	boiling range	
g)	Flash point	25 °C (77 °F) - closed cup
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 7 %(V) Lower explosion limit: 1.1 %(V)
k)	Vapour pressure	24 hPa (18 mmHg) at 37.70 °C (99.86 °F)
l)	Vapour density	3.67 - (Air = 1.0)
m)	Relative density	0.86 g/mL at 25 °C (77 °F)
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition 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

Relative vapour density 3.67 - (Air = 1.0)

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
Vapours may form explosive mixture with air.

10.4 Conditions to avoid
Heat, flames and sparks.

10.5 Incompatible materials
Strong oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
No data available

Inhalation: No data available

Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity

No data available

Carcinogenicity

IARC:	2B - Group 2B: Possibly carcinogenic to humans (Ethylbenzene)
IARC:	3 - Group 3: Not classifiable as to its carcinogenicity to humans (Xylene)
NTP:	No component 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 identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available
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

Additional Information
RTECS: Not available

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Liver - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence (Ethylbenzene)

12. ECOLOGICAL INFORMATION

12.1 Toxicity
No data available

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
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

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: 1307 Class: 3 Packing group: III
Proper shipping name: Xylenes
Reportable Quantity (RQ): 100 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1307 Class: 3 Packing group: III EMS-No: F-E, S-D
Proper shipping name: XYLENES
Marine pollutant: No

IATA
UN number: 1307 Class: 3 Packing group: III
Proper shipping name: Xylenes

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:

	CAS-No.	Revision Date
Ethylbenzene	100-41-4	2007-07-01
Xylene	1330-20-7	1993-04-24

SARA 311/312 Hazards
Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Ethylbenzene	100-41-4	2007-07-01
Xylene	1330-20-7	1993-04-24

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Ethylbenzene	100-41-4	2007-07-01
Xylene	1330-20-7	1993-04-24

New Jersey Right To Know Components

	CAS-No.	Revision Date
Ethylbenzene	100-41-4	2007-07-01
Xylene	1330-20-7	1993-04-24

California Prop. 65 Components

	CAS-No.	Revision Date
WARNING! This product contains a chemical known to the State of California to cause cancer. Ethylbenzene	100-41-4	2007-09-28

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Aquatic Acute	Acute aquatic toxicity
Aquatic Chronic	Chronic aquatic toxicity
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H226	Flammable liquid and vapour.
H312	Harmful in contact with skin.
H312 + H332	Harmful in contact with skin or if inhaled
H315	Causes skin irritation.
H332	Harmful if inhaled.
H401	Toxic to aquatic life.
H411	Toxic to aquatic life with long lasting effects.
Skin Irrit.	Skin irritation

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

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.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 4.7 Revision Date: 10/07/2014 Print Date: 02/26/2015

SAFETY DATA SHEET

Version 5.4
Revision Date 02/24/2014
Print Date 02/26/2015

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : **Toluene**

Product Number : 179418
Brand : Sigma-Aldrich
Index-No. : 601-021-00-3
REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.
CAS-No. : 108-88-3

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
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Skin irritation (Category 2), H315
Reproductive toxicity (Category 2), H361
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336
Specific target organ toxicity - repeated exposure (Category 2), H373
Aspiration hazard (Category 1), H304
Acute aquatic toxicity (Category 2), H401

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 Danger

Hazard statement(s)
H225 Highly flammable liquid and vapour.
H304 May be fatal if swallowed and enters airways.
H315 Causes skin irritation.
H336 May cause drowsiness or dizziness.
H361 Suspected of damaging fertility or the unborn child.

H373	May cause damage to organs through prolonged or repeated exposure.
H401	Toxic to aquatic life.

Precautionary statement(s)

P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ 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/ protective clothing/ eye protection/ face protection.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P308 + P313	IF exposed or concerned: Get medical advice/ attention.
P321	Specific treatment (see supplemental first aid instructions on this label).
P331	Do NOT induce vomiting.
P332 + P313	If skin irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
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

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula	:	C_7H_8
Molecular Weight	:	92.14 g/mol
CAS-No.	:	108-88-3
EC-No.	:	203-625-9
Index-No.	:	601-021-00-3

Hazardous components

Component	Classification	Concentration
Toluene		
	Flam. Liq. 2; Skin Irrit. 2; Repr. 2; STOT SE 3; STOT RE 2; Asp. Tox. 1; Aquatic Acute 2; H225, H304, H315, H336, H361, H373, H401	90 - 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

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.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. 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.

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

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
Carbon oxides

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

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
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).

