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Final

Dynamic Work Plan
Triad Investigation at Site 2

St. Juliens Creek Annex
Chesapeake, Virginia

NAVFAC
Naval Facilities Engineering Command

Prepared for

Department of the Navy

Naval Facilities Engineering Command
Mid-Atlantic

Contract No. N62470-02-D-3052
CTO-0024

April 2007

Prepared by

CH2MHILL

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Under the

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Contract N62470-02-D-3052

Prepared by

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Virginia Beach, Virginia

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Acronyms and Abbreviations

2-D	two dimensional
3-D	three dimensional
ABM	abrasive blast media
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AST	above ground storage tanks
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	chemical of concern
CSM	conceptual site model
CTO	Contract Task Order
CVOC	chlorinated volatile organic compound
DCE	dichloroethene
DI	deionized
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DPT	direct-push technology
DQO	data quality objective
DWP	Dynamic Work Plan
ECD	electron capture device
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ERI	Expanded Remedial Investigation
ESS	Explosives Safety Submission
FID	flame ionization detector
FS	Feasibility Study
ft	feet
ft/min	foot per minute
GC	gas chromatographer
GIS	Geographic Information System
GPS	global positioning system
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment

HSE&Q	Health, Safety, Environment & Quality
ID	inside diameter
IDW	investigation-derived waste
IR	Installation Restoration
ITRC	Interstate Technology Regulatory Council
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
mg/L	milligrams per liter
MAROS	Monitoring and Remediation Optimization System
MCL	Maximum Contaminant Level
MDL	method detection limit
MEC	munitions and explosives of concern
MFSP	Master Field Sampling Plan
MHSP	Master Health and Safety Plan
MIDWMP	Master Investigation-Derived Waste Management Plan
MIP	membrane interface probe
MNA	monitored natural attenuation
MPP	Master Project Plan
MQAPP	Master Quality Assurance Project Plan
mS/cm	millisiemens per centimeter
MS/MSD	matrix spike/matrix spike duplicate
msl	mean sea level
mV	millivolts
MVS	Mining Visualization System
MWP	Master Work Plan
NAS	Natural Attenuation Software
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NFESC	Navy Facilities Engineering Service Center
NOAA	National Oceanic & Atmospheric Administration
NOSSA	Naval Ordnance Safety & Security Activity
ORP	oxidation-reduction potential
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector
PTEG	polyethylene terephalate glycol
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAO	remedial action objective
RBC	risk-based criteria
RCRA	Resource Conservation Recovery Act
RI	Remedial Investigation

RPM	Restoration Project Manager
SJCA	St. Juliens Creek Annex
SOP	standard operating procedure
SVOC	semivolatile organic compound
TCA	trichloroethane
TCE	trichloroethene
TCLP	Toxicity Characterization Leaching Procedure
TOC	total organic carbon
UST	underground storage tank
UXO	unexploded ordnance
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound

SECTION 1

Introduction

This Dynamic Work Plan (DWP) presents the methodology and decision logic required to implement an adaptive sampling and analysis program at Site 2, St. Juliens Creek Annex (SJCA), Chesapeake, Virginia. The locations of SJCA and Site 2 are shown on Figures 1-1 and 1-2, respectively. This investigation is being performed in response to the SJCA Project Management Team; consisting of representatives from the United States Navy, Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, United States Environmental Protection Agency (EPA) Region III, Virginia Department of Environmental Quality (VDEQ), and CH2M HILL; agreement for additional delineation of chlorinated volatile organic compounds (CVOCs).

The project work described in this DWP is being conducted using the Triad approach. The Triad approach has been developed over the years and has more recently evolved into a preferred approach for cost-effective environmental site investigation at selected government-owned facilities (Interstate Technology Regulatory Council [ITRC], 2003). This approach is based on three principle components: Systematic Planning, Dynamic Work Strategies, and Real-Time Measurement Technologies. Systematic Planning identifies key objectives and decision points through use of a conceptual site model (CSM). Dynamic Work Strategies provide contingencies, which give the project team the flexibility to make decisions and modify field activities quickly based on information as it is acquired. Real-time measurement technologies acquire data in near- or real-time to support site decisions and CSM evolution. The primary objective of the Triad approach is to eliminate decision uncertainty by collecting the optimum amount of data using a cost-effective methodology.

This DWP presents the CSM, develops the investigation activities, identifies sample analysis and data management procedures, and presents the project schedule and follow-up activities. This DWP is a "flexible" work plan that can be modified as new data are obtained, the CSM is refined, and the investigation proceeds.

1.1 Systematic Planning Summary

The Systematic Planning phase of the Triad investigation includes meetings and continuous project team communication. A face-to-face meeting was conducted on December 14, 2006 to establish the project team and determine the process for conducting the Triad investigation. Continual communication among project team members through e-mail and phone calls has been conducted following the meeting. Additional meetings will be conducted as necessary throughout the project.

During the Systematic Planning phase, a pre-investigation CSM was developed and is provided in Section 2. The CSM includes the site description and history, hydrogeology, contaminant source and release mechanisms, nature and extent of contamination, contamination fate and transport, human health and ecological risk summaries, remedial action objectives (RAOs), preliminary remedial action alternatives, and a data gap evaluation. The CSM is the basis for this DWP.

1.2 Project Objective

The project objective of this field investigation is to address the data gaps identified in the CSM. The key data gaps, which are further developed in Section 2, are:

- Nature and extent of the shallow groundwater CVOC plume and source area (source area is defined as providing a continuous source of contamination to the groundwater plume and/or where the contaminant release has occurred)
- Magnitude of CVOC concentrations in sediment pore water to screen for potential risk to ecological receptors
- Presence/absence of natural attenuation indicators
- Spatial extent and type of surface debris present within the wetland area

Site-specific tasks to be accomplished in order to address these data gaps are detailed in Sections 3 through 5. The results of this Triad investigation will be used to finalize the RAOs and reduce future decision uncertainty so that an exit strategy can be developed, cleanup levels can be established as necessary, and remedial alternatives can be evaluated. The results will be presented in an Expanded Remedial Investigation (ERI) report and used to develop the Feasibility Study (FS).

1.3 Decision Logic

The project decision logic (Figure 1-3) and sampling decision logic (Figures 1-4 through 1-8) were developed incorporating Dynamic Work Strategies and Real-Time Measurement Technologies to ensure that sufficient data is collected to meet the project objectives. The decision logics present decision points in which project team members need to reach a consensus during the field effort. The CSM will be frequently refined and communicated to the project team throughout the data collection and evaluation process to aid in decision-making, as described in the following subsection.

1.4 Project Team and Communication

An integrated project team utilizing continuous communication is crucial for the successful implementation of a Triad investigation. The project team for this investigation is comprised of three levels: The SJCA Project Management Team, the technical support team, and the field team.

The SJCA Project Management Team includes:

- Agnes Sullivan/NAVFAC Restoration Project Manager (RPM)
- Karen Doran/VDEQ RPM
- Josh Barber/EPA RPM
- Kim Henderson/CH2M HILL

- Janna Staszak/CH2M HILL

The technical support team includes:

- Dan Waddill/NAVFAC
- Pat McMurray/VDEQ
- Simeon Hahn/National Oceanic & Atmospheric Administration (NOAA)
- Mindi Snoparsky/EPA
- Linda Watson/EPA
- Mike Elias/CH2M HILL
- Paul Favara/CH2M HILL
- Kim-Lee Yarberry/CH2M HILL

The field team will consist of CH2M HILL staff and subcontractors, and will be identified prior to implementation of this DWP.

The field team leader will be responsible for frequent communication with the CH2M HILL project manager through electronic data transfer. For field activities to be adaptive to the continually changing CSM, weekly field summaries will be made available to the SJCA Project Management Team and teleconferences will be conducted regularly. The technical support team will be consulted and involved as needed. The SJCA Installation Restoration (IR) Portal website (http://sjca.lantops-ir.org/), which all team members will have access to, will be used to post any other documentation that needs to be shared with the team (such as photographs, Membrane Interface Probe [MIP] logs, updated CSM).

Upon the completion of each activity, the project decision logic will be re-visited to ensure that the applicable data gaps have been resolved to an acceptable level of uncertainty and that the project is proceeding as scheduled. Any unexpected conditions identified during the field work will be addressed as necessary with the SJCA Project Management Team to arrive at a contingency approach.

1.5 Report Organization

This DWP comprises the following sections:

- Section 1—Introduction
- Section 2—Existing Conceptual Site Model
- Section 3—Investigation Activities
- Section 4—Sample Analysis and Data Management
- Section 5—Data Evaluation, Reporting, and Scheduling
- Section 6—References

Figures and tables are provided at the end of each section following the text. Appendixes are provided at the end of the document.

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LEGEND

- Site 2
- St. Juliens Creek Annex

N

0 500 1000 Feet

Figure 1-1
Location of Site 2
Within St. Juliens Creek Annex
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL

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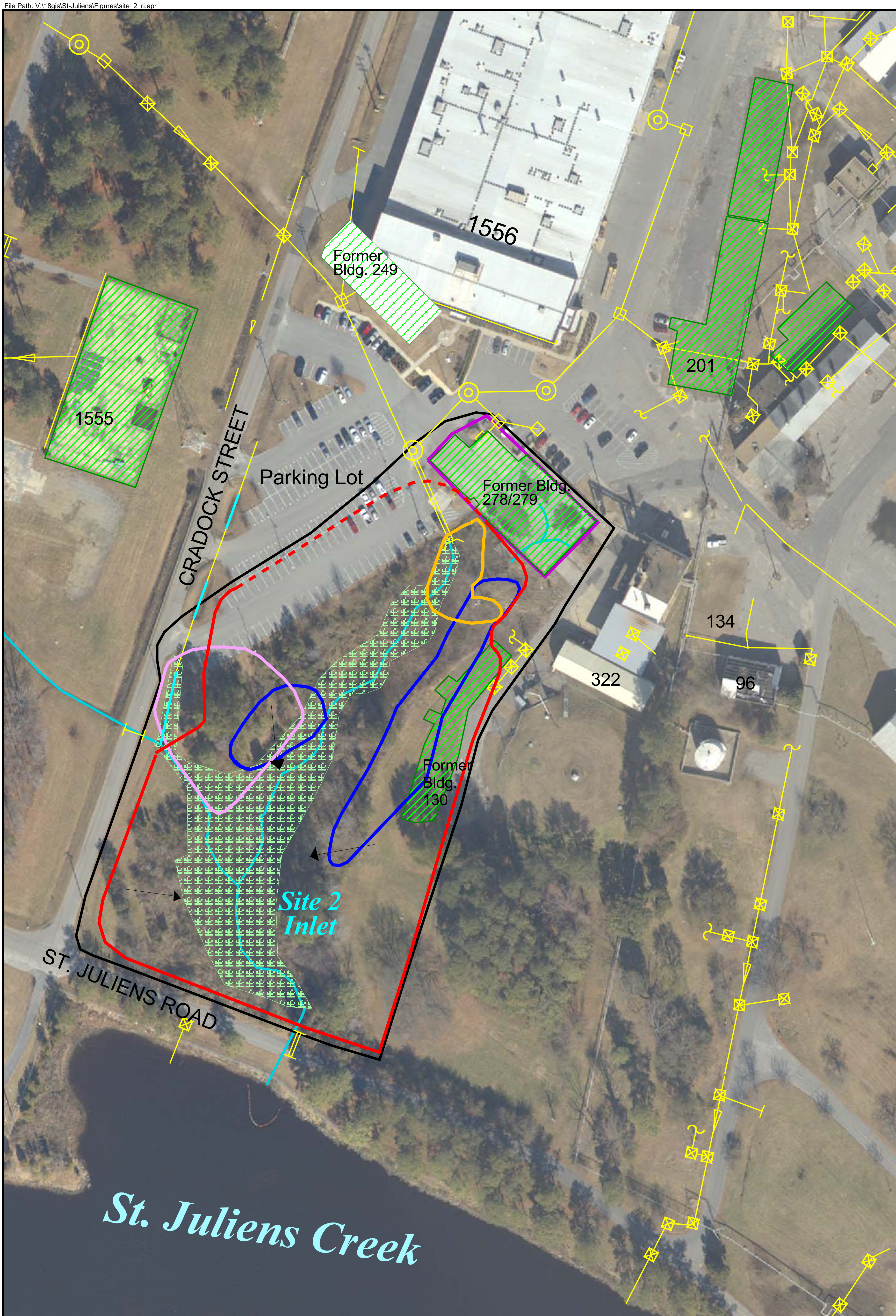


LEGEND

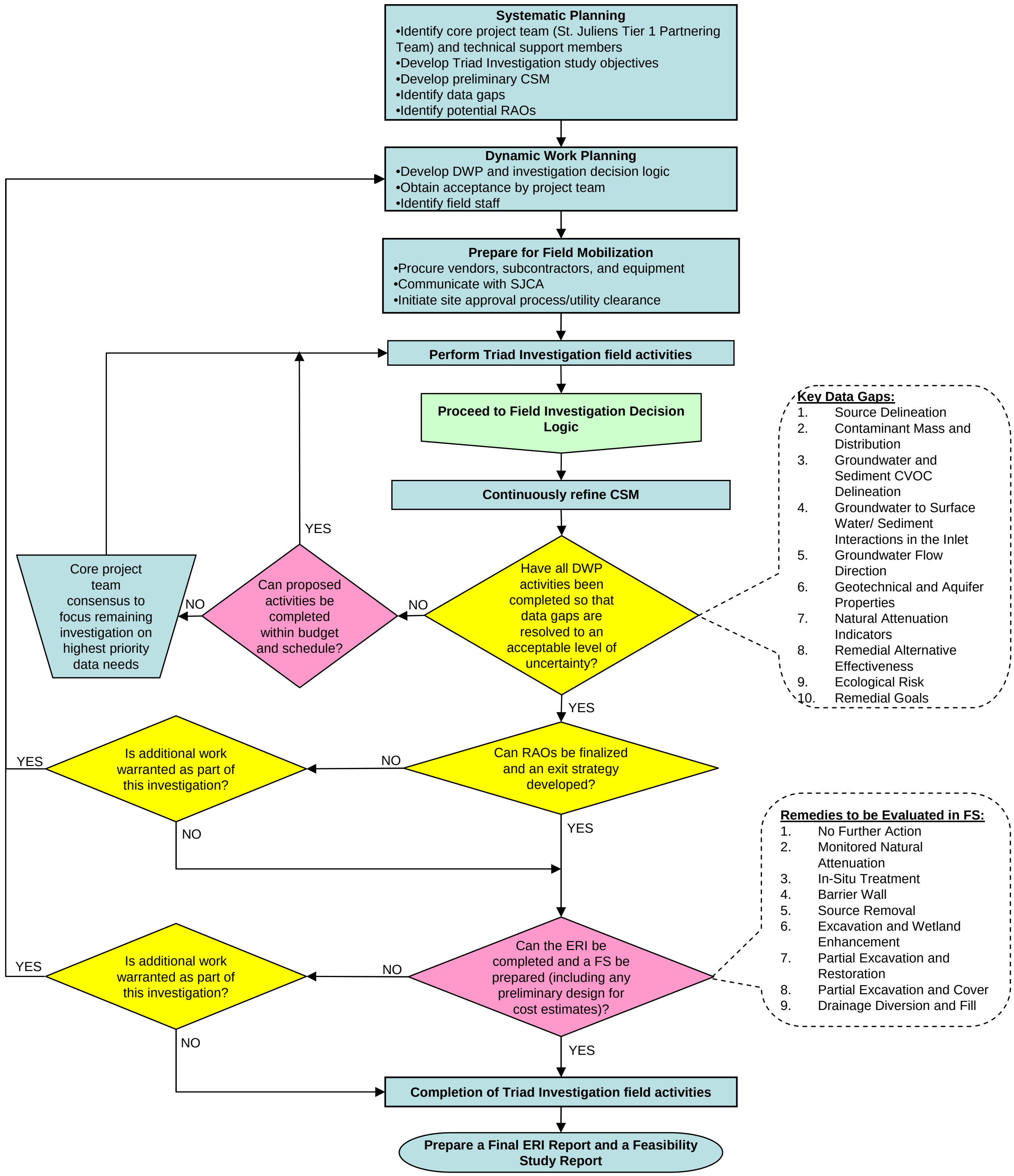
- Drainage
- Stormwater Sewers
- Culverts
- Demolished Buildings
- Wetland
- Site Boundary
- Former Site 17 Boundary
- Extent of Abrasive Blast Media (ABM)
- Extent of Petroleum Impact
- Extent of Waste (3.87 acres)
- Extent of CVOC Plume (2004)
- Groundwater Flow Lines

N

0 50 100 Feet

Figure 1-2
Site 2 Vicinity
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

CH2MHILL



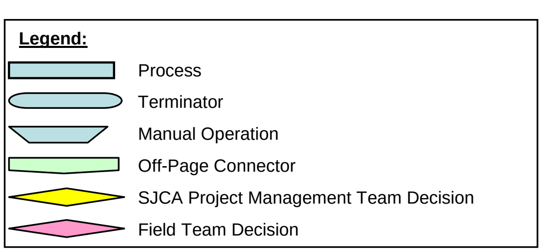


Figure 1-3
Project Decision Logic Flowchart
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

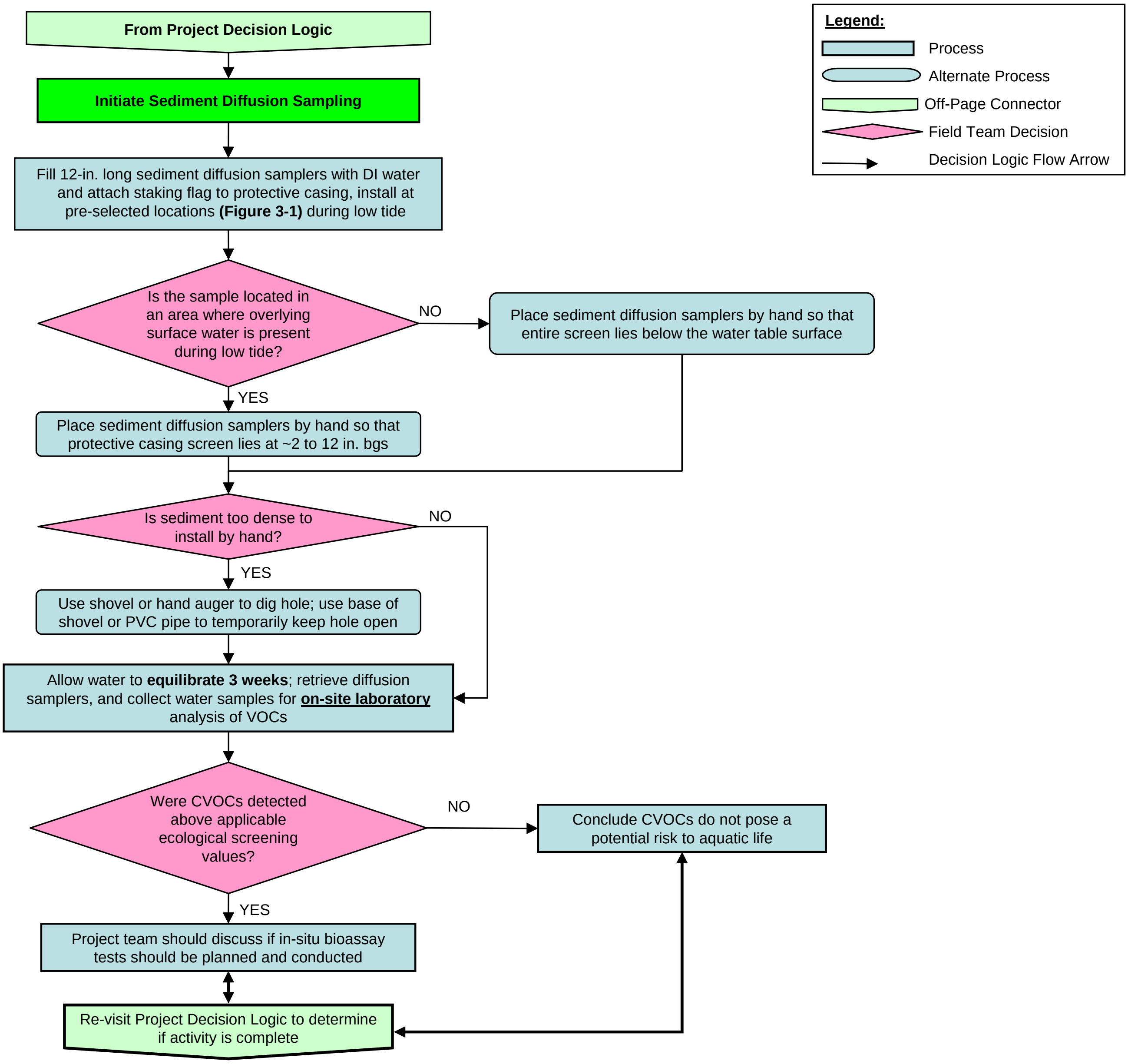


Figure 1-4
Field Investigation Decision Logic Flowchart:
Sediment Diffusion Sampling
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

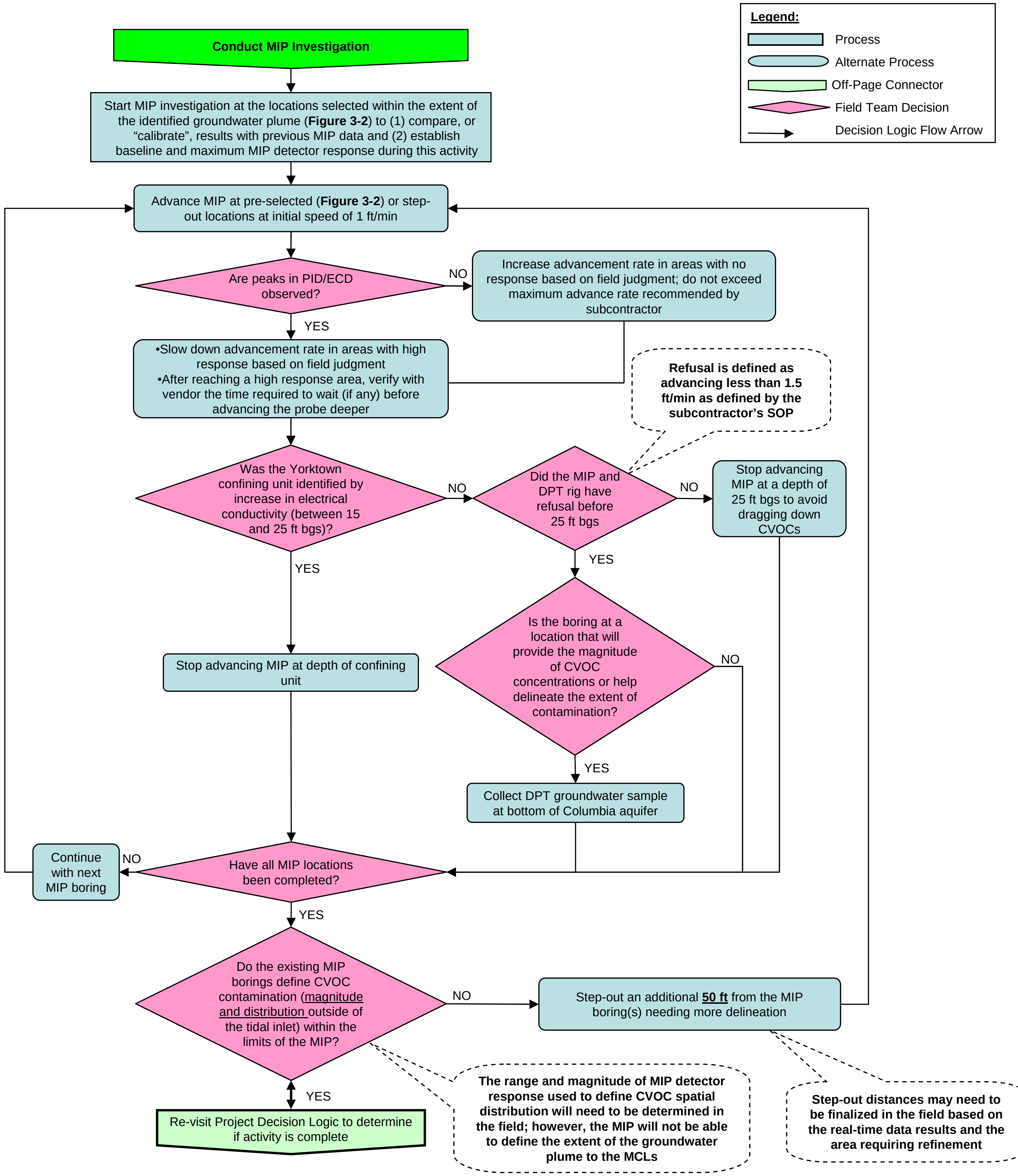


Figure 1-5
Field Investigation Decision Logic Flowchart:
Membrane Interface Probe
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

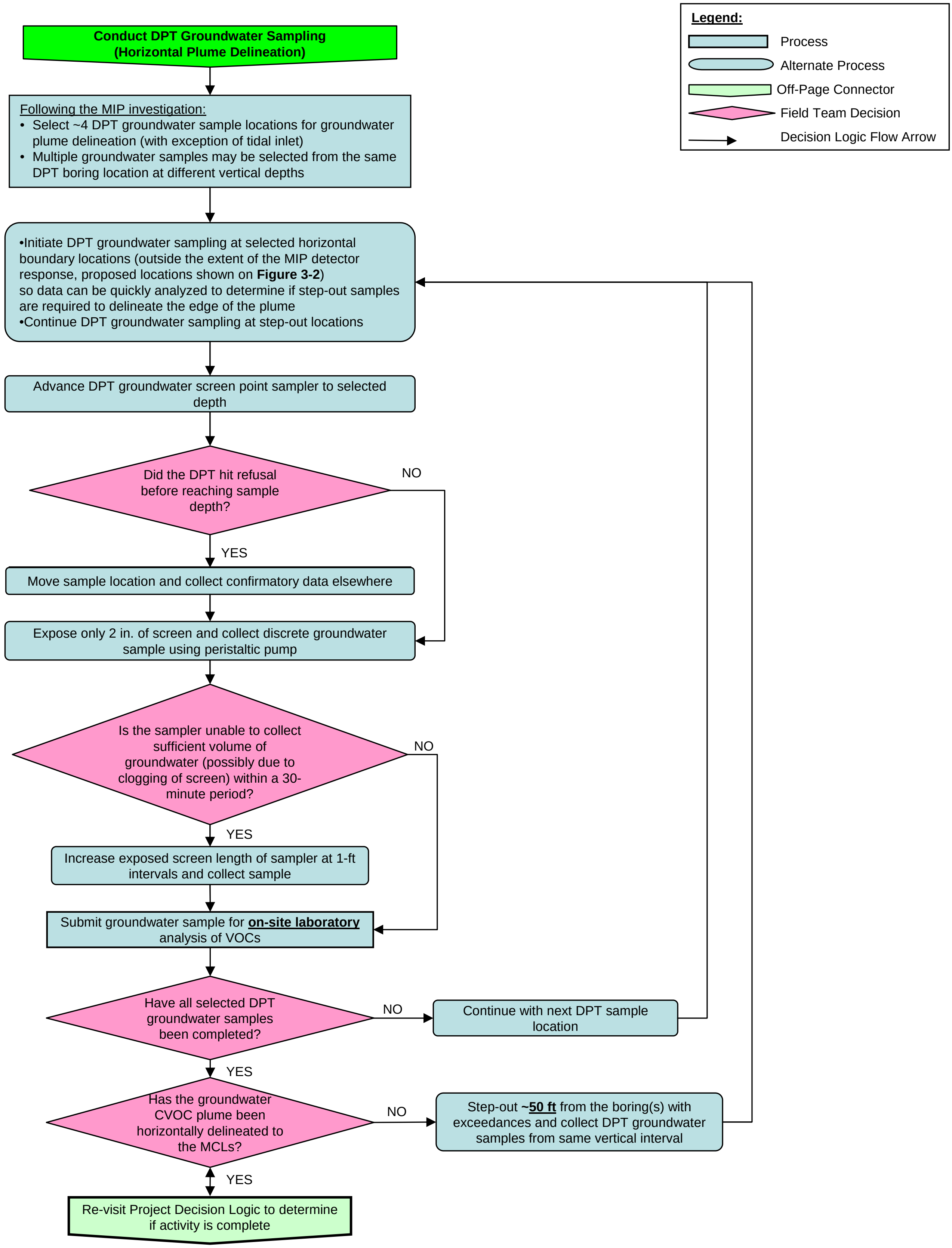


Figure 1-6
Field Investigation Decision Logic Flowchart:
DPT Groundwater Sampling for Horizontal Plume Delineation
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