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 inhalation of vapour or mist.
Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Toluene	108-88-3	TWA	100 ppm 375 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		STEL	150 ppm 560 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	200 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Remarks	Z37.12-1967		
		CEIL	300 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
		Z37.12-1967		
		Peak	500 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
		Z37.12-1967		
		TWA	20 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Visual impairment Female reproductive Pregnancy loss 2010 Adoption Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen		
		TWA	100 ppm 375 mg/m3	USA. NIOSH Recommended Exposure Limits
		ST	150 ppm 560 mg/m3	USA. NIOSH Recommended Exposure Limits

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Toluene	108-88-3	Toluene	0.02 mg/l	In blood	ACGIH - Biological Exposure Indices (BEI)
	Remarks	Prior to last shift of workweek			
		Toluene	0.03 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
		End of shift (As soon as possible after exposure ceases)			
		o-Cresol	0.3 mg/g	Urine	ACGIH - Biological Exposure Indices (BEI)
		End of shift (As soon as possible after exposure ceases)			

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

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.

Full contact
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: 480 min
Material tested:Vitoject® (KCL 890 / Aldrich Z677698, Size M)

Splash contact
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: 480 min
Material tested:Vitoject® (KCL 890 / Aldrich Z677698, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, 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 and safety officer 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, 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.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose 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).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Colour: colourless
b)	Odour	no data available
c)	Odour Threshold	no data available
d)	pH	no data available
e)	Melting point/freezing point	Melting point/range: -93 °C (-135 °F)
f)	Initial boiling point and boiling range	110 - 111 °C (230 - 232 °F)
g)	Flash point	4.0 °C (39.2 °F) - closed cup
h)	Evapouration rate	no data available
i)	Flammability (solid, gas)	no data available

j)	Upper/lower flammability or explosive limits	Upper explosion limit: 7 %(V) Lower explosion limit: 1.2 %(V)
k)	Vapour pressure	29.1 hPa (21.8 mmHg) at 20.0 °C (68.0 °F)
l)	Vapour density	no data available
m)	Relative density	0.865 g/mL at 25 °C (77 °F)
n)	Water solubility	no data available
o)	Partition coefficient: n-octanol/water	no data available
p)	Auto-ignition temperature	535.0 °C (995.0 °F)
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

10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
Vapours may form explosive mixture with air.

10.4 Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

10.5 Incompatible materials
Strong oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - > 5,580 mg/kg

LC50 Inhalation - rat - 4 h - 12,500 - 28,800 mg/m3

LD50 Dermal - rabbit - 12,196 mg/kg

no data available

Skin corrosion/irritation
Skin - rabbit
Result: Skin irritation - 24 h

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
rat
Liver
DNA damage

Carcinogenicity

IARC:	3 - Group 3: Not classifiable as to its carcinogenicity to humans (Toluene)
NTP:	No component 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 identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
Damage to fetus possible
Suspected human reproductive toxicant

Reproductive toxicity - rat - Inhalation
Paternal Effects: Spermatogenesis (including genetic material, sperm morphology,motility, and count).

Experiments have shown reproductive toxicity effects in male and female laboratory animals.

Developmental Toxicity - rat - Oral
Effects on Embryo or Fetus: Fetotoxicity (except death, e.g., stunted fetus).

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: XS5250000

Lung irritation, chest pain, pulmonary edema, Inhalation studies on toluene have demonstrated the development of inflammatory and ulcerous lesions of the penis, prepuce, and scrotum in animals.

Stomach - Irregularities - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Oncorhynchus mykiss (rainbow trout) - 7.63 mg/l - 96 h
	NOEC - Pimephales promelas (fathead minnow) - 5.44 mg/l - 7 d
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 8.00 mg/l - 24 h
	Immobilization EC50 - Daphnia magna (Water flea) - 6 mg/l - 48 h
Toxicity to algae	EC50 - Chlorella vulgaris (Fresh water algae) - 245.00 mg/l - 24 h
	EC50 - Pseudokirchneriella subcapitata (green algae) - 10.00 mg/l - 24 h

12.2 Persistence and degradability
Biodegradability Result: - Readily biodegradable.

12.3 Bioaccumulative potential
no data available

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 Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

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: 1294 Class: 3 Packing group: II
Proper shipping name: Toluene
Reportable Quantity (RQ): 1000 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG

UN number: 1294 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: TOLUENE
Marine pollutant: No

IATA

UN number: 1294 Class: 3 Packing group: II
Proper shipping name: Toluene

15. REGULATORY INFORMATION

REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

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

The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Toluene	108-88-3	2007-07-01

SARA 311/312 Hazards

Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Toluene	108-88-3	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Toluene	108-88-3	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Toluene	108-88-3	2007-07-01

California Prop. 65 Components

WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm. Toluene	CAS-No. 108-88-3	Revision Date 2009-02-01

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Aquatic Acute	Acute aquatic toxicity
Asp. Tox.	Aspiration hazard
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H304	May be fatal if swallowed and enters airways.
H315	Causes skin irritation.
H336	May cause drowsiness or dizziness.
H361	Suspected of damaging fertility or the unborn child.
H373	May cause damage to organs through prolonged or repeated exposure.
H401	Toxic to aquatic life.
Repr.	Reproductive toxicity
Skin Irrit.	Skin irritation