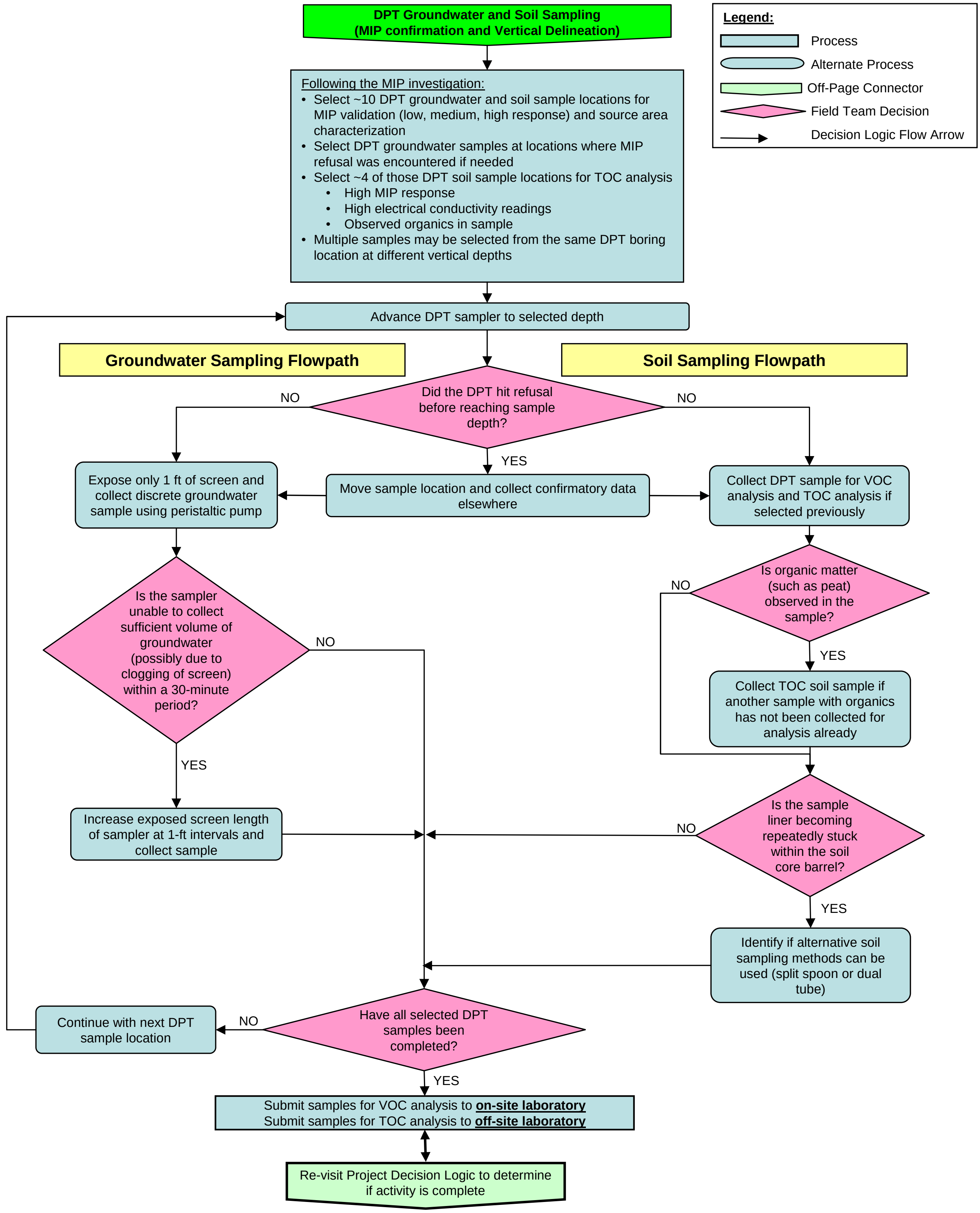


Figure 1-7
Field Investigation Decision Logic Flowchart:
DPT Groundwater and Soil Sampling for Vertical Plume Delineation
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

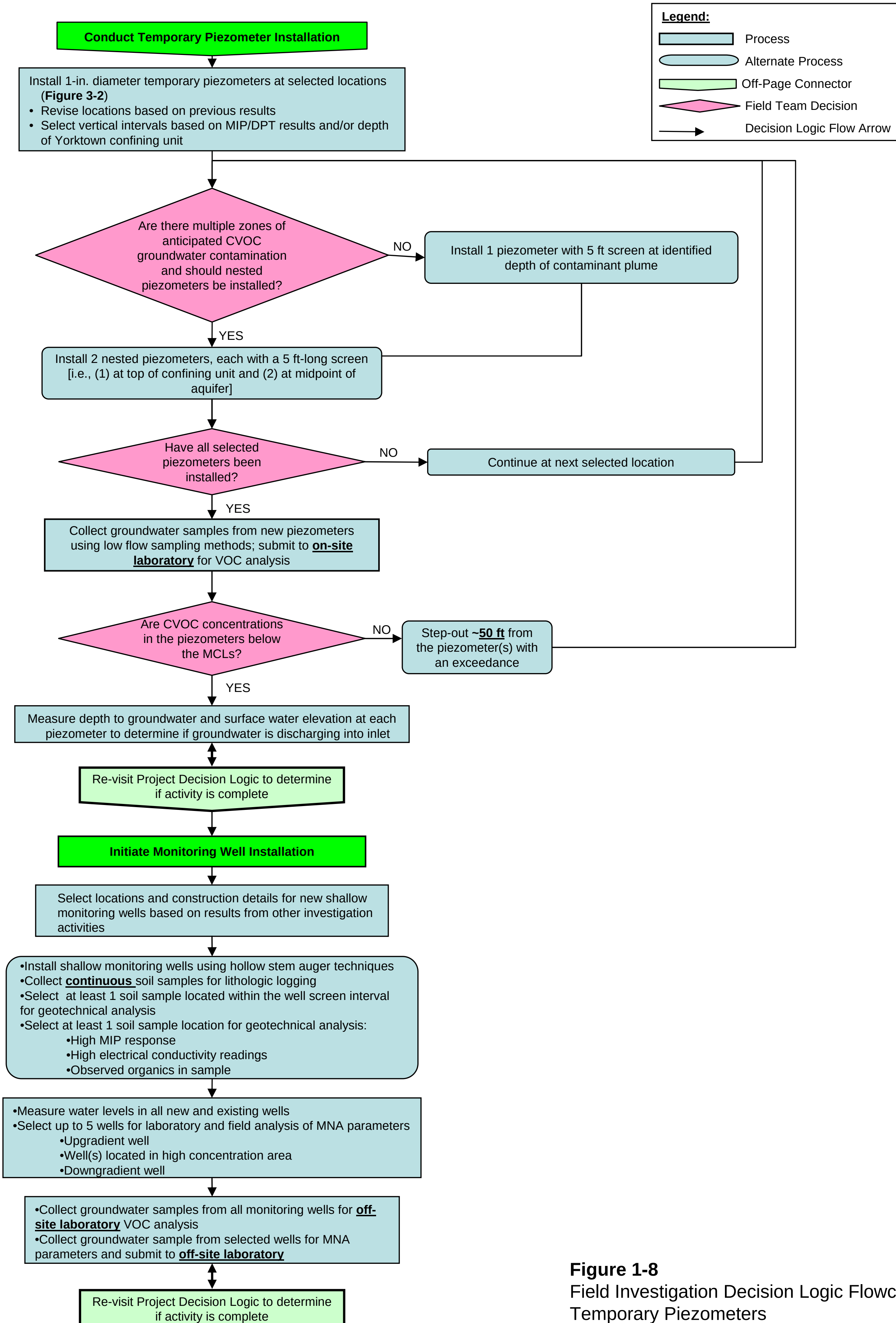


Figure 1-8
Field Investigation Decision Logic Flowchart:
Temporary Piezometers
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

SECTION 2

Existing Conceptual Site Model

This section presents the CSM for Site 2 based on existing data. The CSM is considered a "living" document and will be continuously updated throughout the investigation.

2.1 Site Description and History

2.1.1 Site Description

Site 2 is a former waste disposal area covering approximately 4.4 acres in the southern portion of the SJCA (Figure 1-2). In the center of Site 2 is a tidal inlet surrounded by wetlands, brush, trees, and grass that is directly connected to St. Juliens Creek through a 36-inch (in.) culvert. An asphalt-paved parking lot is located adjacent to the inlet on the northwestern side and the concrete foundation of former Buildings 278/279 is located just north of the inlet. The corner of St. Juliens Road and Cradock Street is located to the southwest of the site and a grassy field is located to the east of the site.

The site topography ranges from 0 to 8 feet (ft) above mean sea level (msl), sloping towards the tidal inlet and St. Juliens Creek. Grass-lined drainage ditches (approximately 2 to 3 ft deep) originate north of Site 2 along Cradock Street and discharge stormwater runoff to the inlet. Additional stormwater from north of Site 2 is carried by an underground stormwater system that also outlets to the inlet. The surface water in the tidal inlet drains into the creek.

The area encompassing SJCA receives an average of approximately 46 in. of precipitation annually. Between 50 and 70 percent of the precipitation is removed from the area via runoff due to the relatively flat topography and via evapotranspiration. The remaining 30 to 50 percent (14 to 23 in.) of precipitation recharges the surficial aquifer system by percolation through the upper soils (Siudyla, 1981).

In the vicinity of SJCA, the mean tide range of the Elizabeth River is approximately 2.8 ft and the spring tide range is approximately 3.4 ft (CH2M HILL, March 2005). During a recent deep aquifer pumping test, background barometric pressure and ambient water level measurements were collected from the deep aquifer wells SJS02-MW01D and SJS02-MW10D and nearby shallow aquifer wells SJS02-MW10S and SJS02-MW12S to evaluate potential fluctuations in the water levels due to natural site conditions/cycles (i.e., tidal influence, interference from other nearby wells, etc). Figure 2-1 provides a chart of the background measurements and the locations of the monitoring wells are shown on Figure 2-2. The results show that the water levels in the deep aquifer wells are influenced by the tidal cycle. The background measurements did not indicate a tidal influence in the shallow aquifer wells. This has been observed at other locations in Southeastern Virginia, and may be attributed to a much lower hydraulic conductivity in the shallower aquifer.

2.1.2 Site History

Waste disposal operations at Site 2 began in 1921 and continued until sometime after 1947. Initially, refuse was burned openly onsite and was used to fill in the adjacent swampy area (Site 2 inlet). In 1942, an incinerator was installed to replace the open burning practices. Mixed municipal wastes, abrasive blast media (ABM), waste ordnance, organics, metals, and solvents were reportedly disposed of. In 1989, the site was used to store heavy equipment and machinery, including storage of tools and tires in sheds and trailers. Construction debris (concrete and brick), as well as ABM, are visible on the ground surface. In the northern portion of the site, Buildings 278/279 (formerly identified as Site 17) were used as a lead-acid battery maintenance facility (Figure 1-2).

The Site 2 inlet historically received stormwater runoff and direct discharges from the industrial area located north of the site, including discharges from vehicle and equipment wash racks and ordnance degreasing operations. It appears that most of the Site 2 area was cleared of trees and vegetation that was pushed into the inlet area to reclaim land. During intrusive investigations, this layer of vegetation is visible indicating the elevation of the former ground surface and tidal inlet area.

The Draft ERI Report (CH2M HILL, October 2005) documents previous investigations performed at Site 2.

2.2 Hydrogeology

The subsurface hydrogeology at Site 2 is separated into three hydrostratigraphic units: the Columbia aquifer, the Yorktown confining unit, and the Yorktown aquifer (Figure 2-3). A layer of waste material, as thick as 6 to 7 ft in some locations, overlies the native soils. The Columbia aquifer begins at 3 to 7 ft below ground surface (bgs) and extends to approximately 15 to 25 ft bgs. In the Site 2 study area, the Columbia aquifer thickness is generally about 20 ft. The Yorktown confining unit separating the aquifers is approximately 30 ft thick on average. The top of the confining unit generally slopes towards St. Juliens Creek and the Southern Branch of the Elizabeth River and is competent beneath the tidal inlet bed. The full thickness of the Yorktown aquifer was not penetrated anywhere on site; the deepest well boring at Site 2 terminates at 70 ft bgs.

The Columbia aquifer consists of silty/clayey sands and well-sorted fine to coarse sands. Peat has also been reported in this groundwater zone from approximately 14 to18 ft bgs in two borings (SJS02-MW11S and SJS02-MW13S). This peat layer was found at the same depth as phragmites debris, indicating the location of the former tidal inlet elevation prior to filling activities. The Yorktown confining unit consists of a thick layer of silty, clayey sand underlain by a thick clay layer. Thin, fine to very fine sand lenses are interbedded in the clay at varying depths in the confining unit. Silt, organic materials, including peat, and shell fragments have been observed in this layer. The Yorktown aquifer consists primarily of fine to medium grained sand and/or silty sand with trace to abundant amounts of shell material, along with traces of finer grained material, gravel, and organic material. The amount of organic matter in the Columbia aquifer, Yorktown confining unit, or Yorktown aquifer is undefined.

There are 13 shallow zone wells and 4 deep zone wells at the site. The locations of the monitoring wells are shown on Figure 2-2 and a monitoring well construction summary is provided on Table 2-1. The water table occurs typically at 4 to 8 ft bgs. Based on a groundwater flux analysis, shallow groundwater discharges to the inlet at a rate of 0.0082 cubic feet per second, or 5,300 gallons per day. Shallow groundwater may also discharge to the nearby drainage ditches during extremely high water-table conditions.

Shallow groundwater flow at Site 2 mimics the topography of the site and flows towards the inlet and St. Juliens Creek (Figure 2-4) at a horizontal hydraulic gradient of 0.004 ft/ft. Groundwater in the underlying Yorktown aquifer has a very flat horizontal hydraulic gradient of 0.0008 ft/ft and generally flows east towards the Southern Branch of the Elizabeth River (Figure 2-5). Based on available data from the shallow and deep groundwater well pairs, the vertical hydraulic gradient west of the Site 2 inlet is generally upward and the vertical hydraulic gradient east of the Site 2 inlet is downward. The upward vertical gradient at well cluster SJS02-MW02S/02D (0.05 ft/ft) and the downward vertical gradient at SJS02-MW05S/05D (0.03 ft/ft) are approximately ten times greater that horizontal gradients at the site.

Results from rising head slug tests and a deep aquifer pump test were used to evaluate aquifer hydraulic conductivity in the vicinity. The geometric average horizontal hydraulic conductivities were interpreted to be about 3 ft/day for the Columbia aquifer and about 34 ft/day for the Yorktown aquifer.

2.3 Contaminant Sources and Release Mechanisms

2.3.1 Potential Sources of Contamination

Waste management operations at Site 2 included open burning, incineration, and disposal from 1921 to sometime after 1947. The total volume of waste prior to burning is reported to have been approximately 35,000 cubic yards. The extent of waste at Site 2 has been defined by historic aerial photographs and waste delineation activities (direct-push technology [DPT] and drilling, electromagnetic and magnetometer geophysical survey, and test pits.) The aerial extent of the waste covers approximately 3.8 acres (Figure 1-2). The horizontal extent of waste beneath the parking lot to the west is inferred. Waste lies within the unsaturated zone (ranging from 0 to 6 ft bgs) and the saturated zone (ranging from 3 to 14 ft bgs). Subsurface waste consists of ABM, burnt/stained soils, concrete, asphalt, brick, metal, glass, wood, solvents, and munitions and explosives of concern (MEC)-related scrap (one shell and three Mark 5 cartridge cases were found during test pit sampling).

Potential sources of petroleum contamination have been identified from four former revetted above ground storage tanks (ASTs) (removed between 1986 and 1990) and one underground storage tank (UST) located east of Site 2 where fuel oil and diesel may have been stored.

Lead-acid battery maintenance was reportedly conducted at Building 279; the waste acid electrolyte was collected and hauled off-station for disposal. There were two 55-gallon drums of PD-680, a commercial degreaser, stored on the concrete storage pad located just outside of Building 279 which had a release onto nearby soil (A. T. Kearney, March 1989).

The Site 2 inlet has historically also received discharges from vehicle and equipment wash racks and ordnance degreasing operations, located north of Site 2. Upgradient buildings were historically used as machine, vehicle, and locomotive maintenance shops; electrical shops; and munitions loading facilities. Outdoor areas at the buildings were used for equipment and chemical storage. CVOCs, such as tetrachloroethene (PCE) and trichloroethene (TCE), were most likely used in the degreasing operations. Several of these buildings and/or their surrounding areas were designated as former IR sites (Sites 9, 10, 11, 12, 13, 14, 18, and Area of Concern [AOC] E). Descriptions of each building or industrial area (NEESA, August 1981) and corresponding historical activities and contaminant sources are described in Table 2-2.

A separate CVOC groundwater plume (Site 21) located upgradient of Site 2 is also suspected to be infiltrating the adjacent stormwater system that discharges to the Site 2 inlet. Surface water samples collected at the discharge point indicated the presence of CVOCs at concentrations below screening criteria. A video inspection of the storm sewer was conducted to confirm the potential for transport and release of CVOCs from Site 21 shallow groundwater through the storm sewer system to Site 2. The video inspection indicated that the storm sewer system is providing a potential transport mechanism. However, the damage was classified as light to moderate and CVOC groundwater concentrations are significantly lower at Site 21 than at Site 2; therefore, transport of Site 21 CVOCs to Site 2 is not considered to be a significant pathway and no repairs will be made to the storm sewer system. In addition, a treatability study is planned to reduce CVOC concentrations at Site 21.

2.3.2 Potential Release Pathways

The primary contaminant release mechanism is attributed to the waste material placed over a 3.8-acre portion of the site. Since the disposal area was unlined and extends approximately 4 ft below the water table, CVOCs from solvents and other disposal materials were in direct contact with natural soils and groundwater if any leaching occurred or waste packaging was breached. Additional releases may have occurred as spills onto the ground surface during operational activities at the site.

Grass-lined drainage ditches (approximately 2 to 3 ft deep) and underground stormwater drainage system originate north of Site 2 and discharge stormwater runoff from upgradient areas to the tidal inlet.

2.4 Nature and Extent of Contamination

The Triad investigation for Site 2 will focus exclusively on CVOC delineation, since prior investigations have adequately delineated the nature and extent of the other chemicals of concern (COCs). The CVOCs identified as COCs in shallow groundwater are 1,1,2-trichloroethane (TCA), 1,1-dichlorethene (DCE), PCE, TCE, vinyl chloride, cis-1,2-DCE, and trans-1,2-DCE. Discussion of other COCs is included in the Draft ERI Report (CH2M HILL, October 2005).

2.4.1 DNAPL and Source Zones

Dense, non-aqueous phase liquids (DNAPLs) were not visually observed during previous site investigations. One of the "rule of thumb" indicators that DNAPL may be present at a site is when chemicals that are known to behave as DNAPLs (due to their hydrophobic nature and density) are found in concentrations above 1 percent of their pure phase solubility in water. The maximum TCE concentration in Columbia aquifer monitoring wells (330,000 micrograms per liter [μg/L]) is approximately 30 percent of the TCE solubility level (11,000 μg/L), suggesting that DNAPL may be present at the site.

A MIP investigation was conducted in November 2004 to help identify the possible source of the TCE in groundwater. Twenty MIP borings were logged from the ground surface to approximately the depth of the Yorktown confining unit (Figure 2-2). Elevated electron capture detector (ECD) response was observed in MIP borings located along the western boundary of the site and extending to the east towards monitoring well SJS02-MW11S (Figures 2-6 and 2-7). The eastern boundary of the elevated ECD response was not defined due to the proximity of the tidal inlet.

The MIP screening logs generally depict a vertical contaminant profile where concentrations were relatively low to a depth of approximately 8 ft bgs and then increased significantly with depth to the Yorktown confining unit (15 to 19 ft bgs). In the area of high ECD, elevated response was located in lower electrical conductivity lithology (Figure 2-8). The higher electrical conductivity readings at the base of the investigation correspond to the top of the Yorktown confining unit. The lack of high electrical conductivity response in the central part of the investigation area suggests that the confining unit is deeper in this location and MIP borings may not have been advanced to the confining layer. Based on the trapping (speciation) data, the highest TCE concentrations were found at MIP location 216, just south of the parking lot.

2.4.2 Soil

Surface soil and subsurface soil samples were collected during the RI. TCE was detected in one subsurface soil location at a concentration (12 micrograms per kilogram [μg/kg]) below the EPA Region III risk-based concentration (RBC) for residential soil (16,000 μg/kg).

2.4.3 Groundwater

Groundwater monitoring at Site 2 was initiated in 1997. During the ERI, nine CVOCs (TCA, 1,1-DCE, chloroform, methylene chloride, PCE, TCE, vinyl chloride, cis-1,2- DCE, and trans-1,2-DCE) were detected at concentrations above their respective Federal Maximum Contaminant Levels (MCLs). Table 2-3 and Figure 2-9 present a summary of historical analytical groundwater data for CVOCs.

The shallow CVOC plume, based on MIP data and laboratory analytical results, is estimated to extend over an area of approximately 17,200 square ft just south of the parking lot (Figures 2-10 and 2-11). The highest CVOC concentrations were detected in groundwater samples collected from SJS02-MW07S and SJS02-MW10S. This area of high groundwater concentrations correlates to the area of elevated ECD response, with one possible exception. Monitoring well SJS02-MW13S had no detections of CVOCs although it is located approximately 40 ft south of MIP-204, which had an elevated ECD response. However, as shown on Figure 2-7, ECD response appears to be sloping downward in this direction and likely would have shown no response just a little further south adjacent to SJS02-MW13S. There is insufficient data available to assess groundwater contaminant trends in shallow zone monitoring wells.

During the ERI, TCE and its breakdown products were detected in the deep monitoring well (SJS02-MW10D), screened within the Yorktown aquifer (Figure 2-2). Based on the deep aquifer pump test results, it is likely that the source of TCE in this deep well is contaminated soil, free product, or a volume of contaminated groundwater carried from the shallow to the deep aquifer during the installation of the monitoring well. Contaminant trend data at SJS02-MW10D shows concentrations of TCE and its breakdown products are decreasing in this well. In November 2006, TCE was not detected while cis-1,2-DCE and vinyl chloride were reported below their respective MCLs. CVOCs have not been detected in any other deep monitoring well, including the downgradient well SJS02-MW02D. Based on site soil borings, the Yorktown confining unit has been shown to be an effective barrier to vertical contaminant migration.

2.4.4 Stormwater, Surface Water, and Sediment

Stormwater samples (SJS02-ST01 through SJS02-ST07) were collected from drop inlets in the stormwater system upstream of Site 2 to determine if CVOCs are discharging to the Site 2 inlet from an upgradient source (Site 21 shallow groundwater CVOC plume). The sample collected on the northern edge of the Site 2 boundary (SJS02-ST01) had a reported value of TCE of 150 μg/L (Figure 2-12).

Ten surface water samples have been collected at Site 2 (Figure 2-12). CVOCs were detected or estimated in all samples except SJS02-SW02, located in the southeastern corner of the site. The highest concentrations were reported in samples just south of the shallow groundwater CVOC plume and south of former Buildings 278/279.

TCE concentrations detected in sediment range from 4J to 9.8J μg/kg (Figure 2-12). The highest concentrations of CVOCs were detected at SJS02-SD21, located at the western stormwater discharge point south of the shallow groundwater CVOC plume. At this location, the TCE concentration was 9.8J μg/kg and the concentration of the breakdown product, vinyl chloride, was significantly higher at 9,800 μg/kg. Additionally, sediment samples were collected in the outfall to St. Juliens Creek to evaluate the potential impacts from the Site 2 inlet to St. Juliens Creek (CH2M HILL, January 2005). Results indicated that although Site 2 is potentially contributing, or has historically contributed, chemicals to St. Juliens Creek via tidal influx through the low-flow culvert, significant site-related effects are only indicated in a localized area directly at the outfall location.

2.5 Contaminant Fate and Transport

As stated in Section 1, other than CVOCs, all contaminants have been sufficiently investigated to evaluate human health and ecological risks. Therefore, this section focuses on the fate and transport of CVOCs at Site 2. Contaminant fate and transport for all other COCs was described in detail in the RI and ERI.

2.5.1 Routes of Migration

Runoff and Surface Water Transport

One of the primary pathways for transport of contaminants is the surface runoff from contaminated surface soils to surface water in the tidal inlet. The tidal inlet has also received runoff from the industrial area to the north. A separate shallow groundwater CVOC plume (Site 21) located upgradient of Site 2 is suspected to be infiltrating the stormwater system and discharging to the Site 2 inlet. In surface water, CVOCs tend to quickly evaporate to the atmosphere; however, this is dependent on the chemical's Henry's Law constant, vapor pressure, and solubility. TCE may sorb to particles in water and settle to the bottom of the inlet as sediment (ASTDR, September 1997); however, previous sediment sample analytical results suggest that this pathway is not contributing to an unacceptable level of risk. Some surface water may recharge groundwater.

Tidal flux has the potential for transporting surface water and suspended sediment into and out of the Site 2 inlet. The configuration of the creek shoreline and the culvert between the inlet and St. Juliens Creek creates a relatively low energy environment with the exception of extreme storm events.

Unsaturated Zone Migration

Contaminants released to surface soil (via direct waste placement or solvent spills) may have also migrated vertically through the unsaturated zone through gravitational force or leaching from infiltration. CVOCs do not have high sorption coefficients. Volatilization of volatile organic compounds (such as TCE) into the air can occur in the unsaturated zone.

Saturated Zone Migration

Some of the waste disposed was placed below the water table. Therefore, contaminants in the waste may have directly diffused or dissolved into groundwater. Contaminants in groundwater may have also migrated vertically from the subsurface soil.

Once in groundwater, TCE may be persistent. Contaminants in the Columbia aquifer would have advected downgradient to the south or east with groundwater flow. Some dispersion and retardation is expected. The shallow groundwater discharges seasonally through the sediment to the surface water of the tidal inlet and creek. CVOCs in groundwater also volatilize into soil gas overlying the water table.

Some of the process waste that entered the subsurface may have been non-aqueous. TCE and some other chlorinated solvents exist as a separate, non-aqueous phase when their solubilities in water are exceeded. DNAPLs do not behave the same as aqueous phase (dissolved) VOCs. They typically tend to sink until they reach a relatively low-permeability zone like a clay lens or a calcified sand stringer, where they may collect and spread laterally before continuing to flow down until they reach a more extensive low-permeability layer like a confining unit or aquitard. DNAPLs can also move laterally following the stratification of the subsurface as they migrate down. During vertical migration, DNAPL remains in the pore spaces of the aquifer material as residual contamination and a continuing source of contaminant mass to groundwater.

2.5.2 Geochemistry and Water Quality

Dissolved oxygen (DO) in shallow groundwater at Site 2 is below 1 milligram per liter (mg/L) while deeper groundwater is anaerobic. Other water quality parameters collected during groundwater sampling include pH, oxidation-reduction potential (ORP), specific conductance, temperature, and turbidity. pH in both groundwater aquifers is generally neutral, averaging 6.4 in shallow groundwater and 8.1 in deep groundwater. Since December 2003, shallow groundwater appears to be more oxidizing in the northeastern portion of Site 2 and on the outer edges with ORP readings above 0 millivolts (mV). The most reduced areas in shallow groundwater were reported at SJS02-MW09S (adjacent to former Building 278/279) and SJS02-MW13S (in the southwestern area of the site). Based on ORP readings, deep groundwater is under more reduced conditions, with readings below -100 mV, consistent with DO readings. Specific conductance on average was below 0.5 millisiemens per centimeter (mS/cm) in all site wells except in monitoring wells SJS02-MW07S, -MW08S, -MW11S, and -MW13S, in which higher concentrations were reported (locations are shown on Figure 2-2).

Additional geochemical parameters [alkalinity, ferrous iron, sulfate, and total organic carbon (TOC)] were collected in 2004 from selected monitoring wells. Alkalinity concentrations in shallow zone wells SJS02-MW11S and -MW13S were more than double the concentration in any other shallow wells, suggesting biological activity. Although alkalinity concentrations were lowest in the monitoring wells with high levels of CVOC contamination (SJS02-MW07S and –MW10S), the presence of TCE degradation products at these wells indicates biological activity is occurring. However, some of this degradation may be due to abiotic processes. In the deep zone, alkalinity was elevated in the monitoring well SJS02-MW10D (which had reported CVOC concentrations) compared to the background well. TOC concentrations ranged from 2.4 to 13 mg/L, which is relatively low considering the depositional environment. Reductive dechlorination requires a supply of organic matter in the aquifer and to serve as an electron donor.

The spatial distribution of geochemical parameters did not provide evidence of iron reduction. Some sulfate reduction may be occurring near SJS02-MW11S since sulfate concentrations were much lower in this well than in upgradient shallow zone wells. There was insufficient data to make any assessment on denitrification or methanogenesis processes. However, the presence of significant quantities of daughter products in the groundwater (vinyl chloride and cis-1,2-DCE) is a good indication that reductive dechlorination is taking place.

2.6 Human Health and Ecological Risk

Detailed Human Health Risk Assessments (HHRAs) and ecological risk assessments (ERAs) are provided in the Final RI and the Draft ERI Reports (CH2M HILL, February 2004 and October 2005, respectively). A summary of the human health and ecological COCs and risk assessment status is provided by media in Table 2-4. Sufficient investigation has been performed to assess human health and ecological risks for all media, except CVOCs in groundwater and sediment pore water, respectively. Potential RAOs are discussed in Section 2.7.

There is not any information regarding the intended changes to future land use of Site 2; therefore, it is expected to remain as its current industrial use including a stormwater drainage inlet, open field of mowed grass, and asphalt parking lot. The closest downgradient receptor to the site is St. Juliens Creek, located less than 100 ft from the site and facility boundary. There is no current or future anticipated use of groundwater from the Columbia aquifer or the Yorktown aquifer at Site 2.

The Commonwealth of Virginia does not have a groundwater classification system and views all groundwater of potential beneficial use (all groundwater is potential drinking water), requiring treatment to the Virginia Groundwater Standards (Federal MCLs). Therefore, risk was evaluated for potential future residential use.

2.7 Remedial Action Objectives

This section presents preliminary RAOs, which will be finalized following the Triad investigation. The RAOs relate to specific contaminated media and to potential exposure routes at the site. They are based on an evaluation of the risks to human health and to the environment resulting from site contaminants and the Applicable or Relevant and Appropriate Requirements (ARARs).

The human health and ecological risk assessments completed to date identified that there were localized hot spots and risks from metals, semivolatile organic compounds (SVOCs), and/or pesticides/polychlorinated biphenyls (PCBs) concentrations in soil, sediment, and surface water. VOCs, SVOCs, pesticides, and metals in groundwater have been identified as posing a risk to industrial workers, construction workers, and future residents. The risks from CVOCs will need to be re-evaluated based on results of any additional investigation.

Preliminary RAOs for Site 2 are as follows:

1. Minimize direct contact of human and ecological receptors with waste
2. Minimize direct contact of human and ecological receptors with COCs in soil and sediment
3. Prevent unacceptable risks to potential human receptors from COCs in groundwater
4. Prevent activities which might cause migration of CVOCs in the Columbia aquifer to the underlying Yorktown aquifer
5. Prevent or minimize CVOC migration from the shallow groundwater to surface water and sediment
6. Control surface water run-off and erosion to prevent migration of contaminants
7. Minimize remedy-related impacts to the existing tidal inlet and mitigate any unavoidable wetland impacts.
8. Reduce CVOC concentrations in groundwater to the MCLs by applying best available technologies
9. Prevent or minimize transport of COCs from waste to site media

2.8 Preliminary Remedial Action Alternatives

Preliminary remedial action alternatives have been developed for consideration in development of this DWP. The objective in establishing the preliminary remedial action alternatives is to identify associated data gaps in order to streamline the RI/FS process and ensure that adequate data will be collected during the investigation to fully develop and evaluate appropriate site remedies.

For the development of the alternatives, the site has been divided into two work elements. Work Element A is comprised of shallow groundwater. Work Element B is comprised of waste, soil, and sediment. These Work Elements are interrelated and will be evaluated in combination to address overall site media. The preliminary remedial action alternatives are described below. The alternatives will be refined as the uncertainties in the CSM are revised and addressed, and the remedial action alternatives will be evaluated in the FS after completion of the ERI.

2.8.1 Work Element A: Shallow Groundwater

No Action

The National Oil and Hazardous Substance Pollution Contingency Plan (NCP) requires the "No Action" alternative as a baseline against which the effectiveness of other remedial alternatives can be compared.

Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is a viable alternative on sites where conditions conducive to natural degradation of contamination are evident. The MNA alternative relies on natural attenuation physical (dilution, volatilization, and adsorption), biological (aerobic and anaerobic biodegradation), and chemical processes (abiotic transformation) to naturally reduce the toxicity, mobility, and volume, mass, or concentration of contaminants. The effectiveness of the natural attenuation processes is periodically monitored.

In-Situ Treatment

This alternative consists of a more aggressive, in-situ treatment to reduce the volume, mass, or concentration of contaminants. It can be applied to the entire plume or a component of the plume, such as the groundwater source area or a downgradient boundary. The remedy may be biological (e.g. vegetable oil, lactic acid, bioaugmentation); physical-chemical (e.g. air sparging, chemical oxidation); or thermal (e.g. dynamic underground stripping).

Barrier Wall

This alternative consists of the construction of an in-situ barrier wall installed perpendicular to groundwater flow. It is typically located either at the downgradient edge of the groundwater source area to migration of the highest-concentration groundwater, or at the downgradient edge of the plume to address contaminants in groundwater before reaching a compliance point. The wall may be a physical barrier to prevent contaminant transport, or filled with amendments to chemically or biologically treat the groundwater flowing though the wall.

Source Removal

This alternative consists of complete excavation and off-site disposal of the soil and/or waste which serves as a continuing source to groundwater.

2.8.2 Work Element B: Waste, Soil, and Sediment

No Action

The NCP requires the “No Action” alternative as a baseline against which the effectiveness of other remedial alternatives can be compared.

Complete Excavation and Wetlands Enhancement

This alternative consists of the complete excavation and off-site disposal of the waste (including ABM and petroleum-impacted areas) and soil and sediment posing risk, followed by restoration of the site as an enhanced wetland.

Partial Removal and Restoration

This alternative consists of the excavation and off-site disposal of portions of the site. Waste identified during test pitting activities consisted mostly of construction debris, including rubble, concrete, and bricks, which are classified as inert by the Virginia Solid Waste Regulations. Because inert wastes are considered to be physically, chemically, and biologically stable from further degradation and nonreactive, leaving the waste on site is not anticipated to contribute to the site risks. Therefore, it is assumed that the inert waste will be left on site in this alternative; materials not classified as inert, including the abrasive blast material, petroleum-impacted soil, and soil and sediment posing risk will be excavated. The waste areas were defined by test pitting during the RI and are shown on Figure 1-2. The site will be restored as a wetland.

Partial Removal and Cover Placement

The alternative will consist of a site-wide excavation to an engineered depth, placement of a cover, backfill with soil capable of sustaining wetland vegetation, and restoration with wetland vegetation. The thickness of the vegetative support layer will be sufficient to prevent the penetration of the wetland plants through the cover.

Drainage Diversion and Fill

This alternative consists of re-routing the drainage (storm sewer system and overland) through a constructed conduit and backfill of the inlet (a cover). This alternative will require compensatory wetland mitigation.

2.9 Data Gap Evaluation

Data gaps were identified based on the uncertainties in the CSM and preliminary remedial action alternatives. The data gaps were used to develop Triad field study objectives and associated investigation activities, which are summarized in Table 2-5.

The underlying data gap, which is whether or not the CVOC groundwater plume is contributing to the risk identified in soil and sediment, must be addressed prior to evaluation of any remedy in the soil and sediment. Because Navy policy typically prohibits remedial actions in areas where there is a continuing source of contamination, addressing waste, soil, and sediment may be affected by the impact of the shallow groundwater CVOC plume on these media. An understanding of contaminant distribution and migration is necessary for the development of final RAOs. The results of all investigation activities will be used for these future evaluations.

Table 2-1
Site 2 Monitoring Well Construction Summary
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

Monitoring Well	Installation Date	Ground Elevation (ft msl)	Top of PVC Elevation (ft msl)	Total Well Depth (ft bgs)	Depth of Surface Casing (ft bgs)	Length of Screen (ft)	Depth of Top of Screen (ft bgs)	Depth of Bottom of Screen (ft bgs)	Depth to Base of Columbia Aquifer (ft bgs)	Depth to Base of Yorktown Confining Unit (ft bgs)	Thickness of Yorktown Confining Unit (ft)	Hydrogeologic Unit of Screened Interval	Description of Screened Lithology	Elevation of Top of Screen (ft msl)	Elevation of Bottom of Screen (ft msl)	Elevation of Base of Borehole (ft msl)	Elevation of Base of Columbia Aquifer (ft msl)	Elevation of Base of Yorktown Confining Unit (ft msl)
Shallow																		
SJS02-MW01S	07/01/97	5.19	7.72	15.1	NA	10	4.6	14.6	25	NA	NA	Columbia Aquifer	Columbia - sandy silt, silty fine sand, organics, interbedded clay, ~ last 3' soft silty clay - gray (fill materials)	0.59	-9.41	-9.91	NA	NA
SJS02-MW02S	06/30/97	4.59	6.98	13.5	NA	10	3	13	23	NA	NA	Columbia Aquifer	Columbia - silty fine sand, trace clay, trace shells/organics-gray to yellowish brown; 10-15' silty clay with fine sand and trace organics, soft, greenish gray; 10-12' petroleum odor no OVM	1.59	-8.41	-8.91	NA	NA
SJS02-MW03S	07/07/97	4.69	7.27	14	NA	10	3.2	13.2	23	NA	NA	Columbia Aquifer	Columbia - fill to ~3'; silty fine sand interbedded silty clay, yellowish brown, olive gray	1.49	-8.51	-9.31	NA	NA
SJS02-MW04S	04/27/99	4.6	5.53	13	NA	10	2	12	17	NA	NA	Columbia Aquifer	Columbia - silty fine sand, yellowish brown, some orange mottling and coarsening toward end of boring	2.6	-7.4	-8.4	NA	NA
SJS02-MW05S	04/27/99	5.87	8.52	13	NA	10	2	12	17	NA	NA	Columbia Aquifer	Columbia - silt and fine sand, trace clay (thin 2" interbedded layer), yellowish brown, 8' - oily odor no OVM hit	3.87	-6.13	-7.13	NA	NA
SJS02-MW06S	12/08/03	6.29	9.31	14	NA	10	4	14	14.5	NA	NA	Columbia Aquifer	Columbia-at 4 4-.5' clay mixed w/ sand, sand, mostly medium density, saturated, greenish yellow, no PID hit	2.29	-7.71	-7.71	NA	NA
SJS02-MW07S	12/09/03	6.79	6.87	15	NA	10	5	15	14.5	NA	NA	Columbia Aquifer	Columbia-medium sand, poorly sorted, pale yellowish brown, wet or saturated, some fines, PID hit 1.0 ppm	1.79	-8.21	-8.21	NA	NA
SJS02-MW08S	12/02/03	4.91	7.99	15	NA	10	5	15	15.5	NA	NA	Columbia Aquifer	Columbia-medium sand, pale yellowish brown, silty clay around 9 feet, then silty sand dark yellowish orange and saturated, medium density, no PID hit	-0.09	-10.09	-10.09	NA	NA
SJS02-MW09S	12/08/03	4.44	7.49	10	NA	5	5	10	10	NA	NA	Columbia Aquifer	Columbia-subrounded sand and silty sand, yellowish brown to light brown, wet, medium density, saturated at 9 feet with evidence of some oxidation, no PID hit	-0.56	-5.56	-5.56	NA	NA
SJS02-MW10S	11/16/04	6.2	9.18	16.5	NA	10	6.5	16.5	16	NA	NA	Columbia Aquifer	Columbia-fine sand (some clay from 5-7) (silty sand at 12-16), saturated, loose, odor (possibly TCE or petroleum), no PID hit	-0.3	-10.3	-10.3	NA	NA
SJS02-MW11S	11/16/04	2.5	5.68	20	NA	5	15	20	20	NA	NA	Columbia Aquifer	Columbia-peat with phragmites fibers, dark gray and moist with organic odor, silty peat with some fine sand and moist from 16.5-17.8, silty sand with some clay from 18-19, 19-20 fine sand with slight silt and then some sandy clay, olive brown, saturated, no PID hit	-12.5	-17.5	-17.5	NA	NA
SJS02-MW12S	11/17/04	6.68	6.13	16	NA	10	6	16	16	NA	NA	Columbia Aquifer	Columbia-fine sand, wet, light gray changing to light olive brown, olive yellow, and brown, medium dense to dense, saturated at 7.5	0.68	-9.32	-9.32	NA	NA
SJS02-MW13S	11/17/2004	3.8	6.3	22	NA	15	7	22	21.7	NA	NA	Columbia Aquifer	Columbia-gravelly sands, dark gray/black and saturated, odor (possibly TCE), greenish gray clay at 10.5-14' with organic odor and wood fragment throughout, dark brown soft clayey peat with some organic and phragmites debris from 14-15', sandy peat and fine silty sand from 15.8-17.8, 17.8-20 clayey sand with silty and sandy silt, loose and saturated at 21.5', clay at 21.7', no PID hit	-3.2	-18.2	-18.2	NA	NA
Deep																		
SJS02-MW01D	07/11/97	5.27	7.94	70	44	10	58	68	25	56	31	Yorktown Aquifer	YCU - clay greenish gray, some organics and mica, trace very fine sand, few shell frags; YF - very fine to fine sand greenish	-52.73	-62.73	-64.73	-19.73	-50.73
SJS02-MW02D	07/12/97	4.71	7.04	67	45	10	54.6	64.6	23	51.5	28.5	Yorktown Aquifer	YCU - dark greenish gray, soft, organics, stiff at 48"; YF - fine sand, shell frags abundant in some intervals, organics, dark greenish gray,	-49.89	-59.89	-62.29	-18.29	-46.79
SJS02-MW05D	04/27/99	6.04	8.66	51	35.5	10	40	50	17	40	23	Yorktown Aquifer	YCU - clay greenish gray, some shells and interbeddded sand, soft; YF - coarse shell frags, trace silt, light greenish gray, trace gravel	-33.96	-43.96	-44.96	-10.96	-33.96
SJS02-MW10D	11/12/04	6.5	9.24	68	19.6	5	63	68	17	54.5	37.5	Yorktown Aquifer	YCU-greenish gray, moist, clayey sand turning to fine silty sand with some clay at 64.2'; YF-fine grain saturated and loose sand at 64.7'; slag material from 65-65.2' and fine/medium sand with some silt, saturate	-56.5	-61.5	-61.5	-10.5	-48

NA - Not Available or Not Applicable
OVM - Organic Vapor Meter
YCU - Yorktown Confining Unit
YF - Yorktown Formation

TABLE 2-2
Historical Building Activities
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

Historical Activity	Description
Former Building 13 (IR Site 10)	**Painting Activities**: Building 13 was used for tank renovation and painting. No releases of paint products have been documented. **Degreasing Activities**: Alodine (a caustic detergent), methyl ethyl ketone (MEK), and acetone were used for degreasing within the building. Prior to 1949, waste fluids were dumped into an engineered drainage swale that ran under Buildings 47 and 13 and eventually fed to St. Juliens Creek. **Sand Blasting Activities**: Sand blasting for paint removal was conducted in a 10-ft long by 18-ft wide by 8-ft high pit. Waste products included spent blast grit mixed with metal and paint chips removed from the blasted items.
Building 46	**Cartridge Cleaning Activities**: Canisters were cleaned with detergents prior to return to the manufacturer. **Reloading Activities**: Smokeless powder was loaded into cartridges. Related chemicals included explosives. **Pump Maintenance:** Hydraulic Fluid was reportedly used for maintenance of pumps in the machine shop and later dumped outside of the building for the purpose of weed and dust control.
Building 47 (IR Site 18)	**Degreasing Activities**: The building was used as the Inert Component Renovation Plant. Cartridge cases were cleaned and degreased with carbon tetrachloride or acid wash. The acid waste was then taken to the burning ground for disposal. Prior to 1949, rinsate was reportedly dumped into a drainage swale that ultimately fed to St. Juliens Creek. In addition, about 2 gallons per day of MEK and acetone were used in the building for degreasing and the waste was usually dumped along the adjacent railroad tracks. **Sandblasting Activities**: Sandblasting activities were conducted to remove paint from cartridge cases. Waste blast grit containing metals particulate and paint chips was reportedly dumped along the south side of the building. **Leaking Petroleum:** Building 47 housed an air compressor which reportedly leaked oil. **Pump Maintenance:** Hydraulic Fluid was reportedly used for maintenance of pumps in the machine shop and later dumped outside of the building for the purpose of weed and dust control.
Building 53 (IR Site 11)	**Degreasing Activities**: Building 53 was an Electrical Shop where station electricians used about 5 gallons per month of trichloroethene (TCE). TCE was reportedly disposed of beside the building and on the railroad tracks. Based on proximity of the site to Site 21, VOCs in groundwater at the site are to be addressed as part of Site 21, and Site 11 was closed under CERCLA.
Building 68	**Metal Machining**: About 5 gallons of salvable cutting oil was used every 6 months for machining metal. Waste oil was poured down the adjacent storm drain.
Former Building 130	**Ordnance Wastewaters**: Ordnance wastewaters and rinsewaters were discharged into the Site 2 inlet by Building 130 that drains to St. Juliens Creek. In the 1950s, most of these discharges were directed to the sanitary sewer system, but several discharges to the other areas continued until the 1970s.
Building 187 (IR Site 21)	**Locomotive Maintenance Activities**: Oils and Degreasers were used for

TABLE 2-2
Historical Building Activities
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

Historical Activity	Description
	locomotive maintenance. Waste fluids were reportedly dumped outside of the building for the purpose of dust control. The ground around the building was saturated with oil.
Former Building 201 (UST Site)	**Vehicle Maintenance Activities**: Oils and Degreasers were used for vehicle maintenance. Waste fluids were reportedly dumped outside of the building for the purpose of dust control. **Fuel Servicing Activities**: A service station was located north of the building. The site consisted of two tanks, a pump island and associated underground piping. The fuel tanks leaked resulting in concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) constituents in groundwater. Although this site has been closed under the UST Program because free product is no longer present on the water table, benzene is still present in groundwater in this area. **Pump Maintenance:** Hydraulic Fluid was reportedly used for maintenance of pumps in the machine shop and later dumped outside of the building for the purpose of weed and dust control.
Former Building 247	**Vehicle Maintenance Activities**: Oils and Degreasers were used for vehicle maintenance. Waste fluids were reportedly dumped outside of the building for the purpose of dust control.
Former Building 249 (IR Site 9/14).	**Pesticide Handling**: Building 249 was utilized for storage and mixing of pesticides from the mid 1960s until 1976. Chemicals included Abate, rodent baits, Bromacil, Carbaryl, Chlordane, Dalapon, Diazinon, Diquat, Gardona, Malathion, Naled, Tandex, and other combinations of pesticide chemicals. Herbicide tanks were rinsed in the adjacent wash pad which drained to the storm sewer adjacent to the building, ultimately feeding to St. Juliens Creek. **Equipment Maintenance Activities**: The wash pad was also used for general cleaning and degreasing for the purpose of equipment maintenance. **Oil/Water Separation**: A former oil water separator on the southeast side of the building received a wide mix of chemicals including petroleum chemicals and solvents. Stained soils in this area were removed prior to construction of Building 1556. The SJCA Partnering Team reached consensus for no further action (NFA) closure based on the soils removal action.
Former Building 257	**Ordnance Wastewaters**: Ordnance wastewaters and rinsewaters were discharged into the Site 2 inlet by Building 257 that drains to St. Juliens Creek. In the 1950s, most of these discharges were directed to the sanitary sewer system, but several discharges to the other areas continued until the 1970s.
Building 263	**Above Ground Storage Tank:** One above storage tank is located at the building for storage of diesel fuel and is active. **Under Ground Storage Tanks:** At least one underground storage tank was located at the building for storage of diesel fuel and was closed in ground in 1986.

TABLE 2-3
Summary of CVOCs in Groundwater
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

Station ID	Date	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	VC
Shallow Groundwater							
SJS02-MW01S	07/16/97	1 U	1 U	1 U	1 U	1 U	1 U
	11/06/97	1 U	1 U	1 U	1 U	1 U	1 U
	05/18/99	1 U	1 U	1 U	1 U	1 U	1 U
SJS02-MW02S	07/23/97	1 U	1 U	1 U	1 U	1 U	1 U
	11/06/97	1 U	1 U	1 U	1 U	1 U	1 U
	05/18/99	1 U	1 U	1 U	1 U	1 U	1 U
SJS02-MW03S	07/17/97	1 U	1 U	1 U	1 U	1 U	1 U
	11/06/97	1 U	1 U	1 U	1 U	1 U	1 U
	05/19/99	1 U	1 U	1 U	1 U	1 U	1 U
SJS02-MW04S	05/19/99	1 U	0.8 J	1 U	0.3 J	1 U	1 U
SJS02-MW05S	05/18/99	1 U	0.8 J	1 U	1 U	1 U	1 U
SJS02-MW06S	12/11/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
SJS02-MW07S	12/12/03	21 =	82,000 =	200 J	34,000 =	160 J	3,600 =
	12/02/04	34 L	270,000 =	1500 L	34,000 =	540 L	13000 U
SJS02-MW08S	12/12/03	0.5 U	0.32 J	0.5 U	0.59 =	0.5 U	0.5 U
SJS02-MW09S	12/11/03	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
SJS02-MW10S	12/03/04	39 L	330000 J	280 L	23000 L	720 L	960 L
SJS02-MW11S	12/02/04	0.5 U	50 =	0.5 U	0.5 J	0.5 U	0.5 U
SJS02-MW12S	12/02/04	0.5 U	1.6 B	0.5 U	1.2 =	0.5 U	0.5 U
SJS02-MW13S	12/02/04	0.5 UJ	1.2 B	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ
Deep Groundwater							
SJS02-MW01D	07/31/97	1 U	1 U	1 U	1 U	1 U	1 U
	11/06/97	1 U	1 U	1 U	1 U	1 U	1 U
	05/18/99	1 U	1 U	1 U	1 U	1 U	1 U
	12/01/04	0.5 UL	0.5 UL	0.5 UL	0.5 UL	0.5 UL	0.5 UL
	03/28/05	10 U	10 U	10 U	10 U	10 U	10 U
SJS02-MW02D	07/17/97	1 U	1 U	1 U	1 U	1 U	1 U
	11/06/97	1 U	1 U	1 U	1 U	1 U	1 U
	05/18/99	1 U	1 U	1 U	1 U	1 U	1 U
	03/28/05	10 U	10 U	10 U	10 U	10 U	10 U
SJS02-MW05D	05/18/99	1 U	1 U	1 U	1 U	1 U	1 U
SJS02-MW10D	12/03/04	0.5 U	2,200 =	0.68	19 =	0.5 U	0.53 =
	01/18/05	83 U	700 =	83 U	83 U	83 U	83 U
	03/28/05	10 U	900 =	10 U	35 =	10 U	10 U
	05/16/06	10 U	3.9 J	10 U	52 =	10 U	3.6 J
	05/17/06	10 U	10 U	10 U	10 U	10 U	10 U
	06/22/06	0.5 U	0.26 J	0.5 U	5.4 =	0.5 U	6.5 =
	11/28/06	0.5 U	0.5 U	0.5 U	1.6 =	0.5 U	1.7 =

Note: All concentrations in micrograms per liter.

PCE tetrachloroethene
TCE trichloroethene
DCE dichlorethene
VC vinyl chloride

TABLE 2-4
HHRA and ERA Summary
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

Media	Receptor	COCs	Risk Assessment Status
Soil and Waste			
Human Health Risk	Trespasser, Industrial Worker, Resident	Dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, aroclor-1260	Investigation and baseline HHRA complete (CH2M HILL, February 2004)
	Resident	DDT, iron	
Ecological Risk	Terrestrial	**Metals** (aluminum, antimony, beryllium, cadmium, chromium, copper, cyanide, iron, lead, mercury, nickel, silver, thallium, vanadium, zinc), **SVOCs** (acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, butylbenzylphthlate, carbazole, chrysene, dibenzofuran, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, bis(2-ethylhexyl)phthalate), **Pesticides/PCBs** (DDD, DDE, DDT, heptachlor epoxide, aroclor-1260)	Investigation and SERA and Step 3 BERA complete (CH2M HILL, February 2004)
Shallow Groundwater			
Human Health Risk	Industrial Worker	TCE, vinyl chloride, cis-1,2-DCE, & iron	Baseline HHRA complete (CH2M HILL, October 2005)
	Construction Worker	TCE	
	Resident	**VOCs** (1,1,2-trichloroethane, carbon disulfide, TCE, vinyl chloride, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE), **SVOCs** (naphthalene, 2,6-dinitrotoluene, carbazole), **Pesticides** (heptachlor epoxide), **Metals** (arsenic, and vanadium)	
Ecological Risk	Benthic Dwelling and Aquatic Receptors	Not evaluated	Not evaluated
Deep Groundwater			
Human Health Risk	Resident	No risk	Baseline HHRA complete (CH2M HILL, February 2004)
Sediment			
Human Health Risk	Resident	Chromium	Baseline HHRA complete (CH2M HILL, February 2004)
Ecological Risk	Benthic-Dwelling Organisms	Toxic effects based on bioassay at SJS02-SD06, -SD24, and -SD25	Investigation and SERA and Step 7 BERA complete (CH2M HILL, October 2005)
Surface Water			
Human Health Risk	All	No risk	Investigation and baseline HHRA complete (CH2M HILL, February 2004)
Ecological Risk	Aquatic	**Metals** (aluminum, cadmium, chromium, copper, cyanide, iron, lead, manganese, nickel, zinc), **3-nitrotoluene, carbon disulfide**	Investigation and SERA and Step 3 BERA complete (CH2M HILL, February 2004)

Note: Yellow shading indicates where additional risk evaluation of CVOCs may be performed using new data collected during the Triad investigation.
RAO remedial action objectives

Table 2-5
Data Gaps and Triad Investigation Objectives and Scope
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

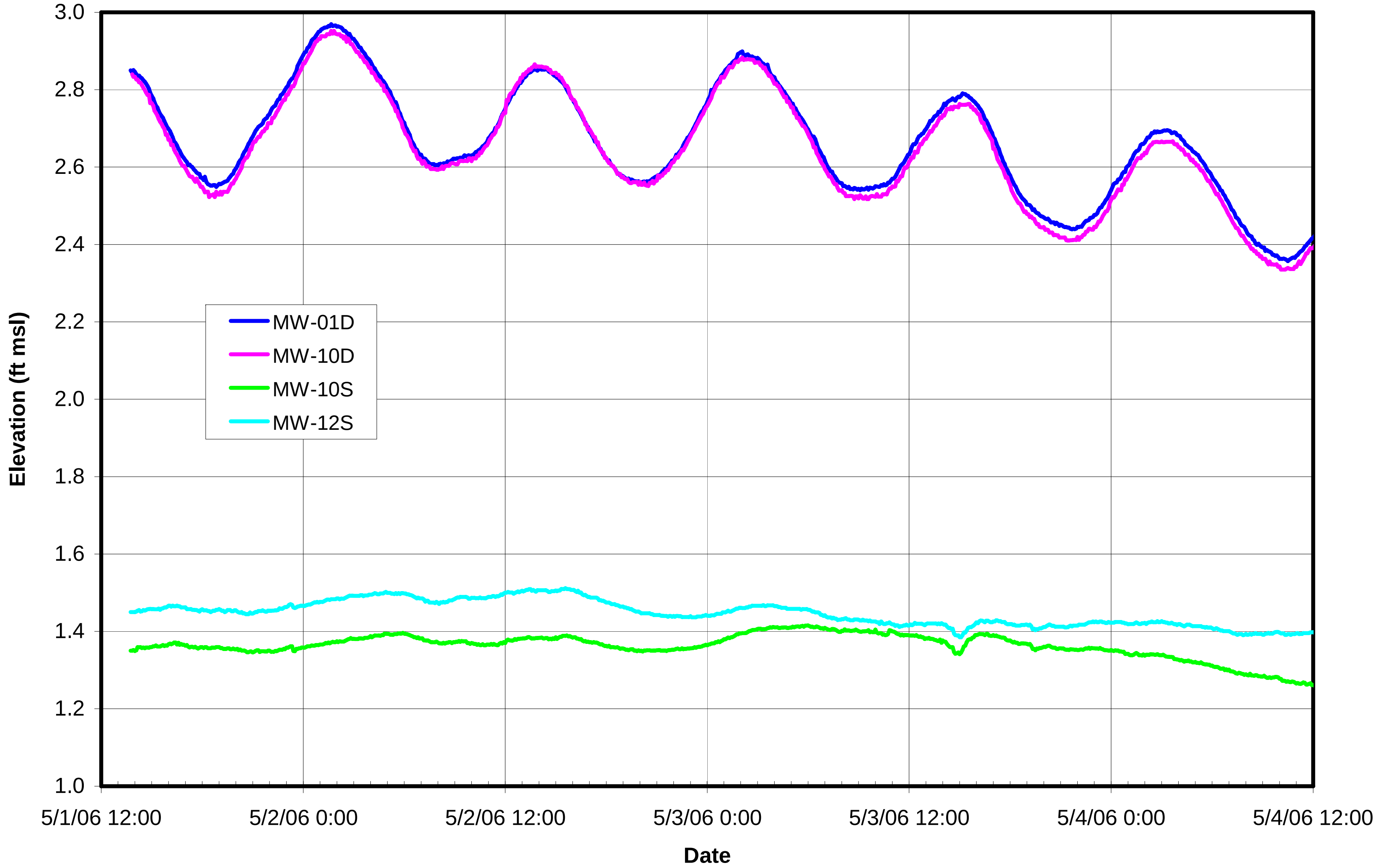
Conceptual Site Model Data Gap	Associated Remedial Action Alternative Data Gaps	Triad Field Study Objective	Scope of Investigation
1. Source Delineation			
Groundwater concentrations at two shallow monitoring wells (SJS02-MW07S and -MW10S) reported values greater than one percent of the solubility for TCE. The extent of this potential source area is an approximately 200 ft by 150 ft area.	For the **in-situ treatment alternative**, data must be collected to refine the vertical and horizontal extent of the groundwater source area (if in-situ treatment is selected for this component of the plume) to determine if a remedy can be feasibly implemented and cost estimates can be developed.	Further refine source area through MIP investigation.	Conduct MIP investigation focused in the vicinity of the identified hot spot to the top of the Yorktown Confining Unit.
		Establish source length, width, and depth for future modeling.	Confirm MIP response by collecting depth-specific soil and groundwater samples.
MIP borings in the source area did not appear to advance deep enough to reach the Yorktown confining unit (suggested by the lack of high conductivity zone at the bottom of the borings). Therefore, there is uncertainty in the vertical definition of CVOCs at the interface of the Columbia Aquifer and confining unit.	For the **source removal alternative**, the horizontal and vertical extent of the groundwater source area must be well defined.	The Yorktown confining unit has been shown to be an effective barrier to vertical contaminant migration; therefore the top of this hydrogeologic zone will not be penetrated.	Collect groundwater and soil samples from ground surface to the top of the Yorktown Confining Unit (~20 ft bgs) in the identified source area for CVOC analysis.
The tidal inlet receives stormwater runoff and drainage from upstream areas at SJCA. It is uncertain the exact location of these sources and the quantity this off-site storm- water contributes to the tidal inlet.		Determine if quantity of off-site stormwater contribution can be estimated or prevented.	Review Navy storm sewer records .
2. Contaminant Mass and Distribution			
The mass of contamination in the saturated zone has not been calculated. Although a reliable estimate of mass may not be achievable, this information can still be useful in the design of a remedy or estimating a remediation timeframe. However, it should be noted that at DNAPL sites, mass estimates are subject to extreme uncertainty, such that the results may have limited usefulness.	For the **in-situ treatment alternative**, design information which may be required includes the magnitude of concentrations in soil and groundwater located within the groundwater source area.	Further define source area .	Conduct a MIP investigation and collect depth-specific soil and groundwater samples to assess extent and magnitude of the source area.
	For the **barrier wall alternative**, the magnitude of groundwater concentrations should be known.		
	For the **source removal alternative**, any soil, present above leachability concentrations or waste should be identified. Residual DNAPL will be difficult to locate and the excavation will likely not address any CVOCs sorbed to the confining unit.		
The lithology, in which contaminant mass is located, has not been defined adequately. This may impact the feasibility of a selected remedy.		Define lithology where contaminant mass is present.	Collect DPT soil samples from select locations adjacent to MIP borings with elevated response and record lithology.
			Record continuous lithology at new monitoring well locations.
			Collect organic carbon data from selected soil samples to perform partitioning calculations.
3. Groundwater and Sediment CVOC Delineation			
The vertical and horizontal extent of CVOCs in groundwater may need additional delineation to select and design an appropriate remedy. This includes the area to the south of the plume (between SJS02-MW07S and MW02S) and to the east. Additional monitoring wells may also be needed at the site boundary to monitor contaminant flux to surface water or sediment.	For the monitored natural attenuation (MNA) alternative, a more thorough understanding of the horizontal and vertical extent and magnitude of the shallow groundwater CVOC plume is necessary prior to collection of MNA data to ensure adequate representation because conditions can vary across a site. If modeling is included as part of a MNA evaluation, the centerline of the shallow groundwater shallow groundwater CVOC plume should be identified.	Further delineate the horizontal and vertical presence of CVOCs in the Columbia aquifer and upper Yorktown confining unit and identify the relative location of the shallow groundwater CVOC plume.	Conduct MIP investigation to help delineate the shallow groundwater CVOC plume.
	For the **in-situ treatment alternative**, data must be collected to refine the vertical and horizontal extent of the groundwater plume (if the entire plume is treated) to determine if a remedy can be feasibly implemented and cost estimates can be developed. If a mass flux component is included in the remedy, the centerline of the groundwater plume should be identified.		Collect groundwater samples by DPT from ground surface to the Yorktown Confining Unit (~20 ft bgs) for CVOC analysis to define the vertical and horizontal extent of the plume.
	For the **barrier wall alternative**, the extent of the groundwater plume must be well defined.		Install piezometers within tidal inlet within the Columbia Aquifer and collect groundwater samples to define CVOC concentrations within tidal inlet and support identiifcation of the plume centerline.
			Install shallow monitoring wells and collect groundwater samples for CVOC analysis from the new wells and existing wells.
4. Groundwater to Surface Water/Sediment Interactions in the Inlet			
The groundwater/surface water interface and the impact of the shallow groundwater CVOC plume discharging to sediment is unknown.	For **all alternatives**, the dicharge of contaminants from groundwater to sediment impact the final RAOs, and thus selection of the remedial action alternative.	Determine the magnitude of CVOC concentrations in sediment pore water at the interface of groundwater discharge to sediment.	Install sediment diffusion samplers within the transition zone between groundwater and surface water in tidal inlet sediment; collect pore water samples for CVOC analysis.
		Confirm groundwater is discharging into the tidal inlet.	Measure groundwater elevations in piezometers installed within the tidal inlet and compare to surface water elevations.
5. Groundwater Flow Direction			
Additional investigation is necessary to further define the flow direction in the vicinity of the site.	For the **MNA alternative**, a more thorough understanding of the groundwater flow direction is necessary prior to collection of MNA data to ensure adequate representation.	Refine the groundwater flow model.	Collect groundwater level data from all new and existing monitoring wells (shallow and deep) and piezometers.
	For the **barrier wall alternative**, groundwater flow direction must be well defined to determine the location of the wall.		