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

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.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

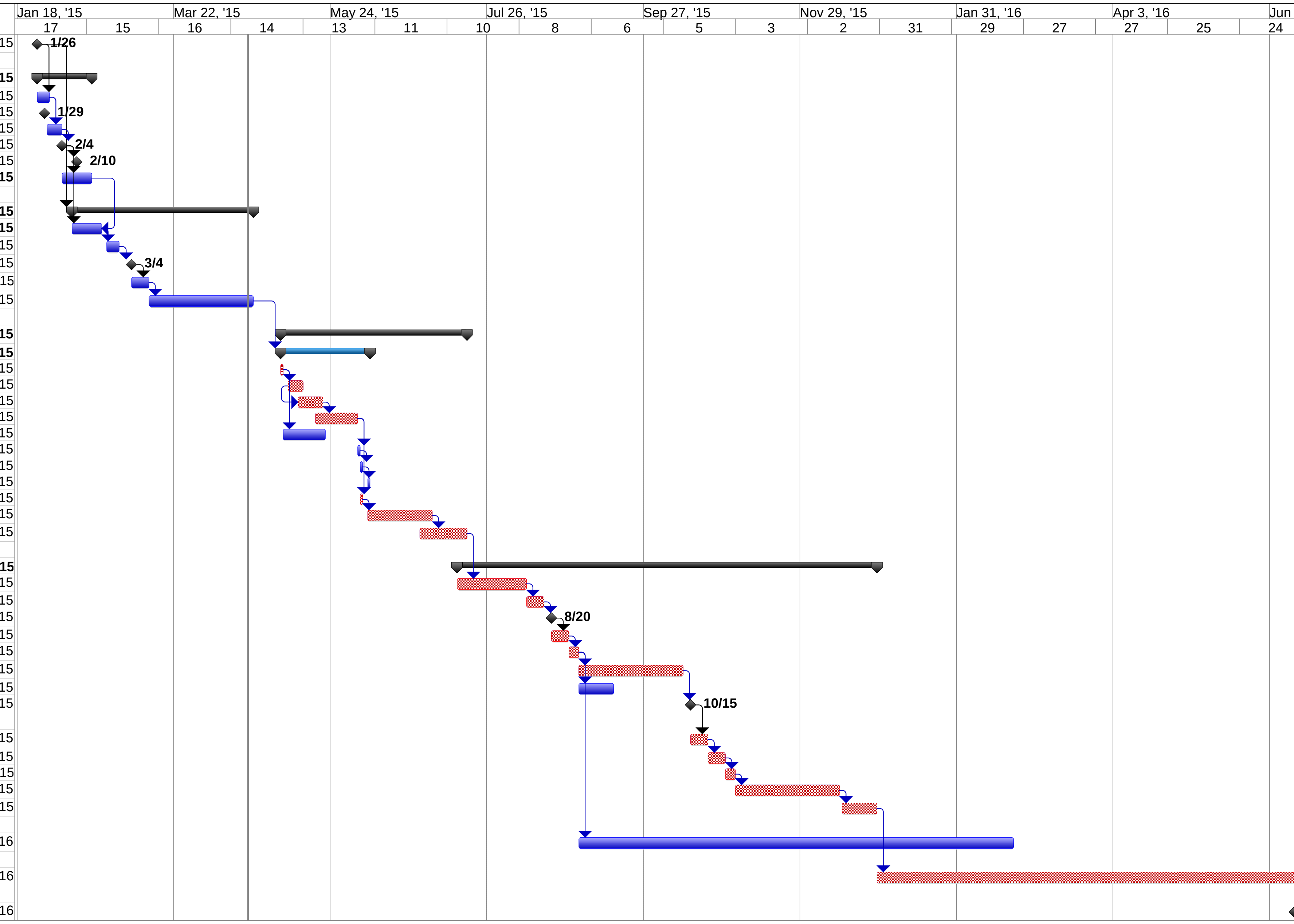
Version: 5.4 Revision Date: 02/24/2014 Print Date: 02/26/2015

APPENDIX C

REMEDIAL DESIGN AND PROCUREMENT SCHEDULE

Remedial Design and Procurement Schedule
Clove and Maple Ave Former MGP Site - Operable Unit 1
Haverstraw, NY