Table 2-5
Data Gaps and Triad Investigation Objectives and Scope
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

Conceptual Site Model Data Gap	Associated Remedial Action Alternative Data Gaps	Triad Field Study Objective	Scope of Investigation
6. Geotechnical and Aquifer Properties			
Geotechnical analyses have not been performed for site soil. Without organic carbon content, it is difficult to assess contaminant retardation or conditions that are detrimental to certain remediation technologies. Without porosity data, it can be difficult to assess fate and transport of contaminants. Additional data are helpful for the selection and design of a remedial alternative.	For the **MNA alternative**, additional data are needed on the organic carbon available for natural attenuation processes at Site 2.	Collect soil geotechnical data (including organic carbon content, total porosity, soil bulk density, moisture content, grain size analysis) in the identified source area and other areas which may be targeted for remedial treatment (such as site boundary or groundwater/sediment interface).	During DPT soil investigation and monitoring well installation, select soil samples for geotechnical analysis of parameters listed in Triad field study objective.
	For the **in-situ treatment alternative**, design information which may be required includes organic carbon content and geotechnical characteristics (porosity, moisture content).		
	For the **barrier wall alternative**, geotechnical properties of the soil must be well defined.		
	For the **source removal alternative**, soil geotechnical characterization would be necessary to ensure excavation stability.		
7. Natural Attenuation Indicators			
Although there is evidence of reduction of CVOCs in site groundwater, the oxidation-reduction reactions, natural attenuation capacity, and all of the competing electron acceptors have not been identified. This information would be helpful in estimating a possible timeframe for an MNA or an EA remedy.	For the **MNA alternative**, there is uncertainty as to whether the plume is at a steady state or whether conditions indicative of natural attenuation processes are present at Site 2 and will result in an acceptable reduction in contamination within a reasonable timeframe.	Collect NA indicator data to evaluate NA processes at the site; NA indicator data includes dissolved oxygen, nitrate, manganese (II), ferrous iron, sulfate, sulfide, carbon dioxide, methane, ethane, ethene, hydrogen, and alkalinity, and total/dissolved organic carbon concentrations	Select shallow monitoring wells, preferably along the shallow groundwater CVOC plume centerline and upgradient of the plume, and collect groundwater samples for geochemical parameters, indicative of NA and potential sustainability.
There is uncertainty if the contaminant plume is at steady state or will naturally attenuate within a reasonable timeframe.		Collect shallow groundwater CVOC concentration data.	Sample all shallow monitoring wells for CVOC analysis; develop groundwater trend data and statistically evaluate stability of plume.
8. Remedial Alternative Effectiveness			
There is uncertainty if the existing site conditions are favorable to the various treatment technologies.	For the **in-situ treatment alternative**, bench-scale or pilot testing of active treatment technologies is typically required to determine if the selected in-situ treatment will be effective at reducing contaminant concentrations to achieve the RAOs and finalize the remedy design.	Refine the CSM so that an initial screening of alternative effectiveness can be conducted during the FS.	Collect information on distribution and extent of CVOC contamination and lithologic and geochemical data which may impact remedy effectiveness.
	For the **barrier wall alternative**, pilot testing will likely be required to evaluate the effectiveness of a treatment wall.	Pilot testing will be conducted following the Triad investigation.	
9. Ecological Risk			
Additional investigation is necessary to further define potential ecological risks associated with the discharge of CVOCs in groundwater to surface water/sediment.	Whether or not the shallow groundwater CVOC plume is contributing to the risk identified in soil and sediment must be determined prior to evaluation of all Work Element B alternatives. If the shallow groundwater CVOC plume is determined to be a continuing source of contaminants causing unacceptable ecological risk, it will be factored into the overall remedial approach for Site 2. Navy policy requires that sources be identified and controlled prior to sediment cleanup.	Conduct additional investigation of CVOCs in groundwater and pore water which will enable completion of the ERA.	Compare pore water results against literature-based ecological screening values (ESVs) developed for the protection of aquatic life from the presence of CVOCs in surface water.
Other than the groundwater discharge pathway, the HHRA and ERA have been completed but will be further assessed based on additional data collected during this investigation.			Further assessment of human and ecological risk based on concentration data obtained during the Triad investigation.
10. Wetland Debris Delineation			
The spatial extent and type of surface debris present within the wetland area has not been delineated.	For the **partial removal and restoration alternative**, a better understanding of the spatial extent and type of surface debris present within the wetland area would be necessary to evaluate whether the debris is impacting the wetland ecosystem.	Determine the spatial extent and type of surface debris present within the wetland area.	Delineate the spatial extent and type of surface debris present within the wetland area.

CSM - conceptual site model
CVOC - chlorinated volatile organic compound
DPT - direct push technology
EA - enhanced attenuation
ERA - ecological risk assessment
ft bgs - feet below ground surface
MIP - membrane interface probe
MNA - monitored natural attenuation
NA - natural attenuation

FIGURE 2-1
Hydrographs of Background Measurements
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia



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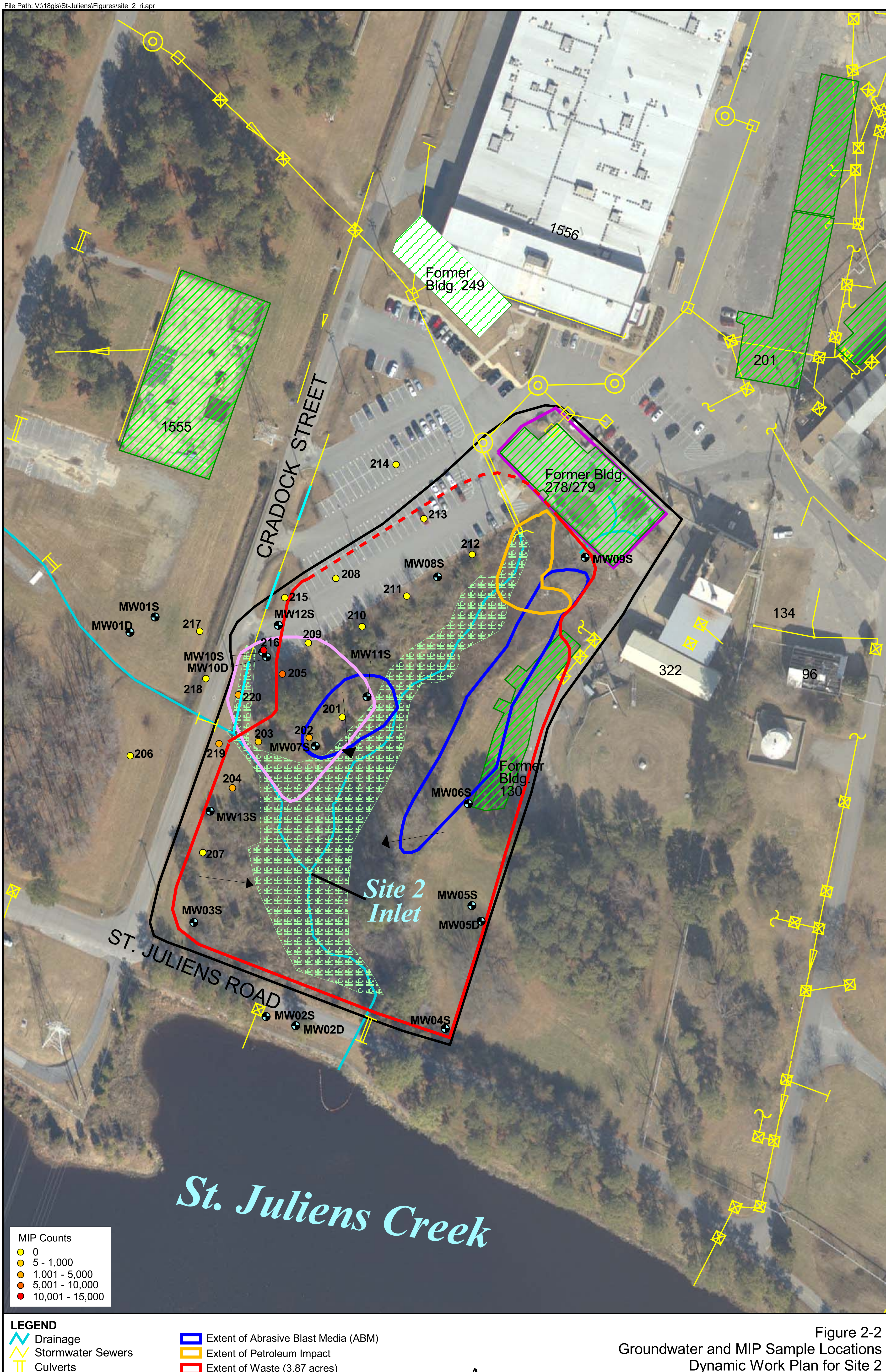

LEGEND

- Drainage
- Stormwater Sewers
- Culverts
- Demolished Buildings
- Wetland
- Site Boundary
- Former Site 17 Boundary
- Extent of Abrasive Blast Media (ABM)
- Extent of Petroleum Impact
- Extent of Waste (3.87 acres)
- Extent of CVOC Plume (2004)
- Groundwater Flow Lines
- Monitoring Well Locations

N

0 50 100 Feet

Figure 2-2
Groundwater and MIP Sample Locations
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

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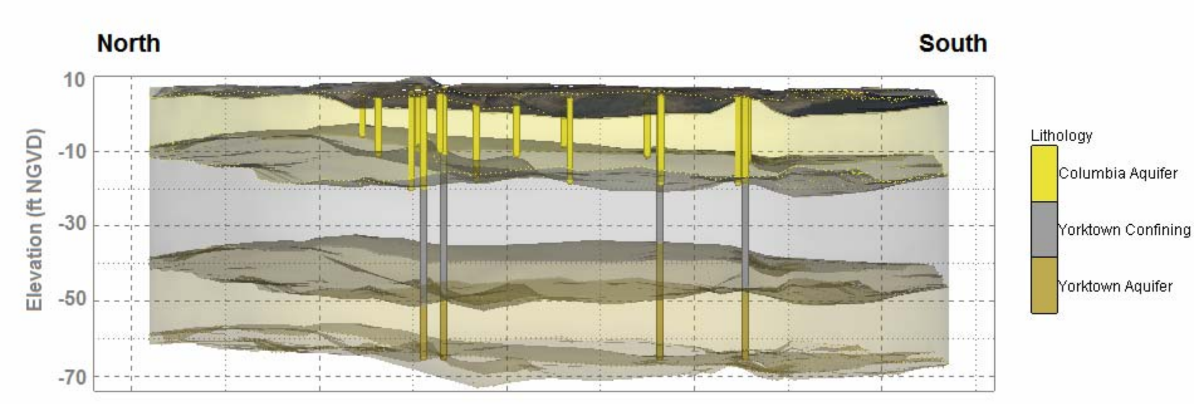
FIGURE 2-3
Hydrostratigraphic Profile and Geologic Borings
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia



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LEGEND

- Shallow Monitoring Wells
- Site 2

Columbia Aquifer Potentiometric Surface Contour
Inferred Potentiometric Surface Contour
Groundwater Flow Lines

Note: Groundwater flow data was collected in April 2005.
*Anomalous data value. Elevation was not considered for potentiometric surface mapping.
Gradient = 0.004 ft/ft

N

0 150 300 Feet

Figure 2-4
Potentiometric Surface Map of the Columbia Aquifer
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

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LEGEND

- Deep Monitoring Wells
- Site Boundaries
- SJCA Boundary

- Yorktown Aquifer Potentiometric Surface Contour
- Inferred Potentiometric Surface Contour
- Groundwater Flow Lines

* SJS21-MW01D is anomolous and is not considered for groundwater flow.

Groundwater Potentiometric Surface was calculated based on April 2005 water level readings.

Gradient = 0.0008 ft/ft

N

0 600 1200 Feet

Figure 2-5
Potentiometric Surface Map of the Yorktown Aquifer
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

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FIGURE 2-6
ECD Response in MIP Borings (2004)
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

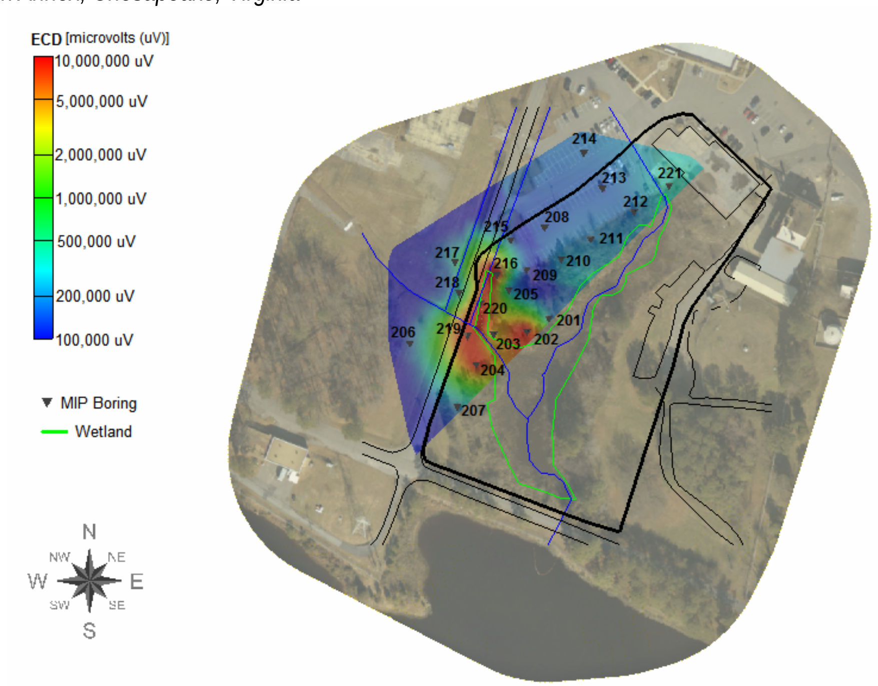


FIGURE 2-7
ECD Response above 1,000,000 mV in MIP Borings (2004)
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

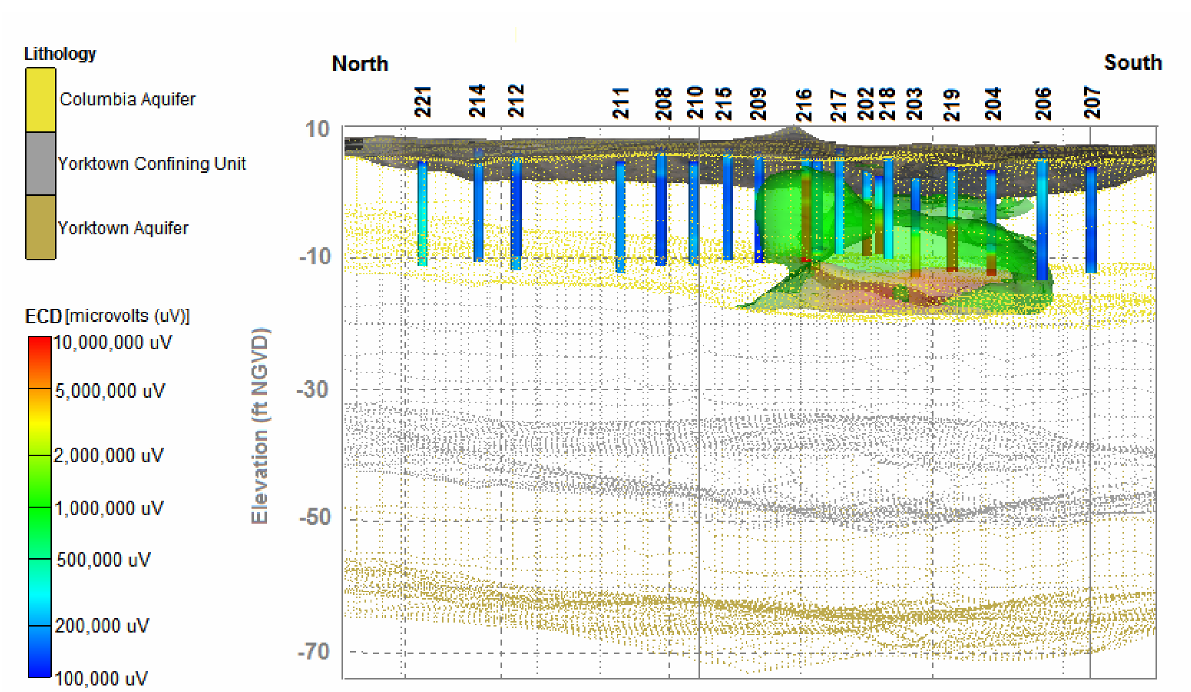
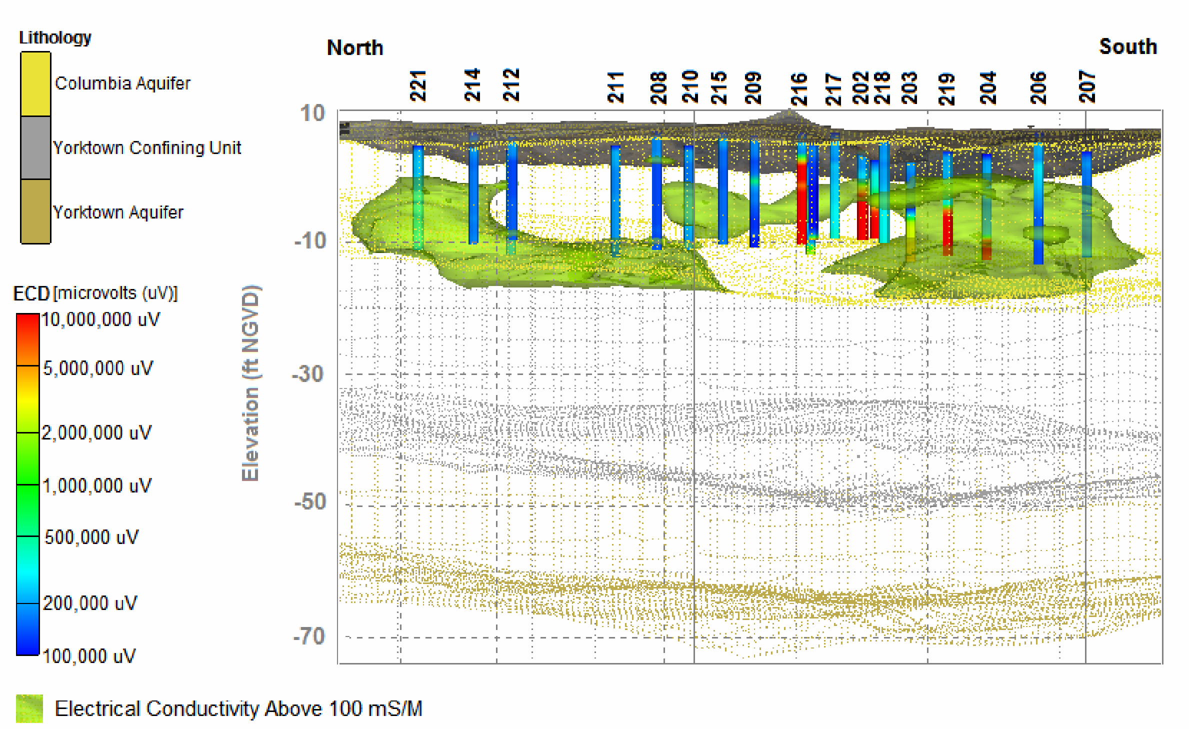


FIGURE 2-8
ECD Response and Conductivity in MIP Borings (2004)
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia



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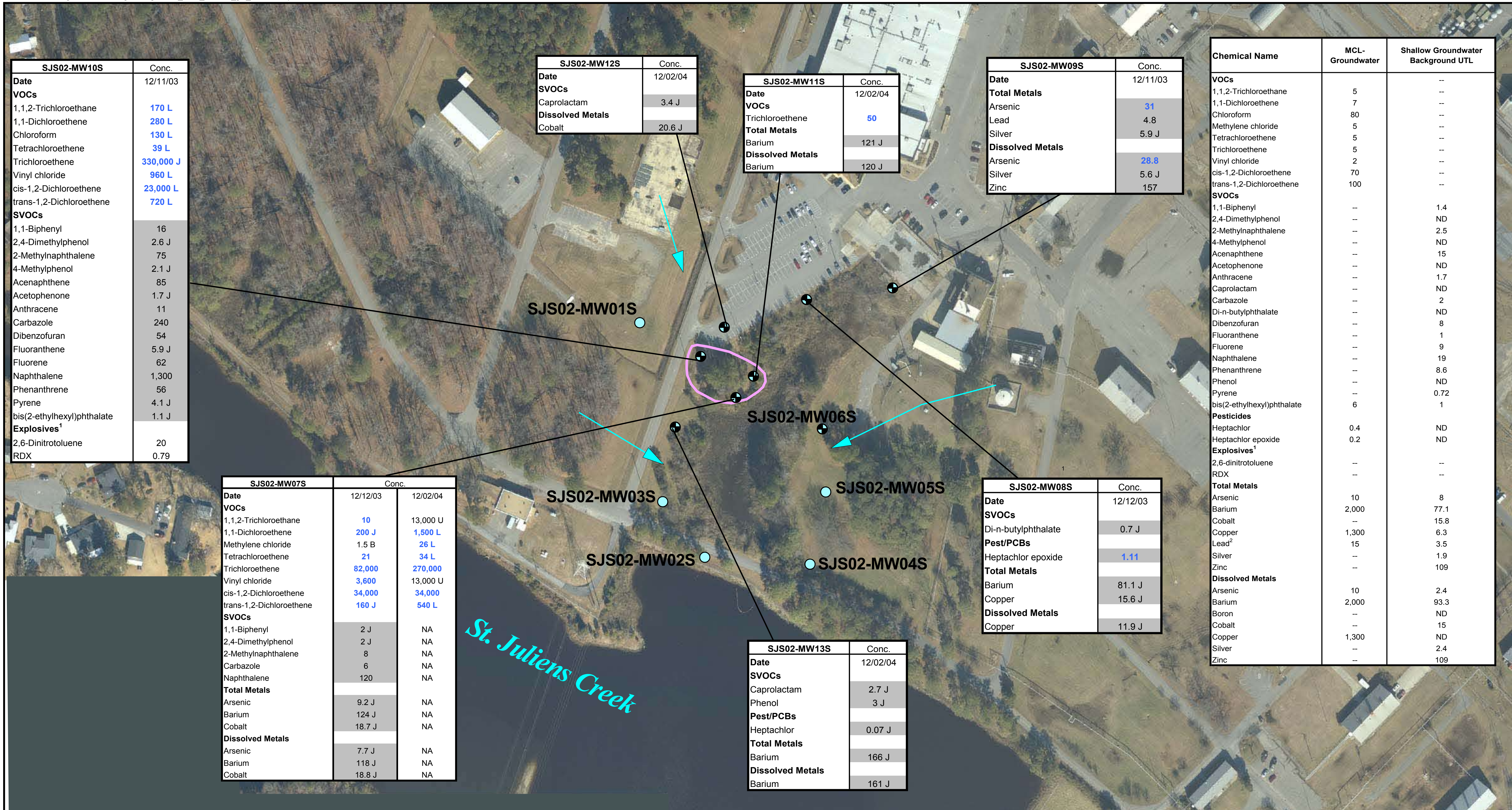

SJS02-MW10S	Conc.
Date	12/11/03
VOCs	
1,1,2-Trichloroethane	**170 L**
1,1-Dichloroethene	**280 L**
Chloroform	**130 L**
Tetrachloroethene	**39 L**
Trichloroethene	**330,000 J**
Vinyl chloride	**960 L**
cis-1,2-Dichloroethene	**23,000 L**
trans-1,2-Dichloroethene	**720 L**
SVOCs	
1,1-Biphenyl	16
2,4-Dimethylphenol	2.6 J
2-Methylnaphthalene	75
4-Methylphenol	2.1 J
Acenaphthene	85
Acetophenone	1.7 J
Anthracene	11
Carbazole	240
Dibenzofuran	54
Fluoranthene	5.9 J
Fluorene	62
Naphthalene	1,300
Phenanthrene	56
Pyrene	4.1 J
bis(2-ethylhexyl)phthalate	1.1 J
Explosives[1]	
2,6-Dinitrotoluene	20
RDX	0.79

SJS02-MW12S	Conc.
Date	12/02/04
SVOCs	
Caprolactam	3.4 J
Dissolved Metals	
Cobalt	20.6 J

SJS02-MW11S	Conc.
Date	12/02/04
VOCs	
Trichloroethene	**50**
Total Metals	
Barium	121 J
Dissolved Metals	
Barium	120 J

SJS02-MW09S	Conc.
Date	12/11/03
Total Metals	
Arsenic	**31**
Lead	4.8
Silver	5.9 J
Dissolved Metals	
Arsenic	**28.8**
Silver	5.6 J
Zinc	157

Chemical Name	MCL-Groundwater	Shallow Groundwater Background UTL
VOCs		--
1,1,2-Trichloroethane	5	--
1,1-Dichloroethene	7	--
Chloroform	80	--
Methylene chloride	5	--
Tetrachloroethene	5	--
Trichloroethene	5	--
Vinyl chloride	2	--
cis-1,2-Dichloroethene	70	--
trans-1,2-Dichloroethene	100	--
SVOCs		
1,1-Biphenyl	--	1.4
2,4-Dimethylphenol	--	ND
2-Methylnaphthalene	--	2.5
4-Methylphenol	--	ND
Acenaphthene	--	15
Acetophenone	--	ND
Anthracene	--	1.7
Caprolactam	--	ND
Carbazole	--	2
Di-n-butylphthalate	--	ND
Dibenzofuran	--	8
Fluoranthene	--	1
Fluorene	--	9
Naphthalene	--	19
Phenanthrene	--	8.6
Phenol	--	ND
Pyrene	--	0.72
bis(2-ethylhexyl)phthalate	6	1
Pesticides		
Heptachlor	0.4	ND
Heptachlor epoxide	0.2	ND
Explosives[1]		
2,6-dinitrotoluene	--	--
RDX	--	--
Total Metals		
Arsenic	10	8
Barium	2,000	77.1
Cobalt	--	15.8
Copper	1,300	6.3
Lead[2]	15	3.5
Silver	--	1.9
Zinc	--	109
Dissolved Metals		
Arsenic	10	2.4
Barium	2,000	93.3
Boron	--	ND
Cobalt	--	15
Copper	1,300	ND
Silver	--	2.4
Zinc	--	109

SJS02-MW07S	Conc.	
Date	12/12/03	12/02/04
VOCs		
1,1,2-Trichloroethane	**10**	13,000 U
1,1-Dichloroethene	**200 J**	**1,500 L**
Methylene chloride	1.5 B	**26 L**
Tetrachloroethene	**21**	**34 L**
Trichloroethene	**82,000**	**270,000**
Vinyl chloride	**3,600**	13,000 U
cis-1,2-Dichloroethene	**34,000**	**34,000**
trans-1,2-Dichloroethene	**160 J**	**540 L**
SVOCs		
1,1-Biphenyl	2 J	NA
2,4-Dimethylphenol	2 J	NA
2-Methylnaphthalene	8	NA
Carbazole	6	NA
Naphthalene	120	NA
Total Metals		
Arsenic	9.2 J	NA
Barium	124 J	NA
Cobalt	18.7 J	NA
Dissolved Metals		
Arsenic	7.7 J	NA
Barium	118 J	NA
Cobalt	18.8 J	NA

SJS02-MW13S	Conc.
Date	12/02/04
SVOCs	
Caprolactam	2.7 J
Phenol	3 J
Pest/PCBs	
Heptachlor	0.07 J
Total Metals	
Barium	166 J
Dissolved Metals	
Barium	161 J

SJS02-MW08S	Conc.
Date	12/12/03
SVOCs	
Di-n-butylphthalate	0.7 J
Pest/PCBs	
Heptachlor epoxide	**1.11**
Total Metals	
Barium	81.1 J
Copper	15.6 J
Dissolved Metals	
Copper	11.9 J

LEGEND

- Shallow Monitoring Well Locations sampled during ERI
- Shallow Monitoring Well Locations not sampled during ERI
- Extent of CVOC Plume (2004)
- Groundwater Flow Direction

-- no criteria
ND - No Detections
NA - Not Analyzed
J- Analyte present. Reported value is estimated.
L- Analyte present. Reported value is biased low.
U - Not Detected

Bold Blue text indicates MCL Exceedances
Shaded cells indicate Background UTL Exceedances

Conc. - Concentration
All concentrations are measured in ug/L.
[1]All explosives detections are presented because no screening criteria exist.
[2]EPA Action Level for Lead

N

0 175 350 Feet

Figure 2-9
Shallow Groundwater Detection and Exceedances of Screening Criteria
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

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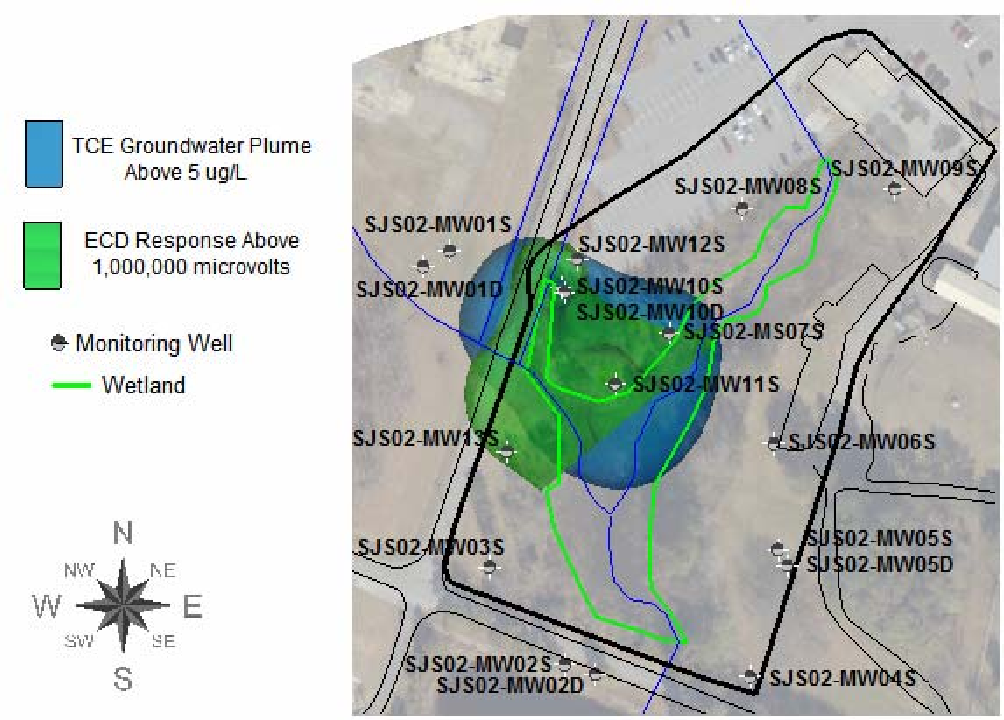
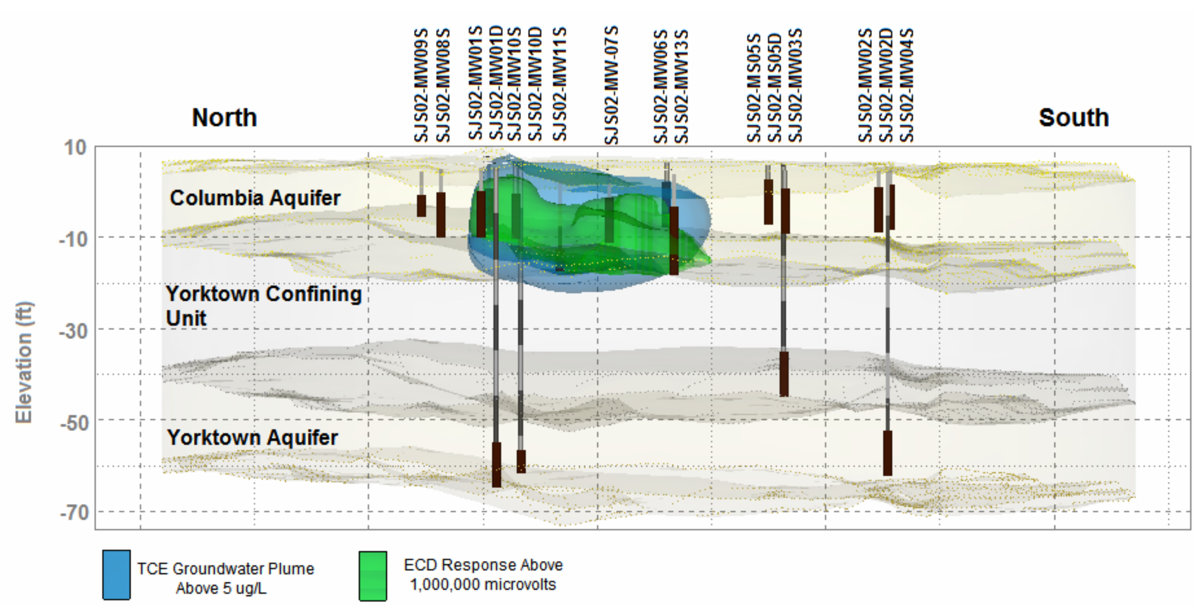
FIGURE 2-10
Horizontal Extent of TCE in Groundwater and ECD Response
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia



Note: Extent of TCE groundwater plume and MIP ECD Response interpolated using three-dimensional Mining Visualization Software (MVS), distributed by C Tech.

FIGURE 2-11
Vertical Extent of TCE in Groundwater and ECD Response
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia



Note: Extent of TCE groundwater plume and MIP ECD Response interpolated using three-dimensional Mining Visualization Software (MVS), distributed by C Tech.

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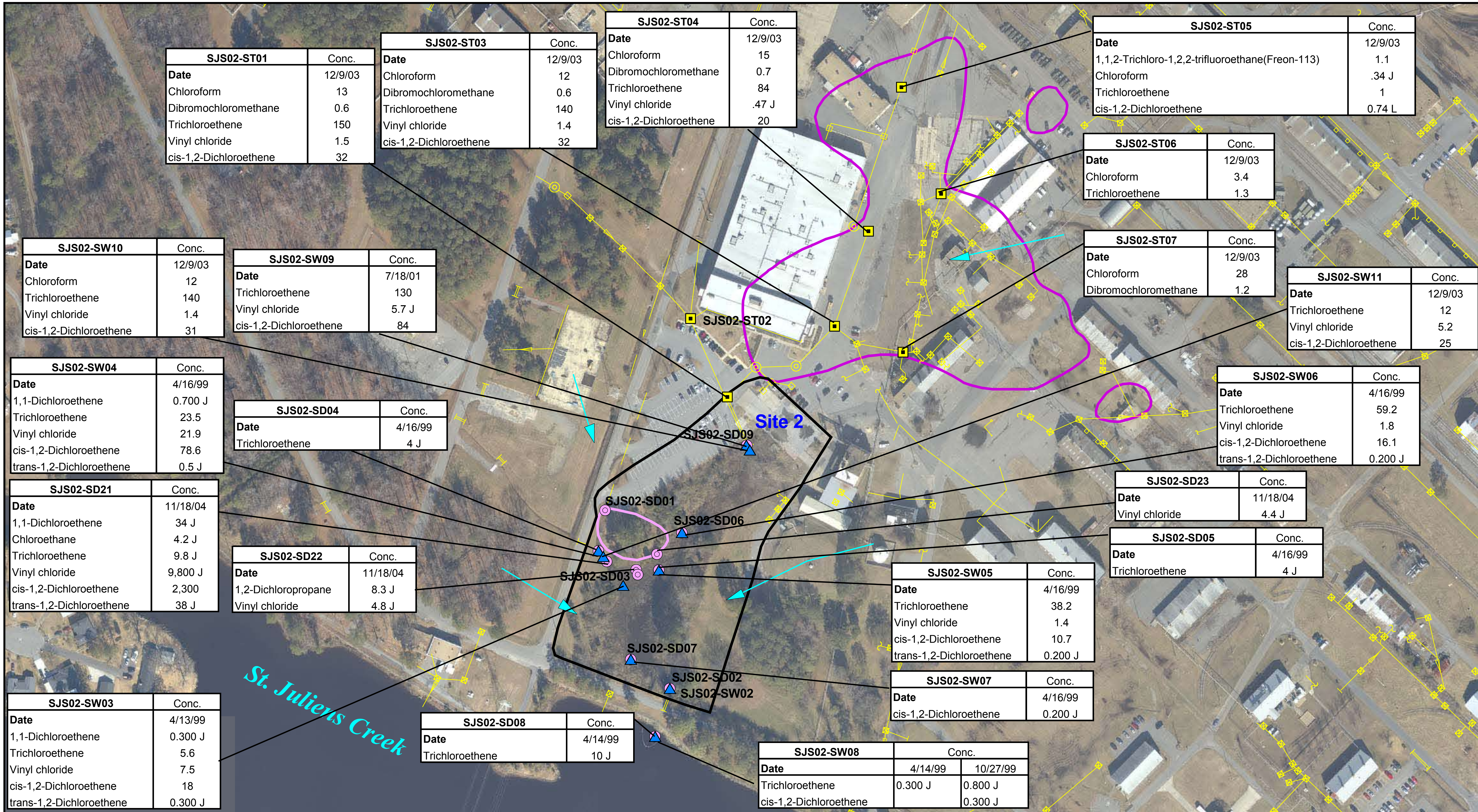

LEGEND

- Surface Water Sampling Locations
- Stormwater Sampling Locations
- Sediment Sampling Locations
- Storm Water Sewer System
- Groundwater Flow Direction
- Site Boundary
- Extent of Site 2 CVOC Plume (2004)
- Extent of Site 21 CVOC Plume (2005)

L - Analyte present. Reported value is biased low.
J - Analyte present. Reported value is estimated.
Conc. - Concentration
All levels measured in µg/L.

N

0 100 200 300 400 Feet

Figure 2-12
Stormwater, Surface Water, and Sediment
CVOC Sample Locations and Detections
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

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SECTION 3

Investigation Activities

The Triad investigation for Site 2 will focus on CVOC delineation to meet the project objectives in Section 1.2. The spatial extent of the investigation is limited to within the Site 2 boundary and directly upgradient from the shallow groundwater CVOC plume (Figure 1-2), and to the vertical depth of the top of the confining unit. This section describes activities that will be conducted prior to and during the field investigation and presents the decision logic for the dynamic sampling and analysis strategy. The proposed activities are described to the extent practical at this stage in the project. Contingencies related to field technology failure are also addressed in this section.

The *Final Master Project Plan (MPP)* (CH2M HILL, July 2003) addresses the protocols and standard operating procedures (SOPs) to be used for all investigations at SJCA. The SJCA MPP consists of the Master Work Plan (MWP), Master Field Sampling Plan (MFSP), Master Quality Assurance Project Plan (MQAPP), Master Investigation-Derived Waste Management Plan (MIDWMP), and Master Health and Safety Plan (MHSP). Preparation of site-specific plans is simplified through reference to the MPP documents. This DWP provides site-specific details for the Site 2 investigation activities and references the MPP as appropriate. A site-specific health and safety plan (HASP) is provided in Appendix A. Table 3-1 provides a list of the applicable SOPs from the SJCA MPP, and the SOPs are included as Appendix B.

3.1 Mobilization

In support of the field mobilization, CH2M HILL will procure subcontractors and equipment to support investigation activities. Prior to initiating field activities, CH2M HILL will notify NAVFAC of the CH2M HILL staff and subcontracted personnel that will conduct the field investigations. Equipment and supplies will be brought to the site when the field team mobilizes for field activities. Large site maps and this DWP will be kept at the site along with the MPP.

Prior to beginning any work, CH2M HILL and its subcontractors will have field meetings to discuss the work items, worker responsibilities, and familiarize workers with the HASP. It is important that the subcontractors understand that the investigation will be a dynamic process and flexibility is needed to implement the decision logic. Clearing of vegetation will be conducted in the wooded areas as necessary in order to provide access to the proposed sample locations by the DPT rig. A decontamination area, equipment and materials staging area, and IDW management area will be established prior to field work. A photo-ionization detector (PID) will be used for monitoring sample locations for VOCs as a health and safety precaution (Appendix A).

3.1.1 Utility Clearance

Prior to any intrusive activities, appropriate site approval will be obtained and the site will be marked for utilities. Due to the dynamic nature of the investigation, the entire site will be cleared for utilities, rather than just the pre-identified sample locations. CH2M HILL will coordinate subsurface utility clearances with a separate utility location subcontractor and maps of utilities identified will be generated to support the work. No intrusive activities will be initiated until the utility clearance has been completed.

3.1.2 Munitions and Explosives of Concern Support

Based on the site history and findings during investigations conducted to-date, there is a low probability of encountering MEC or material potentially presenting an explosive hazard (MPPEH) during the activities proposed in this work plan. An Explosives Safety Submission (ESS) waiver request for intrusive activities at Site 2 was approved by Naval Ordnance Safety & Security Activity (NOSSA), dated October 14, 2004 (Appendix C). The ESS waiver outlines the general field approach, which includes the following:

1. An onsite MEC technician (Tech III) will conduct anomaly avoidance using a Schonstedt magnetometer to detect metallic anomalies. Access routes to sampling locations will be checked by the unexploded ordnance (UXO) technician prior to access by the sample technicians. The MEC technician will conduct a reconnaissance of the sampling area, and each sample location will be verified free of anomalies on or near the ground surface prior to sampling. All anomalies will be considered MEC. If anomalies are detected, the sampling point will be relocated to a location free of anomalies.

2. Vegetation removal will be performed under the direction of UXO Technicians; all activities will be conducted after a visual and/or Schonstedt magnetometer sweep of the area by the UXO Technician. Mechanical and manual vegetation removal teams will include a UXO Technician using appropriate geophysical instruments and observations to avoid MEC.

3. During intrusive activities, continued clearance will be conducted using the Schonstedt to ensure no MEC or MPPEH is present. If no anomalies are encountered, soil or groundwater sampling may proceed. If anomalies are detected, the sampling point will be relocated to a location free of anomalies. Samples will be inspected by the MEC technician to ensure no MEC/MPPEH are present prior to shipment to the laboratory.

4. If any MEC item is encountered, all site activities will be immediately terminated, and the operational risk/hazard assessment will be reviewed. If the operational risk/hazard assessment review results in a higher risk assessment code, an ESS may be prepared prior to the continuance of intrusive activities.

The MEC avoidance procedures will be communicated daily during site safety meetings. The UXO technician directly controls all intrusive activities in order to achieve maximum operational safety and efficiency and can temporarily stop work in order to correct unsafe conditions or procedures. Contact with MEC is PROHIBITED. This approach is in accordance with CH2M HILL SOPs HSE-35 (Drilling) and Health, Safety, Environment & Quality (HSE&Q) SOP 610, Explosives Usage and Munitions Response (MR) (Appendix B).

3.2 Field Activities

Field investigation activities will be conducted in a sequential order to facilitate the decision-making process and address the availability of subcontracted equipment. The following activities will be conducted to address the data gaps presented in Table 2-5:

- Sediment diffusion sampling to evaluate CVOC pore water concentrations
- MIP investigation to delineate shallow groundwater CVOC plume
- DPT groundwater and soil sampling to confirm MIP results, assess magnitude of CVOCs, and to collect geotechnical parameters in support of remedial alternative evaluation
- Temporary piezometer installation and groundwater sampling to delineate the shallow groundwater CVOC plume within the tidal inlet
- Permanent monitoring well installation and sampling to establish a complete CVOC data set for site groundwater and to collect geochemical and geotechnical parameters in support of remedial alternative evaluation

During the field investigation, the decision logics (Figures 1-3 and 1-4 through 1-8) will be used to evaluate the data collection effort with respect to project objectives and to decide whether ongoing field work is necessary. Real-Time Measurement Technologies will be used to provide near- or real-time data to guide the investigation activities. Although some proposed sample locations are presented herein, the actual sample locations will be determined in the field.

All field activities will be recorded in a project field book. Site maps will be maintained in the field, and sample locations will be updated on these maps frequently. The field team and CH2M HILL project manager will review analytical data obtained each day. As results from the investigation activities are available, they will be used to continuously update the CSM and made available to the SJCA Project Management Team.

All samples will be contained in laboratory-prepared pre-preserved sample bottles and either provided to the onsite laboratory for analysis or packed on ice for overnight shipment to an offsite laboratory. Table 3-2 shows the required containers and holding times for samples as well as the analytical methods. Quality assurance/quality control (QA/QC) samples will be collected and analyzed as indicated in Section 3.3 and Table 3-3, unless otherwise indicated. Table 3-4 presents a preliminary summary of analytical samples which will be collected during this investigation.

3.2.1 Sediment Diffusion Sampling

Sediment diffusion samplers will be used to evaluate the CVOC concentrations in the sediment pore water. The data will be used to screen the potential risk to ecological receptors at the sediment/surface water interface from groundwater CVOCs discharging through the tidal inlet sediment and also to help refine the CVOC fate and transport for the CSM. The sediment diffusion samplers will be installed at 100-ft intervals along the entire length of the inlet between former Building 278/279 and the culvert to St. Juliens Creek. To obtain more refined delineation in the vicinity of the identified shallow groundwater CVOC plume, sediment diffusion samplers will be placed at a closer horizontal spacing of 50 ft. Proposed sample locations are presented on Figure 3-1.

Two-in. diameter, 12-in. long sediment diffusion samplers with 10-in. long slotted screens will be used; an image and specifications of the sediment diffusion sampler is included in Appendix D. The sediment diffusion sampler will be placed in a 12-in. long, protective casing with a 1-in. pointed tip and screw-on cap. The screen length will fall approximately between 2 and 12 in. bgs, within the transition zone between surface water and groundwater (assumed to exist between 6 and 18 in. bgs). This depth is shallow enough to intercept the zone that ecological receptors would be exposed to (assumed to be between 0 to 6 in. bgs).

The sediment diffusion sampling decision logic is included in Figure 1-4. Prior to installation, the sediment diffusion samplers will be filled with deionized (DI) water. A staking flag will be attached to each sampler. Sediment diffusion samplers will be installed during low tide. If the sample is selected at a location where there is surface water under high tide conditions, the diffusion samplers will be pushed by hand, so that the top of the protective canister/bottom of the screw-on cap is flush with the sediment. This will protect the diffusion sampler screen from any disturbance at the surface or being moved by the surface water. If the sample is selected at a location, where the water table exists below the sediment surface, the sediment diffusion sampler will need be installed deeper, so that the entire screen is located below the water table. If the sediment is too dense to install the sampler by hand, then a shovel or hand auger should be used to dig a hole for the sampler. A polyvinyl chloride (PVC) pipe can be used to temporarily keep open the hole. The hole will be backfilled with the displaced sediment.

Each sediment diffusion sampler will hold 150 milliliters of water. Therefore, to obtain enough volume for the QA/QC samples, described in Section 3.3 and listed in Table 3-3, additional samplers may need to be installed adjacent each other at one sample location.

The sediment diffusion samplers will be retrieved after three weeks, to allow sufficient time for equilibration, and a water sample will be collected for on-site laboratory analysis of CVOCs by SW 846 8260B. During retrieval, the sediment diffusion samplers will be visually inspected. Any observations, including coatings or deposits will be recorded in the field notebook. Analytical results will be compared to literature-based ecological screening values (ESVs) developed for the protection of aquatic life from the presence of CVOCs in surface water. Based on the presence of brackish water in the Site 2 inlet, the lower of freshwater and marine ESVs (Table 3-5) will be used to conservatively screen the CVOC concentrations detected in pore water. If results do not exceed the ESV, it will be concluded that CVOCs do not pose a risk to aquatic life. If results do exceed the ESV, then the SJCA Project Management Team will discuss whether in-situ bioassay testing or other methods should be planned and conducted to further evaluate risk associated with CVOCs.

3.2.2 Membrane Interface Probe Investigation

MIP technology will be utilized to collect real-time qualitative data to refine the understanding of the horizontal and vertical distribution of CVOCs. The MIP uses a DPT to advance sensors through the subsurface while collecting continuous data on temperature, electrical conductivity, and VOC concentrations in gas phase. The basic operating principle behind the MIP is that a down-hole heating element raises subsurface temperatures, volatilizing most VOCs. VOCs permeate across a membrane at the probe tip and are transported to the surface in an inert carrier gas stream for analysis. MIP rigs are typically equipped with a flame ionization detector (FID), PID, and ECD. The FID measures the mass of total combustible compounds in the gas stream. The PID measures only those ionizable compounds whose ionization potential is less than the PID bulb energy; thus, the PID response is a subset of the FID response. The FID signal includes methane and other high molecular-weight organic chemicals not detected by the PID. The ECD analyzes the mass of a smaller set of organic chemicals that generally represent the CVOCs[1]. Additional sensors on the MIP log measure temperature and electrical conductivity. The temperature meter assists in the estimation of the depth of the saturated zone. Typically, the temperature shows a sharp decline as the probe enters the saturated zone. The electrical conductivity meter is generally used to determine the soil type (e.g. sand or clay). The PID, FID, ECD, temperature, and electrical conductivity data are collected continuously during advancement of the MIP probe. The MIP probe to be used in this investigation will also house a “trapping” device with the ability to “trap” the volatilization gases and analyze them using a mass spectrometer. This device cannot determine exact concentrations but can identify specific compounds (e.g., TCE, cis-1,2 DCE, etc.) and assess concentrations relative to other MIP locations and relative to other depths at the same location.

For consistency with previous MIP data, the subcontractor will confirm which equipment and procedures were used to ensure the data is comparable. The MIP logging will be initiated within the area where the highest CVOC concentrations were previously detected so that the field team can get an understanding of what the baseline and maximum readings for the MIP detectors will be during the investigation. These levels are assumed to be investigation-specific depending on the equipment used.

Fifteen initial MIP borings are proposed based on the existing CSM and are shown on Figure 3-2. The initial MIP borings were selected for the following purposes:

- Provide additional vertical delineation adjacent to the historic MIP points (201, 202, and 203) that showed elevated ECD response but may not have advanced to the depth of the Yorktown confining unit
- Provide additional information on the magnitude and extent of CVOC contamination within the center of the currently identified shallow groundwater CVOC plume
- Provide more refined delineation of the groundwater source area to the north of the shallow groundwater CVOC plume and adjacent to the inlet for evaluation of future remedies
- Provide screening data to help determine if the shallow groundwater CVOC plume extends to the eastern side of the tidal inlet and refine its location

[1] Fluorinated and brominated compounds are also detected by the ECD. These compounds can cause false positive responses for CVOCs; however, these compounds are not expected to be encountered, and PID and FID should provide responses in addition to the ECD when CVOCs are present.

- Provide additional delineation southwest of the shallow groundwater CVOC plume between historic MIP points 204 and 219 (that had elevated ECD response) and SJS02-MW13S (that had no CVOC detections)

Following the completion of all the initial borings on Figure 3-2, it will be determined if any additional MIP borings are needed to meet data objectives. If any of the initial MIP borings located on the perimeter of the investigation had elevated ECD or PID response, then additional MIP borings will be performed at a 50-ft step-out distance or until it is determined that the plume has been sufficiently delineated (within the limitations of the MIP technology). It is assumed that the MIP technology will be able to detect CVOCs in groundwater at concentrations to below 200 μg/L depending on site-specific conditions (i.e., the phase of the contaminant and interferences from the soil, water, and vapor matrix). The decision logic for selection of additional sample locations is provided in Figure 1-5. MIP results indicating CVOC contamination will be used as the starting point for the DPT groundwater delineation activity (Section 3.2.3).

At each selected location, the MIP will initially be advanced at a rate of 1 ft per minute (ft/min). The MIP advancement rate may be increased based on the absence of MIP detector response or decreased based on the presence of MIP detector response. When in a zone of elevated detector response, the MIP should be given enough time to return to baseline conditions before advancing deeper.

The MIP will be advanced to the depth of the Yorktown confining unit, located approximately 15 to 25 ft bgs. The confining unit should be identified by an increase in the electrical conductivity response. If no increase in electrical conductivity is observed, then MIP advancement should stop at 25 ft bgs to avoid dragging contamination into the confining unit. If the MIP has refusal (identified as taking longer than 1.5 minutes of continuous hammering to advance 1 ft as defined by the subcontractor's SOP) before reaching the confining unit then a DPT groundwater sample should be collected from this location from the bottom of the Columbia aquifer during the next activity, if this data is still needed for the CSM.

Each day the MIP technology is used, a response test will be performed prior to its use. The test will be based on the investigated site contaminants, CVOCs. During the test, the time that its takes for the VOC gas to reach the gas chromatographer (GC) from the tip of the probe will be measured to help refine the rate of MIP advancement during the investigation.

3.2.3 Direct-Push Technology Groundwater and Soil Sampling

The DPT will be advanced to collect discrete groundwater and soil samples to provide confirmation of the MIP data, delineate the shallow groundwater CVOC plume, select permanent monitoring well locations, aid in locating the centerline of the groundwater plume, and to evaluate geotechnical properties of site soils. DPT groundwater and soil sample locations and depths will be selected immediately following the MIP investigation. The decision logic for DPT groundwater and soil sampling is provided in Figures 1-6 and 1-7.

To horizontally delineate the shallow groundwater CVOC plume, DPT groundwater samples will be collected outside the extent of the MIP response at the same vertical depth that the response was observed in adjacent locations. These 4 proposed DPT groundwater locations are shown on Figure 3-2. The groundwater samples will be collected (methodology described below) and analyzed by the on-site laboratory for CVOCs by SW 846 8260B. If any of these DPT groundwater samples have CVOC concentrations above the MCLs, then additional DPT groundwater samples will be collected at a 50-ft step-out distance from the same vertical depths until it is determined that the plume has been sufficiently delineated. The decision logic for selection of additional sample locations is provided in Figure 1-6.