ID	Task Name	Duration	Start	Finish
1	**Authorization to Proceed**	0 days	Mon 1/26/15	Mon 1/26/15
2				
3	**Task 1.0 - Pre-Design Investigation Work Plan**	**16 days**	**Mon 1/26/15**	**Mon 2/16/15**
4	Project Transition, Receive Documents	5 days	Mon 1/26/15	Fri 1/30/15
5	Project Kickoff Meeting (Teleconference) w/NYSDEC	0 days	Thu 1/29/15	Thu 1/29/15
6	Review of Site Documents and Analysis of Potential Data Gaps	4 days	Fri 1/30/15	Wed 2/4/15
7	Deliver Analysis of Data Gaps to O&R	0 days	Wed 2/4/15	Wed 2/4/15
8	Data Gaps Discussion (Teleconference)	0 days	Tue 2/10/15	Tue 2/10/15
9	Prepare PDI Work Plan	**8 days**	**Thu 2/5/15**	**Mon 2/16/15**
10				
11	**Task 2.0 - Remedial Design Work Plan (RDWP)**	**53 days**	**Mon 2/9/15**	**Wed 4/22/15**
12	Prepare Draft of Remedial Design Work Plan	**10 days**	**Mon 2/9/15**	**Fri 2/20/15**
13	O&R Review of RDWP	5 days	Mon 2/23/15	Fri 2/27/15
14	Meeting With O&R to Discuss Design Considerations (Spring Valley)	0 days	Wed 3/4/15	Wed 3/4/15
15	**Complete PDI and Remedial Design Work Plan**	5 days	Thu 3/5/15	Wed 3/11/15
16	NYSDEC Review of PDIWP and RDWP	30 days	Thu 3/12/15	Wed 4/22/15
17				
18	**Task 2.1 - Pre-Design Investigation**	**55 days**	**Mon 5/4/15**	**Fri 7/17/15**
19	**Field Activities**	**26 days**	**Mon 5/4/15**	**Mon 6/8/15**
20	Surveying	1 day	Mon 5/4/15	Mon 5/4/15
21	Utility Clearance	4 days	Thu 5/7/15	Tue 5/12/15
22	Delineation Borings	8 days	Mon 5/11/15	Wed 5/20/15
23	Geotechnical Borings	13 days	Mon 5/18/15	Wed 6/3/15
24	Hydrogeologic Data Collection	13 days	Tue 5/5/15	Thu 5/21/15
25	Water Discharge Assessment	1 day	Thu 6/4/15	Thu 6/4/15
26	Drainage Swale Assessment	1 day	Fri 6/5/15	Fri 6/5/15
27	Structural Evaluation	1 day	Mon 6/8/15	Mon 6/8/15
28	Final Survey/IDW Management	1 day	Fri 6/5/15	Fri 6/5/15
29	Laboratory Analytical	20 days	Mon 6/8/15	Fri 7/3/15
30	Design Considerations Summary	15 days	Mon 6/29/15	Fri 7/17/15
31				
32	**Task 3.0 - Remedial Design**	**121 days**	**Tue 7/14/15**	**Tue 12/29/15**
33	Prepare Draft 65% Design	20 days	Tue 7/14/15	Mon 8/10/15
34	Constructability Review and Report	5 days	Tue 8/11/15	Mon 8/17/15
35	65% Remedial Design Meeting with O&R (Spring Valley) - Discuss DEC comments to RDWP	0 days	Thu 8/20/15	Thu 8/20/15
36	O&R Review of 65% Design	5 days	Fri 8/21/15	Thu 8/27/15
37	**Incorporate Revisions - Complete 65% Design**	2 days	Fri 8/28/15	Mon 8/31/15
38	NYSDEC Review (65% Design)	30 days	Tue 9/1/15	Mon 10/12/15
39	Prepare Draft 100% Design	10 days	Tue 9/1/15	Mon 9/14/15
40	100% Remedial Design Meeting with O&R (Spring Valley) - Discuss DEC comments to 65% Design	0 days	Thu 10/15/15	Thu 10/15/15
41	**Complete Draft 100% Design**	5 days	Fri 10/16/15	Thu 10/22/15
42	O&R Review of Draft 100% Design	5 days	Fri 10/23/15	Thu 10/29/15
43	Incorporate Revisions	2 days	Fri 10/30/15	Mon 11/2/15
44	NYSDEC Review	30 days	Tue 11/3/15	Mon 12/14/15
45	**Complete 100% Design**	10 days	Wed 12/16/15	Tue 12/29/15
46				
47	**Permitting**	125 days	Tue 9/1/15	Mon 2/22/16
48				
49	**O&R Procurement**	6 mons	Wed 12/30/15	Tue 6/14/16
50				
51	**Contractor Mobilization**	0 days	Tue 6/14/16	Tue 6/14/16



Project: O&R Clove and Maple Schedu
Date: Tue 4/21/15

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Progress	
Split		External Tasks		Inactive Summary		Manual Summary		Deadline	
Milestone		External Milestone		Manual Task		Start-only		task	
Summary		Inactive Task		Duration-only		Finish-only			

Bold Font - Deliverable
Blue Font - Meeting
Green Font - Agency Review