To confirm the MIP responses and to vertically delineate the shallow groundwater CVOC plume, up to 10 DPT groundwater and soil sample locations will be based on vertical depths indicating a low, medium, and high peak in MIP detector response. Both groundwater and soil samples will be collected since the MIP will respond to contaminants dissolved in groundwater and sorbed to the soil matrix. MIP detector responses with high peaks are assumed to be located in the centerline of the plume and the DPT groundwater samples should be sufficient to identify the CVOC concentration for future MNA modeling. This sampling will also provide a better understanding of the magnitude of CVOC concentrations in the groundwater source area. The decision logic is provided in Figure 1-7.

The DPT groundwater samples will be collected using the Geoprobe® Screen Point Sampler (stainless-steel retractable screen attached to the DPT rods). At each selected DPT groundwater sample location, the groundwater sampling device will be pushed to the desired depth based on MIP response. Since the MIP records variability of VOC concentrations over very small vertical intervals, the screen will only be exposed a few inches to provide the best correlation to MIP response. If there is not sufficient volume to collect a groundwater sample within limited intervals, then the exposed portion of the screen should be increased to 1-ft of screen exposed, thus drawing groundwater from a larger vertical interval. The screen length can be increased up to 4 ft if there is significant difficulty collecting a sample.

Groundwater samples will be collected following a low-flow sampling protocol using a peristaltic pump and disposable tubing. A groundwater sample will be attempted within approximately 5 minutes of low-flow purging, regardless of the observed turbidity. Groundwater collected from the DPT is considered to be representative of groundwater in that sample interval and should not need significant purging.

The DPT soil samples will be collected using a Geoprobe Macro-Core® Sampler with PVC, or polyethylene terephalate glycol (PETG) liners. At each selected DPT soil sample location, the soil sampling device will be pushed to the desired depth based on MIP response. The soil samples will be logged by a CH2M HILL geologist.

Discrete soil samples will be collected for analysis of CVOCs by SW 846 8260B by the on-site laboratory. Up to 4 of the DPT soil samples will also be analyzed for TOC by an off-site laboratory. The soil sample locations selected for TOC analysis will be based on those indicating high electrical conductivity readings, high MIP responses, and/or visually observed organic materials. Because this data will not be validated and/or used as part of a risk assessment, reduced QA/QC samples for DPT groundwater and soil will be collected (i.e., duplicates and equipment blanks as shown on Table 3-3).

If the DPT has refusal (identified as taking longer than 1.5 minutes of continuous hammering to advance 1 ft), then the sample location(s) will be moved. Alternative soil sampling methods, such as a dual tube sampler or split spoon sampler may need to be identified if refusal continues or if the sampler liner is repeatedly stuck in the core barrel, during sample collection.

3.2.4 Temporary Piezometer Installation and Sampling

Temporary piezometers will be installed to assess CVOC groundwater concentrations within the tidal inlet and aid in locating the centerline of the groundwater plume. The depth to groundwater inside of the piezometers and the depth to surface water on the outside of all piezometers will be measured to confirm if different portions of the tidal inlet are discharge or recharge areas for groundwater. At least one continuous split-spoon or macro core sample will be collected in the inlet to identify the depth of the Yorktown confining unit to aid in the determination of the appropriate installation depth. A CH2M HILL geologist will observe and record soil descriptions that include grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information such as possible evidence of contamination.

Piezometers will be installed at 4 locations along the tidal inlet bank, at the downgradient edge of the shallow groundwater CVOC plume, at 50-ft horizontal spacing. Piezometers will also be set at 100 ft upstream and downstream of the shallow groundwater CVOC plume area. Proposed temporary piezometer locations are presented on Figure 3-2. The selected horizontal spacing should be sufficient to identify the CVOC concentrations in the relative location of the plume centerline for future MNA modeling.

The temporary piezometers will be installed so that the screened interval is placed in the anticipated zone of CVOC groundwater contamination identified during the previous Triad investigation activities, or just above the Yorktown confining unit if a specific vertical zone of contamination is not identified. If vertical delineation is required at multiple depths, then pairs of nested piezometers will be installed. The final screen interval(s) will be determined in the field by the on-site geologist. Figure 1-8 presents the piezometer installation decision logic.

The groundwater samples will be collected (methodology described below) and analyzed by the on-site laboratory for CVOCs by SW 846 8260B. If CVOC concentrations are above the MCLs in a groundwater sample collected from a piezometer location then additional piezometers will be installed at a 50-ft step-out distance from the same vertical depth until it is determined that the plume has been sufficiently delineated. The decision logic for selection of additional sample locations is provided in Figure 1-8.

The temporary piezometers will be installed using a tripod and hammer method. The tripod may be equipped with a motorized cathead, pulley, and hammer. A 2-in. diameter casing with a disposable end point will be driven to the total well depth and a 1-in. diameter PVC well with a 5-ft long, 0.010-in. slotted screen will be installed inside the casing. The 2-in. diameter casing will eventually be removed, allowing natural materials to fall into the borehole. Any remaining annual space will be filled with #1 silica pack sand. If a temporary piezometer is located in an area where CVOCs were identified during the sediment diffusion sampling activity or previous investigations, then a temporary casing will be used while installing the piezometer so that CVOCs are not carried down during the installation.

Development of the piezometers is not necessary because they are temporary and the data will not be used to evaluate potential remedy effectiveness.

Following installation, the depth to groundwater and the surface water elevation at each piezometer will be measure and recorded to determine if the tidal inlet is a discharge or recharge area for groundwater. If the groundwater elevation in the piezometer is higher than the surface water elevation outside the piezometer, it will be concluded that groundwater is discharging to surface water and sediment. Water is assumed to flow towards the lowest energy level, which is determined by elevation in this scenario.

Groundwater samples will be collected following a low-flow sampling protocol using a peristaltic pump and disposable tubing. All groundwater samples will be collected by placing the sample tubing intake in the middle of the screen interval. Groundwater quality parameters (DO, ORP, pH, temperature, conductivity, turbidity, and salinity) will be measured in the field using an in-line flow-through cell prior to sampling. Purging will continue until water quality readings collected five minutes apart are stabilized to within 10% of one another. After the parameters have stabilized, the flow-through cell will be disconnected and samples will be collected for analysis of CVOCs by SW 846 8260B by the on-site laboratory. Because this data will not be validated and/or used as part of a risk assessment, reduced QA/QC samples for groundwater will be collected (i.e., duplicates and equipment blanks as shown on Table 3-3).

3.2.5 Permanent Monitoring Well Installation and Sampling

Following completion of the MIP, DPT, and piezometer investigation activities, locations for up to 3 shallow monitoring wells will be determined. Groundwater samples will be collected from the newly installed and existing shallow monitoring wells and existing deep monitoring wells to establish a current CVOC data set for the site. A water level survey will be conducted at all the wells prior to sampling to establish updated groundwater flow maps. Additionally, groundwater and soil samples will be collected for geochemical and geotechnical parameters, respectively for remedial alternative evaluation.

The monitoring wells will be installed using hollow stem auger (HSA) drilling methods. Each new monitoring well will be constructed with 2-inch inside diameter (ID) Schedule 40 PVC screen and riser. Ten-ft long monitoring well screens will be machine slotted to 0.010-in. The well screens will be placed at a depth just above the Yorktown confining unit, estimated at 20 ft bgs. The final screen interval will be determined in the field by the on-site geologist. A silica filter pack will be placed around the annular space of the well screen from the bottom of the boring extending to a depth of 2 ft above the top of the screen. A 2-ft bentonite layer will be placed at the top of the sand pack. After the bentonite has been hydrated, a cement-bentonite grout will be placed in the remaining annular space. If a monitoring well is located within the extent of ABM (Figure 1-2), then a temporary casing will be used while installing the well so that ABM does not contaminate the well.

During monitoring well installation, continuous split-spoon samples will be collected to the depth of the Yorktown confining unit, estimated to be at no more than 25 ft bgs. A CH2M HILL geologist will observe and record soil descriptions that include grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information such as possible evidence of contamination.

Where monitoring wells are placed in concrete, asphalt, or areas where using above-grade wells is not permitted, they will be completed flush to ground surface with a watertight steel cover. The above-grade monitoring wells will be completed with a locking steel protective casing set in a concrete pad. Guard posts may be installed in high-traffic areas for additional protection. A locking watertight cap will be placed on the PVC pipe and the wells will be clearly marked.

Following installation, each new monitoring well will be developed. Additionally, because some of the existing wells have not been utilized since 1999 (SJS02-MW01S through MW05S and MW05D), they will be redeveloped in order to ensure the hydraulic conductivity is consistent across the aquifer and a representative sample is obtained at each location. Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Groundwater samples will be collected from the new wells no sooner than 24 hours after installation.

Prior to the start of groundwater sampling, the depth to groundwater will be measured at all new and existing wells. Groundwater samples will be collected from all wells following a low-flow sampling protocol using a peristaltic pump and disposable tubing. The samples will be collected by placing the sample tubing intake in the middle of the screen interval. Groundwater quality parameters (DO, ORP, pH, temperature, conductivity, turbidity, and salinity) will be measured in the field using an in-line flow-through cell prior to sampling. Purging will continue until water quality readings collected five minutes apart are stabilized to within 10% of one another. After the parameters have stabilized, the flow-through cell will be disconnected and samples will be collected for analysis of CVOCs by CLP OLM04.3 or OLC03.2 by the off-site laboratory. The analytical method will be based on previous CVOC results to meet the lowest detection limit possible. Groundwater samples will also be collected from at least 5 wells (1 upgradient, 3 within the shallow groundwater CVOC plume, and 1downgradient) for off-site laboratory analysis of geochemical parameters (manganese II, methane, ethane, ethane, hydrogen, TOC, carbon dioxide, sulfide, sulfate, nitrate, nitrite, ferrous iron, and alkalinity) to evaluate natural attenuation. At least 2 soil samples will be collected for analysis of geotechnical parameters (grain size, bulk density, moisture content, TOC, and total porosity) by an off-site laboratory. One sample will be collected from the screened interval of a new monitoring well boring and one in a location with high electrical conductivity readings, high MIP responses, and/or visually observed organic materials.

3.2.6 Wetland Surface Debris Delineation

Delineation of the spatial extent and type of surface debris present within the wetland area will be conducted to evaluate potential impacts to the wetland ecosystem. The timing of the delineation is independent of the other investigation activities; however, it will be conducted during a low tide to ensure that the maximum amount of surface debris is visible at the time of the delineation. Surface debris type and description will be recorded in the field log book, and locations will be marked on a site figure. A global positioning system (GPS) unit will be used, as necessary, to record the location and extent of surface debris if the figure and visible site features are not sufficient to accurately perform the delineation.

3.3 Quality Assurance/Quality Control Sampling

QA/QC samples comprising duplicates, blanks, and matrix spikes/matrix spike duplicates (MS/MSDs) are used to provide a measure of the internal consistency of the samples and to provide an estimate of the components of variance and the bias in the analytical process. QA/QC samples will be collected as outlined in Table 3-3, unless noted otherwise in the field activities sections.

3.4 Sampling Equipment Decontamination

All non-disposable sampling equipment will be decontaminated immediately after each use in accordance with the applicable SOPs. Heavy equipment such as drill rig and DPT equipment (augers, rods, or split spoons) will be steamed cleaned prior to each new DPT or monitoring well location. A decontamination pad will be set up to prevent the run-off of decontamination water and to allow for easy collection of decontamination fluids.

3.5 Demobilization Activities

Demobilization activities include general surveying of sample locations, site restoration, and IDW disposal.

3.5.1 Surveying

Installed MIP borings, DPT borings, piezometers, and monitoring wells will be surveyed using a licensed surveyor. The surveying subcontractor will provide locations (horizontal control) of MIP and DPT borings. Each piezometer and monitoring well will be surveyed both vertically and horizontally using the Virginia State Plane Coordinate System. The vertical elevations accuracy will be +/- 0.01 ft, while the horizontal location will have an accuracy of +/- 0.1 ft. The elevation for each monitoring well shall be established at the top of the monitoring well's inner PVC casing (this elevation point shall be designated by a permanent notch placed on top of each well's inner casing) and at ground surface. The elevation for each piezometer shall be established at the top of the PVC casing and at ground surface. Locations of sediment diffusion samples will be measured by the field team using a portable GPS unit.

3.5.2 Site Restoration

The temporary piezometers will be abandoned immediately following surveying. The PVC portion of the well will be removed and any remaining void will be filled with bentonite chips or pellets. Remaining voids from the MIP and DPT borings will also be filled with bentonite chips or pellets. At locations paved with concrete or asphalt, the top 6 in. will be patched to match the existing ground surface.

3.5.3 Investigation-Derived Waste

Field investigation activities will result in the generation of IDW. The IDW will include drill cuttings from the soil borings for monitoring well installations, well development and purge water, and solutions used to decontaminate non-disposable sampling equipment. Under

EPA guidance (EPA, January 1992), soil and sediment IDW will be replaced into the area of contamination from which it was generated, since the waste will not treated prior to placement and the area is subject to further response measures under DEQ and/or EPA oversight. Aqueous and soil IDW will be containerized in 55-gallon drums, which will temporarily be stored onsite. Secondary containment will be provided by the drilling subcontractor. IDW drums will be labeled in accordance with the procedures outlined in the MPPs. The IDW will be properly disposed of based on the results of the waste characterization within 90 days of generation by subcontractors. Disposable equipment, including personal protective equipment, poly sheeting, and paper towels, will be disposed of as solid waste.

Table 3-1
List of Applicable Standard Operating Procedures from the Master Project Plans
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

Locating Subsurface Utilities
Locating and Clearing Underground Utilities
Completing Field Log Books
Log Books
Health and Safety Monitoring
Volatiles Monitoring by OVM
MEC Support
Explosives Usage and Munitions Response (MR)
Hydrogeologic Investigations
Drilling
General Guidance for Monitoring Well Installation
Installation of Shallow Monitoring Wells
Water-Level Measurements
Soil Sampling
Soil Sampling
Shallow Soil Sampling
Logging of Soil Borings
Direct-Push Soil Sample Collection
Piezometer Installation
General Guidance for Performing Cone Penetrometer Testing
Piezometer Completion Diagram
Field Screening
Close Support Laboratory Method for Analysis of Chlorinated Volatiles in Soil[1]
Groundwater Sampling
Low-Flow Groundwater Sampling from Monitoring Wells
Groundwater Sampling from Monitoring Wells
Direct-Push Groundwater Sample Collection
Sediment and Surface Water Sampling
Sediment Sampling
Surface Water Sampling
Field Parameters
Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using the Horiba U-22 with Flow-Through Cell
Sample Preparation
VOC Sampling - Water
Field Rinse Blank Preparation
Homogenization of Soil and Sediment Samples
Packaging and Shipping Procedures
Chain-of-Custody
Decontamination and Waste Management
Decontamination of Drilling Rigs and Equipment
Decontamination of Personnel and Equipment
Disposal of Waste Fluids and Solids
Surveying
Civil Surveying

Notes:
[1]The onsite laboratory chosen for this project may have slight variances from the SOP

Table 3-2
Analytical Methods and Required Containers, Preservatives, and Holding Times for Aqueous and Solid Samples
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

Analysis	Method	Sample Container	Preservative	Holding Time	Volume of Sample
Aqueous Samples					
Select[1] TCL VOCs (offsite lab)	CLP OLM04.3	Three 40-mL glass vial with Teflon-lined cap	HCl to pH < 2, Cool to 4°C	14 days	Fill completely; no air bubbles
Select[1] TCL VOCs (offsite lab)	CLP OLC03.2	Three 40-mL glass vial with Teflon-lined cap	HCl to pH < 2, Cool to 4°C	14 days	Fill completely; no air bubbles
Select[1] TCL VOCs (onsite lab)	SW 846 8260B	Three 40-mL glass vial with Teflon-lined cap	HCl to pH < 2, Cool to 4°C	14 days	Fill completely; no air bubbles
Manganese II	Hach Test Kit	sample cells provided in kit	n/a	as soon as possible	Fill to line
Methane, ethene, ethane Hydrogen Carbon Dioxide	LLVFA (AM 23 G)	One 22-cc glass vial (gas); One 40-mL glass vial (aqueous)	Cool to 4°C; BAK, Cool to 4°C	14 days	Fill with 15 mL gas from sample; Fill completely; no air bubbles
Total organic carbon	SW 846 9060	40 mL glass vial	H2SO4 to pH < 2; Cool to 4°C	28 days	Fill completely; no air bubbles
Sulfide	EPA 376.1	250 mL polyethylene bottle	NaOH to pH < 9, Cool to 4°C	7 days	Fill to shoulder
Sulfate	EPA 375.4	100 mL polyethylene bottle	Cool to 4°C	28 days	Fill to shoulder
Nitrate	EPA 352.1	250 mL polyethylene bottle	H2SO4 to pH < 2; Cool to 4°C	48 hours	Fill to shoulder
Nitrite	EPA 354.1	100 mL polyethylene bottle	Cool to 4°C	48 hours	Fill to shoulder
Ferrous Iron	3500-Fe D	250 mL polyethylene bottle	HCl to pH < 2, Cool to 4°C	as soon as possible	Fill to shoulder
Alkalinity	EPA 310.1	250 mL polyethylene bottle	Cool to 4°C	14 days	Fill to shoulder
Solid Samples					
Select[1] TCL VOCs	CLP OLM04.3	One 8-oz glass bottle with Teflon-lined cap	Cool to 4°C	14 days	Fill completely
Total organic carbon	Lloyd Kahn	One 4-oz. glass jar	Cool to 4°C	28 days	Fill completely
Total porosity	Lab supplied method	One 12-in Shelby tube	Sample needs to be well-sealed and not moved around much during transit, Cool to 4°C	None as long as sample is well-sealed	Fill tube completely
Bulk density	ATI RP40				
Grain size	ASTM D422				
Moisture content	ASTM D 2216				

Notes:
1: Select TCL VOCs will consist of chlorinated volatile organic compounds (CVOCs) only.
CLP: Contract Laboratory Program
TAL: Target Analyte List
TCL: Target Compound List
VOCs: Volatile Organic Compounds

Table 3-3
General Requirements for QA/QC Sample Collection
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

QA/QC Samples	QA/QC Sample Purpose	QA/QC Specified Collection Frequency
Field Duplicate	Measures accuracy of laboratory and field procedures	One per 10 samples per matrix or one duplicate per day and matrix, whichever is more frequent
Trip Blank	Measures outside sources of potential VOCs contamination	One per cooler containing samples collected for VOC analysis
Equipment (Rinsate) Blank	Measures effectiveness of decontamination	One per day per matrix
Field Blank	Measures ambient condition	One per week unless ambient conditions change
Temperature Blank	Measures sample preservation temperature	One per cooler
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	Measures sample specific interferences due to the matrix of the sample	One per matrix for each group of up to 20 samples sent to a single laboratory (count QC samples)

Table 3-4
Site 2 Sample Summary
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

Station ID	Sample ID	Select** TCL VOCs (OLM04.3)	Select** TCL VOCs (OLC03.2)	Select** TCL VOCs (SW846 8260B)	Total Organic Carbon (SW846 9060)	Nitrate (352.1)	Nitrite (354.1)	Sulfate (375.4)	Manganese II (Hach Test Kit)	Alkalinity (310.1)	Ferrous Iron (3500-Fe D)	Sulfide (376.1)	Methane, Ethane, Ethene (LLVFA [AM 23 G])	Carbon Dioxide (LLVFA [AM 23 G])	Hydrogen (LLVFA [AM 23 G])	Total or Fraction Organic Carbon (Lloyd Kahn)	Total Porosity (Lab-supplied method)	Bulk Density (ATI RP40)	Moisture Content (ASTM D2216)	Grain Size (ASTM D422)
Direct-Push Groundwater Samples (Onsite Lab)																				
SJS02-GW01	SJS02-GW01-07B			X																
SJS02-GW02	SJS02-GW02-07B			X																
SJS02-GW03	SJS02-GW03-07B			X																
SJS02-GW04	SJS02-GW04-07B			X																
SJS02-GW05	SJS02-GW05-07B			X																
SJS02-GW06	SJS02-GW06-07B			X																
SJS02-GW07	SJS02-GW07-07B			X																
SJS02-GW08	SJS02-GW08-07B			X																
SJS02-GW09	SJS02-GW09-07B			X																
SJS02-GW10	SJS02-GW10-07B			X																
SJS02-GW11	SJS02-GW11-07B			X																
SJS02-GW12	SJS02-GW12-07B			X																
SJS02-GW13	SJS02-GW13-07B			X																
SJS02-GW14	SJS02-GW14-07B			X																
Direct-Push Soil Samples (Onsite Lab)																				
SJS02-SB01	SJS02-SB01-07B			X												X				
SJS02-SB02	SJS02-SB02-07B			X												X				
SJS02-SB03	SJS02-SB03-07B			X												X				
SJS02-SB04	SJS02-SB04-07B			X												X				
SJS02-SB05	SJS02-SB05-07B			X																
SJS02-SB06	SJS02-SB06-07B			X																
SJS02-SB07	SJS02-SB07-07B			X																
SJS02-SB08	SJS02-SB08-07B			X																
SJS02-SB09	SJS02-SB09-07B			X																
SJS02-SB10	SJS02-SB10-07B			X																
Piezometer Groundwater Samples (Onsite Lab)																				
SJS02-PZ01S	SJS02-PZ01S-07B			X																
SJS02-PZ01D	SJS02-PZ01D-07B			X																
SJS02-PZ02S	SJS02-PZ02S-07B			X																
SJS02-PZ02D	SJS02-PZ02D-07B			X																
SJS02-PZ03S	SJS02-PZ03S-07B			X																
SJS02-PZ03D	SJS02-PZ03D-07B			X																
SJS02-PZ04S	SJS02-PZ04S-07B			X																
SJS02-PZ04D	SJS02-PZ04D-07B			X																
SJS02-PZ05S	SJS02-PZ05S-07B			X																
SJS02-PZ05D	SJS02-PZ05D-07B			X																
SJS02-PZ06S	SJS02-PZ06S-07B			X																
SJS02-PZ06D	SJS02-PZ06D-07B			X																
Pore Water Samples (Onsite Lab)																				
SJS02-PW01	SJS02-PW01-07B			X																
SJS02-PW02	SJS02-PW02-07B			X																
SJS02-PW03	SJS02-PW03-07B			X																
SJS02-PW04	SJS02-PW04-07B			X																
SJS02-PW05	SJS02-PW05-07B			X																
SJS02-PW06	SJS02-PW06-07B			X																
SJS02-PW07	SJS02-PW07-07B			X																
SJS02-PW08	SJS02-PW08-07B			X																
SJS02-PW09	SJS02-PW09-07B			X																
SJS02-PW10	SJS02-PW10-07B			X																
SJS02-PW11	SJS02-PW11-07B			X																
SJS02-PW12	SJS02-PW12-07B			X																
SJS02-PW13	SJS02-PW13-07B			X																
SJS02-PW14	SJS02-PW14-07B			X																
SJS02-PW15	SJS02-PW15-07B			X																
Soil Boring Samples (Offsite Lab)																				
SJS02-MW14S*	SJS02-SB11-07B															X	X	X	X	X
Permanent Monitoring Well Groundwater Samples (Offsite Lab)																				
SJS02-MW01S	SJS02-MW01S-07B		X		X	X	X	X	X	X	X	X	X	X	X					
SJS02-MW01D	SJS02-MW01D-07B		X																	
SJS02-MW02S	SJS02-MW02S-07B		X		X	X	X	X	X	X	X	X	X	X	X					
SJS02-MW02D	SJS02-MW02D-07B		X																	
SJS02-MW03S	SJS02-MW03S-07B		X																	
SJS02-MW04S	SJS02-MW04S-07B		X																	
SJS02-MW05S	SJS02-MW05S-07B		X																	
SJS02-MW05D	SJS02-MW05D-07B		X																	
SJS02-MW06S	SJS02-MW06S-07B		X																	
SJS02-MW07S	SJS02-MW07S-07B	X			X	X	X	X	X	X	X	X	X	X	X					
SJS02-MW08S	SJS02-MW08S-07B		X																	
SJS02-MW09S	SJS02-MW09S-07B		X																	
SJS02-MW10S	SJS02-MW10S-07B	X			X	X	X	X	X	X	X	X	X	X	X					
SJS02-MW10D	SJS02-MW10D-07B		X																	
SJS02-MW11S	SJS02-MW11S-07B	X																		
SJS02-MW12S	SJS02-MW12S-07B		X																	
SJS02-MW13S	SJS02-MW13S-07B																			
SJS02-MW14S*	SJS02-MW14S-07B	X			X	X	X	X	X	X	X	X	X	X	X					
SJS02-MW15S*	SJS02-MW15S-07B	X																		
SJS02-MW16S*	SJS02-MW16S-07B	X																		

Notes:

*Potential new monitoring wells

** Select TCL VOCs will consist of chlorinated volatile organic compounds (CVOCs) only.

1. This sample summary is considered to be preliminary. The quantity of samples and sample locations will be finalized during the investigation.
2. Quality assurance/quality control samples should be collected at the frequency listed in Table 3-3, unless otherwise noted in work plan.

Table 3-5
Ecological Screening Values for Pore Water
Dynamic Work Plan for Site 2
St. Juliens Creek Annex, Chesapeake, Virginia

CVOCs	Surface Water Screening Value[1] (ug/L)	Source
1,1,2-Trichloroethane (TCA)	9,400	IRIS; FW
1,1-Dichloroethene (DCE)	1,160	IRIS; FW
Tetrachloroethene (PCE)	450	IRIS; MAR
Trichloroethene (TCE)	2000	IRIS; FW
Vinyl chloride	11,600	IRIS; FW
cis-1,2-DCE	11,600	IRIS; FW
trans-1,2-DCE	11,600	IRIS; FW

[1]Based on the presence of brackish water at Site 2, the lower of freshwater (FW) and marine (MAR) screening values were selected, as indicated in the table. The lower of flora and fauna values were used when BTAG values were selected.

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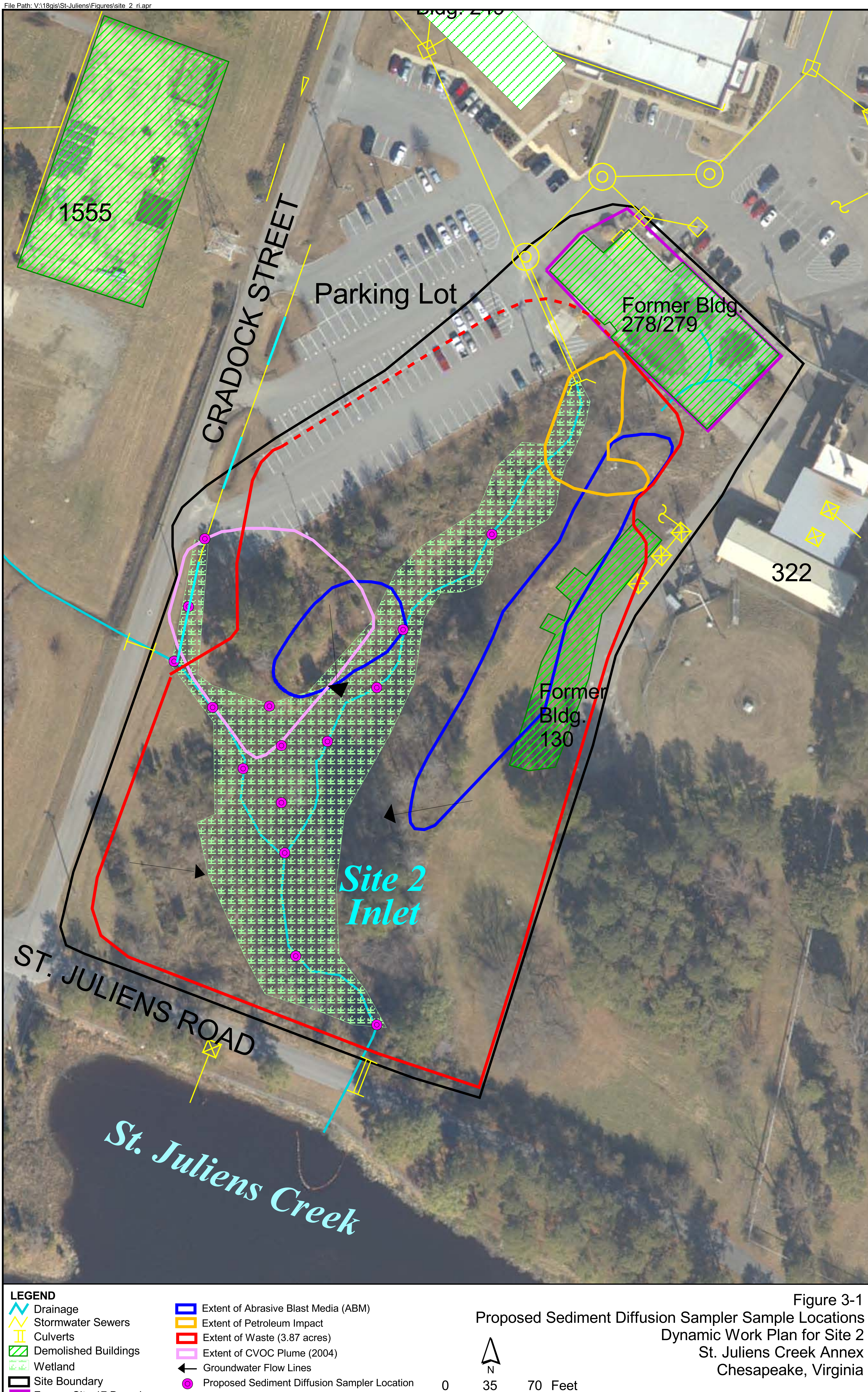

Figure 3-1
Proposed Sediment Diffusion Sampler Sample Locations
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

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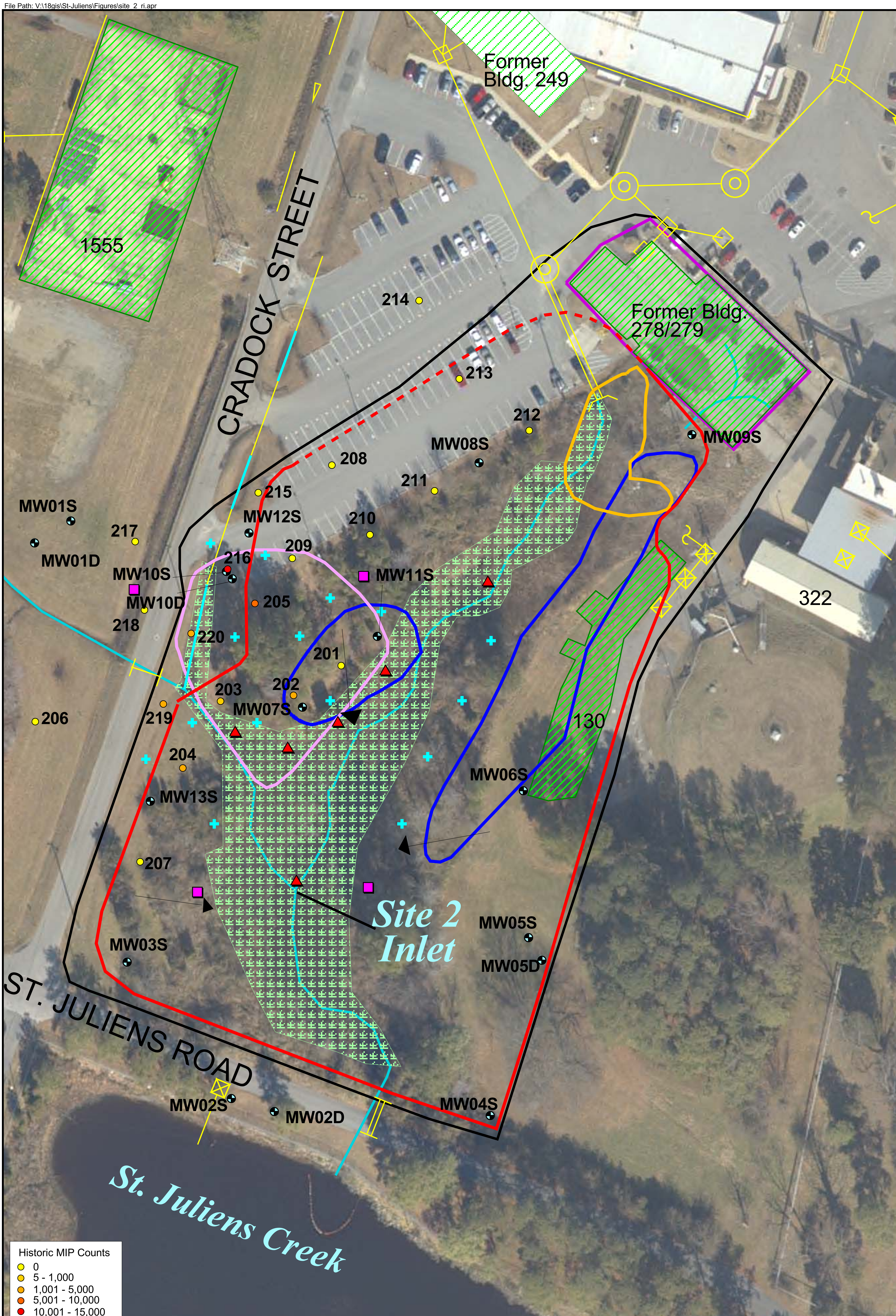

LEGEND

- Drainage
- Stormwater Sewers
- Culverts
- Demolished Buildings
- Wetland
- Site Boundary
- Former Site 17 Boundary
- Extent of Abrasive Blast Media (ABM)
- Extent of Petroleum Impact
- Extent of Waste (3.87 acres)
- Extent of CVOC Plume (2004)
- Groundwater Flow Lines
- Monitoring Well Locations
- Proposed MIP Locations
- Proposed DPT Groundwater Locations (in addition to MIP locations)
- Proposed Piezometer Locations

N

0 35 70 Feet

Figure 3-2
Proposed MIP, DPT Groundwater, and Piezometer Locations
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

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SECTION 4

Sample Analysis and Data Management

CH2M HILL will track samples from collection through analysis and obtain results from the subcontracted laboratories using the sample designation and procedures described below. The analytical data that will be used in risk assessments will be validated by an independent data validation subcontractor as specified below. Data management will include incorporation of investigation results into the CSM.

4.1 Sample Designation

Sampling locations and samples collected will be assigned unique designations to allow the sampling information and analytical data to be entered into the existing Geographic Information System (GIS) data management system for SJCA.

A standardized numbering system will be used to identify all samples collected during the sampling. The numbering system will provide a tracking procedure to ensure accurate data retrieval of all samples collected. The field team leader, who will be responsible for applying the use of the standardized numbering system during all sampling activities, will provide a listing of the sample identification numbers in the site-specific project instructions. The sample identification for all samples collected during this investigation will use the formats identified in Table 4-1. A preliminary list of nomenclature for the proposed samples is presented in Table 3-4.

4.2 Sample Analysis

The on-site laboratory for groundwater CVOC analysis will have National Environmental Laboratory Accreditation program (NELAP) certification. The off-site analyses will be conducted at a laboratory that fulfills all requirements of the Navy's QA/QC Program Manual and EPA's CLP. A signed certificate of analysis will be provided with each laboratory data package, along with the applicable federal, state, and local regulations. On-site analysis QC for groundwater samples will include duplicate and equipment blank sample analysis. For sediment pore water, a full QA/QC sample suite (Table 3-3) will be submitted. Off-site analyses will include the proper ratio of field QC samples recommended by Navy Facilities Engineering Service Center (NFESC) guidance for the data quality objectives (DQOs).

The sediment pore water, DPT groundwater and soil, and groundwater piezometer samples will be analyzed by the onsite lab for CVOCs by SW 846 8260B using CLP OLM04.3 analytical suite and reporting limits. In an effort to obtain the lowest possible result for ecological screening purposes, the onsite lab will report down to the method detection limit (MDL). Analytical results between the MDL and reporting limit will be "J" flagged (estimated below the detection limit). The reporting limits for the CLP OLM04.3 are listed in the MQAPP.

Groundwater samples collected from the permanent monitoring wells for submittal to the offsite laboratory will be analyzed by for CVOCs by CLP OLM04.3 and/or OLC03.2. The method will be determined based on the sample location and DPT groundwater results to obtain the lowest possible result for comparison to the MCL.

The laboratories will submit the data in hard copy and an electronic format that can be amended and readily incorporated into the EnDat Oracle database and geographic information system (GIS) management system for SJCA. The laboratories have not been determined for this sampling event; however, once they are identified, EPA will be notified.

4.3 Data Validation

On-site sediment pore water analytical results and off-site groundwater analytical results for CVOCs, methane, ethane, and ethene will be validated by a CH2M HILL subcontractor. Procedures used for the validation process will be in accordance with *Region III Modifications to National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration* (EPA, September 1994) and the *Contract Laboratory Program National Functional Guidelines for Low Concentration Organic Data Review* (EPA, 2001). Data that should be qualified will be flagged appropriately. The data validator will be provided with the hard copy and electronic version of the laboratory results and will add data validation qualifiers to both versions. Results for QA/QC samples will be reviewed and the data will be qualified further, if necessary. Finally, the data set as a whole will be examined for consistency, anomalous results, reasonableness, and utility; and downloaded into the SJCA database.

4.4 CSM Refinement

The CSM will be updated continuously throughout the investigation. Data will be evaluated using 2-dimensional (2-D) and 3-dimensional (3-D) visualization software. Surfer® is a 2-D software package distributed by Golden Software (2002). Mining Visualization System (MVS) is a 3-D software package distributed by C Tech Development Corporation (2003). Partitioning calculations may be performed using NAPLANAL software, from INTERRA, Inc. (Mariner et al., 1997) and equilibrium equations, presented in the EPA *Soil Screening Guidance: Technical Background Document* (EPA, 1996). Statistical evaluations may be performed to define a correlation between screening data and laboratory groundwater concentrations.

The software program Monitoring and Remediation Optimization System (MAROS), Version 2.2, developed by Groundwater Services, Inc., can be used to statistically define trends in the groundwater data. MAROS is a Microsoft® Access-based program The program uses statistical trend analyses (a non-parametric Mann-Kendall and a first-order Linear Regression) and a spatial Moment Analysis (using the non-parametric Mann-Kendall Trend Methodology) to assess plume stability.

Software may also be used to estimate timeframes for potential remedial actions and evaluate the uncertainties associated with those time estimates. SourceDK is a Microsoft® Excel-based program developed for the Air Force Center for Environmental Excellence by Groundwater Services, Inc (2004). This software is a screening- and planning-level tool and is applicable to the data objectives in this DWP. Natural Attenuation Software (NAS), developed at the Virginia Polytechnic Institute and State University (2005), is a Visual Basic interface that was designed to calculate estimates for time or remediation and stabilization for sites contaminated with either fuels or chlorinated solvents.

Table 4-1
Summary for Sample Identification Scheme
St. Juliens Creek Annex
Chesapeake, Virginia

First Segment		Second Segment		Third Segment	Fourth Segment
Installation	Site Type and Number	Sample Type	Sample Location; MW Depth	Solid Sample Depth	Sample Date; Qualifier
AA	ANN	AA	NNA	NN	NNAA
Installation: SJ = SJCA	Site Type: S = Site Site Number/Letter: 02 = Site 2	Sample Type: GW = Direct Push Groundwater MW = Monitoring Well PW = Pore Water PZ = Piezometer SB = Subsurface Soil SD = Sediment SS = Surface Soil ST = Stormwater SW = Surface Water TW = Temporary Well	Sample Location: Sequential Location Number Monitoring Well Depth: S = Shallow D = Deep	Sample Depth: XX = Sample Interval Top Depth	Sample Date: NN = Last 2 digits of year A = Quarter of the Year: A = 1st Quarter B = 2nd Quarter C = 3rd Quarter D = 4th Quarter Qualifier (only if duplicate sample): P - Duplicate

Numbering format for QA/QC Samples:			
AAANN-AANNNNNN-AA			
AAANN = Installation, Site Type, and Number SJS02 = SJCA Site 2	AA = QA/QC type: TB = Trip Blank EB = Equipment Blank FB = Field Blank	NNNNN = DDMMYY (example = 051507)	AA = Media/Sample Type (example = SS)

Notes: “A”= alphabetic “N”= numeric

SECTION 5

Reporting and Scheduling

5.1 Reporting

Results of this investigation will be presented in the ERI report for Site 2. This report will comprise the following:

- History, background, and physical characteristics, including the environmental setting and results of previous studies
- Description of the ERI field activities
- Presentation and evaluation of the chemical data
- Nature and extent of site-related constituents
- Fate and transport of site-related constituents
- Human health and ecological risk assessment summaries and updates, as needed
- Final CSM
- Conclusions regarding the investigation findings
- Final RAOs and cleanup levels

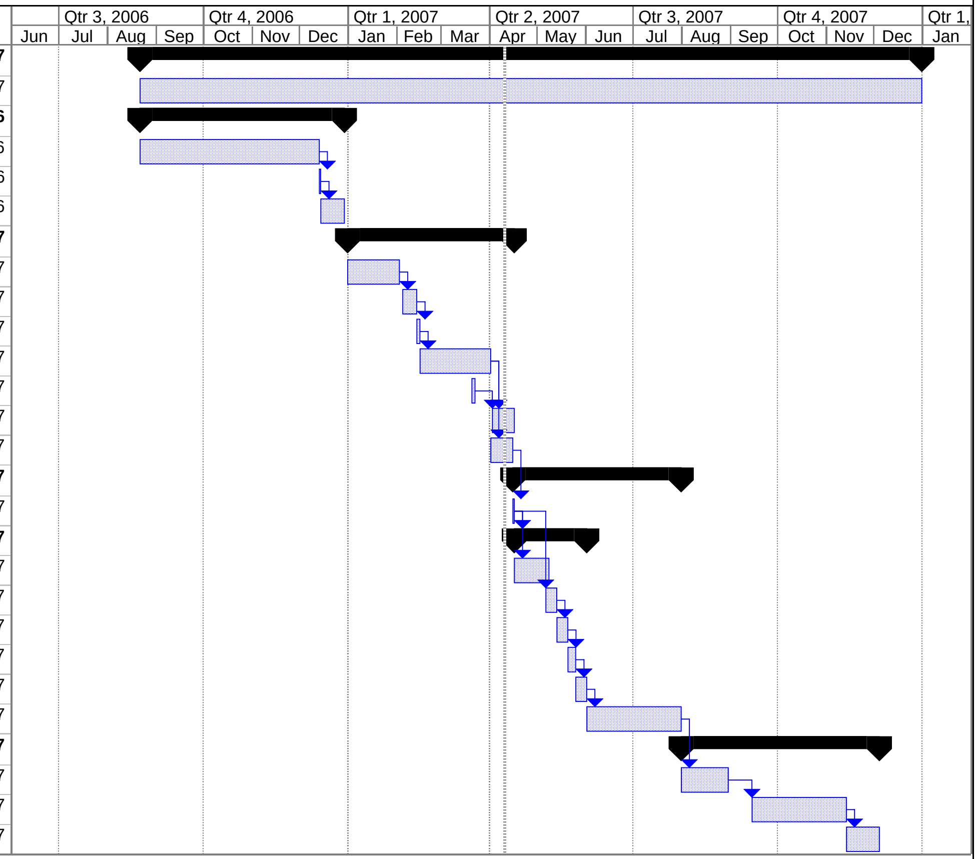
The ERI report will be used to support the development of an FS. The ERI and FS will be provided to the Navy, VDEQ, and EPA for review. The reports will be finalized following review and approval.

5.2 Schedule

The proposed schedule for this project is attached as Figure 5-1. The schedule is based on standard review times and the projected duration of field work, laboratory analysis and data validation. The schedule presented is tentative and may be subject to change as the project progresses.

Figure 5-1
Proposed Project Schedule
Dynamic Work Plan for Site 2
St. Juliens Creek Annex
Chesapeake, Virginia

ID	Task Name	Duration	Start	Finish
1	**Project Management**	**497 days**	**Tue 8/22/06**	**Mon 12/31/07**
2	Project Management	497 days	Tue 8/22/06	Mon 12/31/07
3	**Systematic Planning**	**130 days**	**Tue 8/22/06**	**Fri 12/29/06**
4	CSM Development	114 days	Tue 8/22/06	Wed 12/13/06
5	Systematic Planning Meeting	1 day	Thu 12/14/06	Thu 12/14/06
6	CSM Revisions and Status Meetings	15 days	Fri 12/15/06	Fri 12/29/06
7	**Dynamic Work Plan (DWP)**	**106 days**	**Mon 1/1/07**	**Mon 4/16/07**
8	Draft DWP Development	33 days	Mon 1/1/07	Fri 2/2/07
9	Navy Review and Comment Resolution	9 days	Mon 2/5/07	Tue 2/13/07
10	Draft DWP Submitted to SJCA PM Team	2 days	Wed 2/14/07	Thu 2/15/07
11	Regulatory Review	45 days	Fri 2/16/07	Sun 4/1/07
12	Draft DWP Review Meeting	2 days	Wed 3/21/07	Thu 3/22/07
13	Final DWP and Responses to Comments	14 days	Tue 4/3/07	Mon 4/16/07
14	Subcontracting	14 days	Mon 4/2/07	Sun 4/15/07
15	**Field Investigation**	**107 days**	**Mon 4/16/07**	**Tue 7/31/07**
16	Mobilization	1 day	Mon 4/16/07	Mon 4/16/07
17	**Field Investigation Activities and Weekly Status Meetings**	**46 days**	**Tue 4/17/07**	**Fri 6/1/07**
18	Sediment Diffusion Sampling	22 days	Tue 4/17/07	Tue 5/8/07
19	Membrane Interface Probe Investigation	7 days	Mon 5/7/07	Sun 5/13/07
20	Direct Push Technology Sampling	7 days	Mon 5/14/07	Sun 5/20/07
21	Temporary Piezometer Installation and Sampling	5 days	Mon 5/21/07	Fri 5/25/07
22	Permanent Monitoring Well Installation and Sampling	7 days	Sat 5/26/07	Fri 6/1/07
23	Sample Management and Data Evaluation	60 days	Sat 6/2/07	Tue 7/31/07
24	**Reporting**	**126 days**	**Wed 8/1/07**	**Tue 12/4/07**
25	Draft Final Site 2 Expanded RI Report	30 days	Wed 8/1/07	Thu 8/30/07
26	Review and Response to Comments	60 days	Sat 9/15/07	Tue 11/13/07
27	Final Site 2 Expanded RI Report	21 days	Wed 11/14/07	Tue 12/4/07



Date: Tue 4/10/07

Task		Milestone		External Tasks		External Milestone	
Split		Summary		External Milestone		Deadline	
Progress		Project Summary		External Milestone			

SECTION 6

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Appendix A
Site-Specific HASP

Project-Specific Health and Safety Plan

This Project-Specific Health and Safety Plan (HASP) presents the hazards known or anticipated to be present at the at the St. Juliens Creek Annex Dynamic/ Triad Investigation, Site 2 scheduled to take place in the spring of 2007. This Project-Specific HASP will be used by CH2M HILL and its subcontractors to identify and mitigate task-specific hazards and to select appropriate health and safety protective measures not otherwise covered in the Master HASP.

The St. Juliens Creek Master HASP has been previously developed and must accompany/supplement this Project-Specific HASP. The Master HASP contains information pertinent to the general conditions at St. Juliens Creek, such as general site information, hazard evaluation and control, personnel responsibilities and requirements, a general description of personal protective equipment, customary decontamination procedures, and emergency response procedures. On-site personnel must review both the Master-HASP and the site-specific HASP and sign an agreement to comply with its provisions prior to commencing on-site work. The Master-HASP and site-specific HASP are considered operational documents that are subject to revisions in response to various site-specific conditions that may be encountered. However, these documents may be modified or updated only with the approval of the Site Safety Coordinator (SSC) and Project Manager.

Policy

CH2M HILL's policy is that on-site hazardous waste management activities be performed in conformance with both the Master HASP and a Project-Specific HASPs. The documents are written based on the anticipated hazards and expected work conditions, and apply to field activities to be performed under the Work Plan. Applicability of this Master-HASP and the Project-Specific HASPs extends to all CH2M HILL employees, CH2M HILL's subcontractors, and visitors entering the site. CH2M HILL subcontractors must follow an established health and safety plan; in most cases, either adopting this master plan with appropriate site-specific HASP (e.g., surveyor), or adopting same and amending both with safety and/or health requirements specific to their work (e.g., driller). HASPs authored by a subcontractor must be reviewed by CH2M HILL's SSC before commencing on-site work. After being reviewed, this information will become part of the appropriate site-specific HASP.

This Project-Specific HASP in combination with the Master HASP will, at a minimum, meet the requirements under Occupational Safety and Health Administration (OSHA) Standard 29 Code of Federal Regulations (CFR) 1910.120 (Hazardous Waste Operations and Emergency Response).

Pre-Entry Requirements

During site mobilization, the SSC will perform a reconnaissance of each site as identified in the site-specific Work Plan (WP) to evaluate and determine the chemical, physical, and environmental hazards; establish or confirm emergency points of contact and procedures; and review any other issues deemed necessary to address site safety and health. The SSC will then conduct a health and safety briefing with the site personnel to discuss data obtained from the previous site reconnaissance, provisions outlined in this Master HASP and site-specific HASP, and appropriate safety and health procedures and protocols.

CH2M HILL HEALTH AND SAFETY PLAN

This Project-Specific HASP will be kept on the site during field activities and will be reviewed as necessary. The plan will be amended or revised as project activities or conditions change or when supplemental information becomes available. The plan adopts, by reference, the Standards of Practice (SOPs) in the CH2M HILL Corporate Health and Safety Program, Program and Training Manual, as appropriate. In addition, this plan adopts procedures in the project Work Plan. The SSC is to be familiar with these SOPs and the contents of this plan. CH2M HILL's personnel and subcontractors must read both the Master HASP and this Project-Specific HASP, and sign **Attachment 1** of both documents.

Project Information and Description

PROJECT NO:	181812
CLIENT:	Department of the Navy, Naval Facilities Engineering Command Mid-Atlantic
PROJECT/SITE NAME:	St. Juliens Creek Annex/Dynamic Triad Investigation Site 2
SITE ADDRESS:	Victory Blvd. Chesapeake, VA
CH2M HILL ACTIVITY MANAGER:	Kim Henderson
CH2M HILL OFFICE:	Virginia Beach
DATE HASP PREPARED:	January 2007
DATE(S) OF SITE WORK:	April - June 2007
SITE ACCESS:	Main Gate (NNSY pass required)
DESCRIPTION OF SPECIFIC TASKS TO BE PERFORMED:	Conduct MIP investigation both open and heavily wooded areas; perform limited clearing to access wooded areas. Collect groundwater and soil samples through DPT drilling. Sample surface and sediment pore water with PDB technology. Install monitoring wells with hollow stem augers. Install temporary piezometers using a tripod within wetland. Conduct low flow sampling of monitoring wells and piezometers. Conduct water level measurements. Survey all sample locations. Perform onsite lab analysis of samples

SECTION 1

Tasks to be Performed Under this Plan

1.1 Description of Tasks

(Reference Field Project Start-up Form)

Refer to project documents (i.e., Work Plan) for detailed task information. A health and safety risk analysis (Section 1.2) has been performed for each task and is incorporated in this plan through task-specific hazard controls and requirements for monitoring and protection. Tasks other than those listed below require an approved amendment or revision to this plan before tasks begin. Refer to Section 1.1.2 for procedures related to "clean" tasks that do not involve hazardous waste operations and emergency response (Hazwoper).

1.1.1 Hazwoper-Regulated Tasks

- Direct Push Technology (DPT)
- Hollow Stem Auger Drilling
- MIP's Investigation
- On site laboratory analysis of samples
- Groundwater sampling (via DPT)
- Groundwater sampling (via PDB)
- Surface water sampling (via Shore)
- Sediment sampling (via Shore)
- Hand Augering
- MEC Avoidance
- Utility Clearance
- Surface soil sampling
- Conduct water level measurements
- Conduct low flow sampling of monitoring wills and piezometers
- Investigation-derived waste (drum) sampling and disposal
- Observation of material loading for offsite disposal
- Oversight of well installation

1.1.2 Non-Hazwoper Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal and state Hazwoper regulations are not applicable. It must be demonstrated that the tasks can be performed without the possibility of exposure in order to use non-Hazwoper trained personnel. Prior approval from the Health and Safety Manager (HSM) is required before these tasks are conducted on regulated hazardous waste sites.

Task	Controls
• Clearing and Grubbing • Utility Clearance • Surveying	• Brief on hazards, limits of access, and emergency procedures

1.1.3 Project HS&E Change Management Form

This evaluation form should be reviewed on a ***continual basis*** *to determine if the current site-specific HASP adequately addresses ongoing project work, and it should be modified whenever new tasks are contemplated or changed conditions are encountered.*

Project Task: **Drilling & G.W. Sampling** Activity Manager: **Kim Henderson/VBO**
Project Number: **181812** Project Name: **Dynamic Triad Investigation Site 2**

	Evaluation Checklist	**Yes**	**No**
1.	Has CH2M HILL staff changed?		
2.	Has a new subcontractor been added to the project?		
3.	Is any chemical or product to be used that is not listed in Attachment 2 of the plan?		
4.	Are all tasks addressed in Section 1.1 of the site-specific HASP?		
5.	Have new contaminants or higher than anticipated levels of original contaminants been encountered?		
6.	Has other safety, equipment, activity, or environmental hazards been encountered that are not addressed in Section 2.1 of the plan?		

If the answer is "YES" to Questions 1-3, a HASP revision is NOT needed. Please take the following actions:

- Confirm that the staff's medical and training status is current—check training records at: http://www.int.ch2m.com/hands (or contact your regional SPA) and confirm subcontractor qualifications.
- Confirm with the project KA that subcontractor safety performance has been reviewed and is acceptable.
- Confirm with H&S that subcontractor safety procedures have been reviewed and are acceptable.

If the answer is "YES" to Questions 4-6, a HASP revision MAY BE NEEDED. To determine if a revision is needed, please
contact HS&E directly or complete the field project start-up form at:
http://www.int.ch2m.com/hsdocgen/fppricing.asp.

SECTION 2

Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the site or the particular hazard. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the SSC for clarification.

In addition to the controls specified in this section, Project-Activity Self-Assessment Checklists are contained in **Attachment** 7. These checklists are to be used to assess the adequacy of CH2M HILL and subcontractor site-specific safety requirements. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. Self-assessment checklists should be completed early in the project, when tasks or conditions change, or when otherwise specified by the HSM. The self-assessment checklists, including documented corrective actions, should be made part of the permanent project records, and be promptly submitted to the HSM.

Project-specific frequency for completing self-assessments: **Weekly, during drilling.**

2.1 Project-Specific Hazards

2.1.1 Field Vehicle

- Familiarize yourself with rental vehicle features.
  - Mirror adjustments, seat adjustments, cruise control features, etc.
  - Pre-program radio stations.
- Ensure snow, ice and fog are completely removed from windows prior to driving.
- Review driving directions prior to departing
- Inspect vehicle prior to departure (tire pressure, tread, signals, horn, lights).
- Adjust headrest to proper position.
- Always wear seatbelt while operating vehicle.
- Inquire; and obtain, a vehicle pass from the client if required.
- Observe warning signs, yield to traffic, and observe all posted traffic signs.
- Pull off the road, put the car in park and turn on flashers before talking on a mobile phone.
- Maintain both a First Aid kit, Bloodborne Pathogens kit and Fire Extinguisher in the field vehicle at all times.
- Close car doors slowly and carefully.
  - Fingers can get pinched in doors or in the trunk.
- Use a spotter when backing up near monitoring wells.
- Turn off vehicle when leaving it. Leave keys in vehicle.
- Maintain valuables in the trunk.

2.1.2 Inclement Weather

- Work may proceed in light rain- wear rain gear.
- Exposure to slips, trips and falls is increased during rainy and snowing conditions.
- Take cover in field vehicle during adverse weather conditions (High winds, heavy rain).
  - Work shall cease and cover sought in the event of lightning or tornado warnings.
  - Identify "Take Shelter" areas before starting project.
  - Work may proceed in light rain- wear rain gear.
- Notify the Project Manager and Client Representative after shelter has been sought.

2.1.3 Munitions and Explosives of Concern (MEC)

MEC avoidance procedures have been incorporated into the Work Plan due to the potential presence of MEC/MPPEH. This “avoidance” plan must be reviewed by all CH2M HILL and subcontractors.

- Contact with MEC is PROHIBITED.
- MEC avoidance will be required during all sampling activities.
- Avoidance procedures will consist of one UXO Technician III.
- A Schonstedt (or equivalent) will be utilized to identify anomalies.
- All anomalies will be considered to be MEC.
- All sampling locations will be verified by the Schonstedt (or equivalent) free of anomalies prior to samples being taken.
- Samples will be viewed by the UXO Technician to ensure that no MEC/MPPEH are present.
- Access routes to sampling locations shall be checked prior to crews on site.
- The UXO Technician along with one other person (two-man rule), will conduct a reconnaissance of the sampling area.
- All MEC contacts and anomalies will be avoided.
- MEC will be reported in accordance with contractual requirements.
- If anomalies are detected the sampling point will be relocated to a location free of anomalies.
- Once the designed point has been cleared, an access route for the sampling crew's vehicles and the boundaries of operations will be clearly marked to prevent personnel from straying into non cleared areas.
- The area will be large enough to accommodate the vehicles, equipment and crews.
- As a minimum the cleared area will be a square, with the side dimensions equal to twice the length of the largest vehicle or piece of equipment.
- If surface MEC is encountered, the UXO Technician will mark and report the item, then divert the approach path around the MEC.
- If a subsurface magnetic anomaly is encountered, it will be assumed to be MEC and the path diverted to avoid it.

Prior to departure for the work site, the UXO Technician will conduct a safety briefing. This briefing will include, in addition to those subjects identified within the Health & Safety Plan (HSP), the hazards associated with this particular area and the "avoidance" procedures that will be utilized. This briefing may be conducted during the routine daily "tool box" safety meeting.

2.1.4 Procedures for Locating Buried Utilities

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.
- Where necessary (e.g., uncertainty about utility locations), excavation or drilling of the upper depth interval should be performed manually.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SSC should confirm that arrangement.

2.1.5 Drilling/Direct-push

(Reference CH2M HILL SOP HS-204, *Drilling*)

- Only authorized personnel are permitted to operate drill rigs.
- Stay clear of areas surrounding drill rigs during every startup.
- Stay clear of the rotating augers and other rotating components of drill rigs.
- Stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel.
- Do not wear loose-fitting clothing or other items such as rings or watches that could get caught in moving parts. Long hair should have it restrained.
- If equipment becomes electrically energized, personnel shall be instructed not to touch any part of the equipment or attempt to touch any person who may be in contact with the electrical current. The utility company or appropriate party shall be contacted to have line de-energized prior to approaching the equipment.
- Smoking around drilling operations is prohibited.

2.1.6 Hand Safety

- Review Dow Knife Procedure prior to using any cutting device. **Refer to Attachment 12**.
- While opening monitoring well caps.
  - Wear gloves.
  - Watch hand position.
  - Be aware of bees and wasps.
- Use Kevlar gloves when using cutting tools.
- Utilize scissors while cutting tape- not a knife.

2.1.7 Digging

(Reference CH2M HILL SOP HS-112, *Lifting*)

- Digging activities have a potential for back injuries.
- If someone is going to be digging remind them of the proper techniques which include:
  - **Warming up and stretching before exertion**,
  - Using the legs to lift the weight of the full shovel
  - Using your feet to change direction to unload the shovel.
- Never twist your trunk when you are carrying a load.

2.1.8 Soil and Ground Water Sampling

- Tie down loose items if utilizing a van.
- Utilize a spotter if backing vehicles or equipment towards sampling location.
- Inspect the sampling area for obstructions and Poison Ivy and Poison Oak, or other physical hazards.
- If sample locations are located in dense tall grassy areas consider utilizing a “Bug-Out” suit or Tyvek to mitigate the potential for tick bites.
- If lifting heavy equipment from vehicle, move items to the rear and get assistance when lifting.
- Be alert for bees, wasps and other insects when sampling.
- Ensure only personnel with current 40-hour Hazwoper and 8 hour refresher training perform task.
- Log calibration of Direct Reading Instrument in either a field log book or on attached form.
- Notify others in area that task is going to be performed, delineate an exclusion zone as applicable.
- Don personal protective equipment (PPE) as specified in Section 4 of this site-specific HASP.
- Position yourself upwind prior to sampling, if possible.
- Review Material Safety Data Sheets for chemical preservatives, decontamination agents and calibration gas.
- Do not handle sample jars without nitrile gloves.

2.1.9 IDW Drum Sampling

Personnel are permitted to handle and/or sample drums containing investigation-derived waste (IDW) only; handling or sampling other drums requires a plan revision or amendment approved by the CH2M HILL HSM. The following control measures will be taken when sampling drums containing IDW:

- Minimize transportation of drums.
- Sample only labeled drums or drums known to contain IDW.
- Use caution when sampling bulging or swollen drums. Relieve pressure slowly.
- If drums contain, or potentially contain, flammable materials, use non-sparking tools to open.
- Picks, chisels, and firearms may not be used to open drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer the content of drums using a method that minimizes contact with material.
- PPE and air monitoring requirements specified in Sections 4 and 5 must address IDW drum sampling.
- Spill-containment procedures specified in Section 7 must be appropriate for the material to be handled.

2.1.10 Working Above or Near Water

- Fall protection should be provided to prevent personnel from falling into water. Where fall protection systems are not provided and the danger of drowning exists, U.S. Coast Guard-approved personal flotation devices (PDFs), or life jacket, shall be worn.
- Inspect PFDs prior to use. Do not use defective PFDs.
- A life-saving skiff must be provided for emergency rescue.
- A minimum of one ring buoy with 90 feet of 3/8-inch solid-braid polypropylene (or equal) rope must be provided for emergency rescue.

2.1.11 Arsenic

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Avoid skin and eye contact with liquid and particulate arsenic or arsenic trichloride.
- Arsenic is considered a "Confirmed Human Carcinogen."
- Arsenic particulates (inorganic metal dust) are odorless. Vapor and gaseous odor varies depending upon specific organic arsenic compound.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

2.1.12 Cadmium

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Cadmium is considered a "Suspected Human Carcinogen."
- Cadmium particulates (fumes and dust) are odorless.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

2.1.13 Vinyl Chloride

(Reference CH2M HILL SOP HSE-512, *Vinyl Chloride*)

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Vinyl Chloride is considered a "Confirmed Human Carcinogen."
- A Short Term Exposure Limit (STEL: 15 minutes) exists for this material.
- Vinyl Chloride has a mild, sweet, chloroform-like odor.
- Review Vinyl Chloride Fact Sheet found in Attachment 9 of this Site Specific Health and Safety Plan.

2.1.14 Lead

The following requirements pertain to lead contaminated soils:

- Work shall progress in a sequence from less contaminated to more contaminated areas.
- Water should be added to soils prior to and during excavation, air rotary drilling, and other activities that create or have the potential to create airborne lead contaminated dust. For air rotary drilling operations, water can be added to the boring to reduce dust generation from the cyclone. Depending upon soil type, watering of soil may be required several days prior to commencing ground intrusive activities.
- Personnel working in the vicinity of lead contaminated soil shall wear disposable coveralls or equal and exercise enhanced personal hygiene (i.e., frequent hand washing prior to eating, drinking, and smoking; separation of work and street clothing/footwear; etc.).

2.1.15 Pressure Washing

- **To Prevent Malfunction**
  - Review operation manual before initial use.
  - Ensure connections are correctly attached and tight.
  - Inspect hoses (no broken braids, flat surfaces, or damaged threads).
  - Perform a pre-operation check before each use.
- **During Pressure Washing Operations**
  - Only capable and qualified persons operate equipment.
  - Water pressure at the nozzle tip shall be less than 3,600 psig.
  - The operator shall always maintain a firm grip on the lance
  - The operator shall not place their hand or body in front of the wand while it is operating.
  - The wand trigger shall never be tied or blocked in the open position.
  - The operator shall not direct the water stream towards people or electrical components.
  - Shut off equipment when not in use.
  - Prevent the formation of standing water or ice.
- **Personal Protective Equipment**
  - At a minimum, eye protection and footwear with slip resistant souls and ankle support are required.
  - Consult Material Safety Data Sheets (MSDS's) if detergents are used.
- **Equipment Set Up:**
  - Where possible, place motor outside t prevent build up of carbon monoxide.
  - When it is not possible to place the motor outside, place it near an open door and monitor for CO.
- **Refueling**
  - Never refuel a gas engine until it is turned off and had a chance to cool.
  - Store extras fuel in an approved metal fuel can.
  - Have a fire extinguisher readily available.

2.2 General Hazards

- **Refer to the MASTER HASP for General Hazards**

2.3 Biological Hazards

- **Refer to the MASTER HASP for Biological Hazards**

2.4 Radiological Hazards

- **Refer to the MASTER HASP for Radiological Hazards**

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Metals					
Arsenic	**GW: 9.2** SJS02-MW07S **SW: 4.40** SJS02-SW04 **SB: 41.7** SJS02-SB12 **SS: 18.0** SJS02-SS13	0.01 mg/m³	5 Ca	Ulceration of nasal septum, respiratory irritation, dermatitis, gastrointestinal disturbances, peripheral neuropathy, hyperpigmentation	NA
Cadmium	**GW: ND** **SW: 2.5** **SB: 11.2** SJS02-SB12 **SS: 3.10** SJS02-SS20	0.005 mg/m³	9 Ca	Pulmonary edema, coughing, chest tightness/pain, headache, chills, muscle aches, nausea, vomiting, diarrhea, difficulty breathing, loss of sense of smell, emphysema, mild anemia	NA
Chromium (hexavalent)	**GW: 0.0017** **SB: 335** SJS02-SB13 **SS: 246** SJS02-SS06	0.01 mg/m³	15 Ca	Irritated respiratory system, nasal septum perforation, liver and kidney damage, leucytosis, leupen, monocytosis, eosinophilla, eye injury, conjunctivitis, skin ulcer, sensitization dermatitis	NA
Lead	**GW: 4.8** SJS02-MW09S **SB: 8850** SJS02-SB12 **SS: 2370** SJS02-SS06	0.05 mg/m³	100	Weakness lassitude, facial pallor, pal eye, weight loss, malnutrition, abdominal pain, constipation, anemia, gingival lead line, tremors, paralysis of wrist and ankles, encephalopathy, kidney disease, irritated eyes, hypertension	NA
Mercury	**GW: ND** **SB: 6.3** **SS: 0.710** SJS02-SS16	0.05 mg/m³	10	Skin and eye irritation, cough, chest pain, difficult breathing, bronchitis, pneumontitis, tremors, insomnia, irritability, indecision, headache, fatigue, weakness, GI disturbance	NA

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Pesticides					
Heptachlor epoxide	**GW: 1.06** MW-08S	0.5 mg/m³	500 Ca	Paresthesia of tongue, lips, hand, and face; tremors; dizziness; confusion; headache; fatigue; convulsion; eye and skin irritation; vomiting	UK
VOCs					
Vinyl Chloride	**GW: 13** SJS02MW07S **SB: ND** **SW: 0.0219** SJS02-SW04-001	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor, or cyanosis of extremities.	9.99
Cis-1,2 Dichloroethene	**GW: 34** SJS02-MW07S **SB: ND** **SW: 0.084** SJS02-SW09	10 ppm	1,000	Skin, eye, and nose irritation; drowsiness; uncoordination; CNS depression	9.07
Trichloroethylene (TCE)	**GW: 330** SJS02-MW10S **SB: 0.012** SJS02-SB06 **SW: 0.140** SJS02-SW10	50 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
Trans-1,2-Dichloroethene	**GW: 0.072** SJS02-MW10S **SB: ND** **SW: 0.0003J** SJS02-SW03	200 ppm	1000 ppm	Irritated eye and respiratory system; CNS depression	UK
SVOCs					
1,1′-Biphenyl	**GW: 2** MW-07S	1 ppm	100pp m	Eye and throat irritant; headache, nausea, fatigue, limb numbness; liver damage	7.95
2,4-Dimethylphenol	**GW: 2** MW-07S	UK	UK	Not Known	UK
2-Methylnaphthalene	**GW: 8** MW-07S	UK	UK	Not Known	UK

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Acenaphthene	**GW: 8** MW-07S	UK	UK	Not Known	UK
Carbazole	**GW: 6** MW-07S	UK	UK	Not Concerned	UK
Di-n-butylphthalate	**GW: 0.7** MW-08S	5 mg/m³	4000 mg/m³	Eye, upper respiratory system and stomach irritant	UK
Dibenzofuran	**GW: 5** MW-07S	UK	UK	Not Known	UK
Fluorene	**GW: 5** MW-07S	UK	UK	Not Known	UK
Naphthalene	**GW: 120** MW-07S	10 ppm	250 ppm	Eye irritant; headache, confusion, excitement, malaise; nausea, vomiting, abdominal pain; bladder irritation; profuse sweating; jaundice; hematuria, hemoglobinuria, renal shutdown; dermatitis; optical neuritis, corneal damage	8.12
Phenanthrene	**GW: 4** MW-07S	UK	UK	Not Known	UK
Bis-(2-ethylhexyl)phthalate (DEHP, DOP)	**GW: 0.6** MW-07S	5 mg/m³	5,000 Ca	Eye and mucous membrane irritant	UK

Footnotes:

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water).

[b] Appropriate value of PEL, REL, or TLV listed.

[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.

[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.

2.6 Potential Routes of Exposure

Dermal: Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 4.

Inhalation: Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in Sections 4 and 5, respectively.

Other: Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).

SECTION 3

Project Organization and Personnel

3.1 CH2M HILL Employee Medical Surveillance and Training

(Reference CH2M HILL SOPs HS-113, *Medical Surveillance,* and HS-110, *Health and Safety Training)*

The employees listed below are enrolled in the CH2M HILL Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated "SSC" have completed a 12-hour site safety coordinator course, and have documented requisite field experience. An SSC with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during all tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. At least one FA-CPR designated employee must be present during all tasks performed in exclusion or decontamination zones. The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. Certain tasks (e.g., confined-space entry) and contaminants (e.g., lead) may require additional training and medical monitoring.

Pregnant employees are to be informed of and are to follow the procedures in CH2M HILL's SOP HS-04, *Reproduction Protection,* including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

Employee Name	Office	Responsibility	SSC/FA-CPR
Adrienne Jones	VBO	Field Team Leader/SC-HW	Level C SC-HW; FA-CPR
Andy Bogdanski	WDC	Field Team Member/SC-HW	Level C SC-HW; FA-CPR
Lindsey Carr	WDC	Field Team Member/SC-HW	Level C SC-HW; FA-CPR
Megan Hilton	VBO	Field Team Member/SC-HW	
Phil Balvocius	VBO	Field Team Member/SC-HW	FA-CPR
Ted Dingle	VBO	Field Team Member/SC-HW	FA-CPR
Kim-Lee Yarberry	ATL	Field Team Member/SC-HW	Level C SC-HW; FA-CPR

3.2 Field Team Chain of Command &Communication Procedures

3.2.1 Client

Contact Name:	**Agnes Sullivan** NAVFAC MID-LANT Building N-26 Rm 3208 9742 Maryland Ave. Naval Station Norfolk, VA 23511-3095
Phone:	**757/444-4120**

3.2.2 CH2M HILL

Activity Manager:	**Kim Henderson/VBO**
Project Manager:	**Kim Henderson/VBO**
Health and Safety Manager:	**Steve Beck/MKE**
Field Team Leader :	**Adrienne Jones/VBO**
Site Safety Coordinator:	**Adrienne Jones/VBO**

The SSC is responsible for contacting the Field Team Leader and Project Manager. In general, the Project Manager will contact the client. The Health and Safety Manager should be contacted as appropriate.

3.2.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HS-215, *Subcontractor, Contractor, and Owner*)

Vegetation Removal Subcontractor: Agviq Subcontractor Contact Name: Dave Leadenham Telephone: 757-318-9420	**Utilities Location** Subcontractor: The Spectra Group Subcontractor Contact Name: John Fowler Telephone: 757-497-5862
Drilling Subcontractor: Parrott Wolff Subcontractor Contact Name: Butch Stevens Telephone: 919-644-2814	**Surveying** Subcontractor: To be determined Subcontractor Contact Name: Telephone:
MIP Subcontractor: Columbia Technologies Subcontractor Contact Name:Pete Ballard Telephone: 410-536-9911	**Onsite Lab** Subcontractor: New Age Landmark Subcontractor Contact Name: Telephone:

The subcontractors listed above are covered by this HSP and must be provided a copy of this plan. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., drilling, excavation work, electrical). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to CH2M HILL for review before the start of field work. Subcontractors must comply with the established health and safety plan(s). The CH2M HILL SSC should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plan(s). CH2M HILL's oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

CH2M HILL should continuously endeavor to observe subcontractors' safety performance. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SSC is responsible for confirming CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment checklists. Self-assessment checklists contained in **Attachment 6** are to be used by the SSC to review subcontractor performance.

Health and safety related communications with CH2M HILL subcontractors should be conducted as follows:

- Brief subcontractors on the provisions of this plan, and require them to sign the Employee Signoff Form included in **Attachment 1.**
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent non-compliance/unsafe conditions or practices are observed, notify the subcontractor safety representative and require corrective action – the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When repeat non-compliance/unsafe conditions are observed, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented.
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented. Notify the Project Manager and HSM as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

SECTION 4

Personal Protective Equipment (PPE)

(Reference CH2M HILL SOP HS-117, *Personal Protective Equipment*, HS-121, *Respiratory Protection*)

Task	Level	Body	Head	Respirator [b]
• General site entry • Utility Clearance • Surveying • Observation of material loading for disposal	D	Work clothes; steel-toe, leather work boots; work glove.	Hardhat [c] Safety glasses Ear protection [d]	None required
• Surface water sampling • Sediment sampling • Surface soil sampling • Hand augering	Modified D	Work clothes or cotton coveralls **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Safety glasses Ear protection [d]	None required
• Groundwater sampling • Soil boring • IDW (drum) sampling and disposal	Modified D	**Coveralls:** Uncoated Tyvek® **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Safety glasses Ear protection [d]	None required.
• Tasks requiring upgrade Note: No level C for Vinyl Chloride.	C	**Coveralls:** Polycoated Tyvek® **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Ear protection [d] Spectacle inserts	APR, full face, MSA Ultratwin or equivalent; with GME-H cartridges or equivalent[e].
• Tasks requiring upgrade	B	**Coveralls:** Polycoated Tyvek® **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Ear protection [d] Spectacle inserts	Positive-pressure demand self-contained breathing apparatus (SCBA); MSA Ultralite, or equivalent.

Reasons for Upgrading or Downgrading Level of Protection

Upgrade[f]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels (Section 5) exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decreases the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.

[b] No facial hair that would interfere with respirator fit is permitted.

[c] Hardhat and splash-shield areas are to be determined by the SSC.

[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.

[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range (refer to Section 5)--then at least every 4 hours. If encountered conditions are different than those anticipated in this HSP, contact the HSM.

[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SSC qualified at that level is present.

SECTION 5

Air Monitoring/Sampling

(Reference CH2M HILL SOP HS-207, *Air Monitoring)*

5.1 Air Monitoring Specifications

PID: MultiRAE with 10.6eV lamp or equivalent	All intrusive activities	Up to 1 ppm→	Level D	Initially and periodically during task	Daily
		1 to - 5 ppm above b.g. → (Sustained for 1 minute)	Level D; collect benzene tube; benzene action level not exceeded		
		5 to 250 ppm above b.g → (Sustained for 1 minute)	Level C		
		> 250 ppm above b.g . → (Sustained for 1 minute)	Level B (Not Anticipated or authorized)		
Colormetric Tube: Drager vinyl chloride specific (0.5 to 30 ppm range) with pre-tube, or equivalent	All intrusive activities	<0.5 ppm→ 0.5 ppm→	Level D Level B- contact HSM prior to upgrade	Initially and periodically when PID >1 ppm	Not applicable
Dust Monitor: Miniram model PDM-3 or equivalent	Drilling, digging or if dusty conditions exist.	Up to 0.5 mg/m3 →	Level D	Initially and periodically during tasks	N/A
		0.5 to 1 mg/m3 →	Level D – Use Dust Suppression techniques		
		> 1 mg/m3 →	Level C – contact HSM prior to upgrade		
Nose-Level Monitor[e]: Voice	All	Conversations can be held at distances of 3 feet without shouting →	No action required	Initially and periodically during task	N/A
		Conversations cannot be held at distances of 3 feet without shouting →	Hearing protection required Stop; re-evaluate		

[a] Action levels apply to sustained breathing-zone measurements above background.

[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SSC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., "Breathing Zone/MW-3", "at surface/SB-2", etc.).

[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry (refer to Section 2).

[d] Refer to SOP HS-10 for instructions and documentation on radiation monitoring and screening.

[e] Noise monitoring and audiometric testing also required.

5.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
PID: MultiRAE, 10.6 eV bulb	100 ppm isobutylene	CF = 100	100 ppm	1.5 lpm reg T-tubing
Dust Monitor: Miniram-PDM3	Dust-free air	Not applicable	0.00 mg/m3 in "Measure" mode	Dust-free area OR Z-bag with HEPA filter
CGI: MultiRAE	0.75% pentane	N/A	50% LEL + 5% LEL	1.5 lpm reg direct tubing

5.3 Air Sampling

Sampling, in addition to real-time monitoring, may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the HSM immediately if these contaminants are encountered.

Method Description

- **Personal Air Sampling is required for all drilling activities. Refer to Attachment 15 of this HASP for Specifications.**

Personnel and Areas

Results must be sent immediately to the HSM. Regulations may require reporting to monitored personnel. Results reported to:

HSM: **Steve Beck/MKE**

Other: James Verbrugge/MKE

SECTION 6

Drug-Free Workplace & Screening Program

(SOP HSE-105, *Drug-Free Workplace*)

- Refer to the Master HASP

SECTION 7

Decontamination

(Reference CH2M HILL SOP HSE-506, *Decontamination*)

- Refer to the Master HASP

7.1 General Decontamination Specifications

- Refer to the Master HASP

7.2 Diagram of Personnel-Decontamination Line

- Refer to the Master HASP

SECTION 8

Spill-Containment Procedures

- Refer to the Master HASP

SECTION 9

Site-Control Plan

9.1 Site-Control Procedures

(Reference CH2M HILL SOP HSE-502, *Site Control*)

- Refer to the Master HASP

9.2 Hazwoper Compliance Plan

(Reference CH2M HILL SOP HSE-220, *Written Plans)*

- Refer to the Master HASP

SECTION 10

Emergency Response Plan

(Reference CH2M HILL, SOP HSE-106, *Emergency Planning*)

10.1 Pre-Emergency Planning

- Refer to the Master HASP

10.2 Emergency Equipment and Supplies

- Refer to the Master HASP

10.3 Incident Response

- Refer to the Master HASP

10.4 Emergency Medical Treatment

- Refer to the Master HASP

10.5 Evacuation

- Refer to the Master HASP

10.6 Evacuation Signals

- Refer to the Master HASP

10.7 Incident Notification and Reporting

- Refer to the Master HASP

10.8 Serious Incident Reporting

- Refer to the Master HASP

SECTION 11

Behavioral Based Loss Prevention

- Refer to the Master HASP

11.1 Activity Hazard Analysis

- Refer to the Master HASP

11.2 Pre-Task Safety Plans

- Refer to the Master HASP

11.3 Safe Work Observations

- Refer to the Master HASP

11.4 Loss/Near Loss Investigation

- Refer to the Master HASP

SECTION 12

Approval

This site-specific Health and Safety Plan has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

12.1 Original Plan

Written By: Dan Holloway **Date: 06/03/2003**

Approved By: SteveBeck/MKE **Date: 06/03/2003**

12.2 Revisions

Revisions Made By: Mark Ost/VBO **Date: 02/08/2007**

Revisions to Plan: Update for Dynamic Work Plan Triad Investigation Site 2

Revisions Approved By: Steve Beck/MKE **Date: 04/27/2007**

SECTION 13

Attachments

Attachment 1:	Employee Signoff Form – Site Specific HASP
Attachment 2:	Emergency Contacts
Attachment 3:	Biological Hazards- Refer to Master HASP
Attachment 4:	BBLPS Forms & Permits- Refer to Master HASP
Attachment 5:	Project-Specific Chemical Product Hazard Communication Form
Attachment 6:	Chemical Specific Training Form
Attachment 7:	Initial Medical Treatment Form-Refer to Master HASP
Attachment 8:	Material Safety Data Sheets
Attachment 9:	Project Specific Forms and Permits
Attachment 10:	Self-Assessment Checklists

Employee Signoff Form

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

- The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name: St. Juliens Creek Annex/Site 2 Dynamic/Triad Investigation **Project Number:** 181812

EMPLOYEE NAME (Please print)	EMPLOYEE SIGNATURE	COMPANY	DATE

Emergency Contacts

Emergency Contacts

24-hour CH2M HILL Emergency Beeper – 888/444-1226 CH2M HILL Occupational Health Nurse – 1-800-756-1130	
Off Site Medical Emergency – 911 Facility Medical Response #: 757-396-3333 Local Ambulance #: 757-396-3333 **911 cannot respond to calls within SJCA**	**CH2M HILL Medical Consultant** Health Resources Dr. Jerry H. Berke, M.D.,M.P.H. 600 West Cummings Park, Suite 3400 Woburn, MA 01801 1-781-938-4653 or 1-800-350-4511 (After hours calls will be returned within 20 minutes)
Fire/Spill Emergency Facility Fire Response #: 757-396-3335 Local Fire Dept #: 757-382-6297 **911 cannot respond to calls within SJCA**	**Corporate Director Health and Safety** Name: Jerry Lyle/BOI Phone: 1-208-850-2532 **24-hour emergency beeper: 888-444-1226**
Security & Police Facility Security #: 757-396-5111 Local Police #: 757-382-6161	**Regional Health, Safety & Environmental Manager** Name: Steve Beck/MKE Phone: 414-272-2426 x277
Utilities Emergency Water: 757-382-3550 Gas: 1-877-572-3342 Electric: 1-888-667-3000	**Health and Safety Manager (HSM)** Name: Steve Beck/MKE Cell: 14-526-4517 Phone: 414-272-2426 ext. 40277
Designated Safety Coordinator (DSC) Name: TBD Phone: 757-671-8311 x 448	**Regional Human Resources Department** Name: Cindy Bauder/WDC Phone: 703-471-6405 ext. 4243
Project Manager Name: Kim Henderson Phone: 757-671-8311 x 440	**Corporate Human Resources Department** Name: Pete Hannon/DEN Phone: 303/771-0900
Federal Express Dangerous Goods Shipping Phone: 800/238-5355 **CH2M HILL Emergency Number for Shipping Dangerous Goods** Phone: 800/255-3924	**Worker's Compensation** Contact either the Regional Human Resources Dept. to have an Incident Report Form (IRF) completed. After hours contact Julie Zimmerman 303-664-3304 **Auto Claims** Rental: Linda Anderson/DEN 1-303-713-2757 CH2M Hill owned: Zurich Insurance 1-800-987-3373
Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.	
Facility Alarms: Sound Field Vehicle Horn (3x)	**Evacuation Assembly Area(s):** Field Vehicle
Facility/Site Evacuation Route(s): See Site Map	

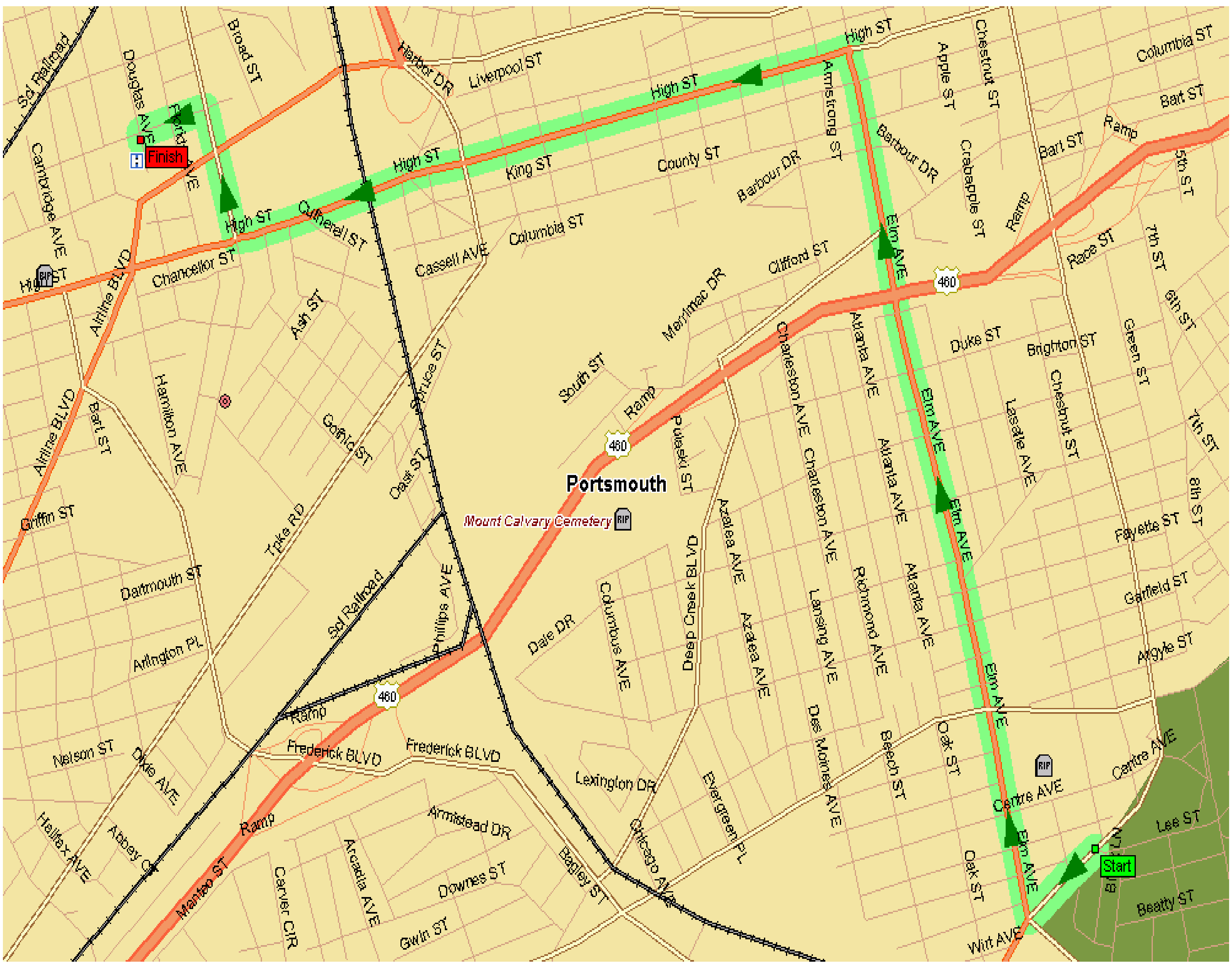
Hospital

Hospital Name/Address:
Maryview Medical Center
3636 High Street
Portsmouth, VA 23707

Hospital Phone #: 757-398-2200

Directions to Hospital

Leave main gate of Annex and take left onto Victory Blvd.
At route 17 (George Washington Highway) take a right and go north.
Make left onto Fredrick Blvd, and continue on Fredrick until it dead ends.
Make left onto High Street, the Maryview Medical Center is on the right at the first light.



Biological Hazards

Refer To Master HASP

Behavioral Based Loss Prevention Form – AHA, PTSP, Incident & Near Loss Investigation Report Form, Root Cause Analysis

Refer to Master HASP

Project – Specific Chemical Product Hazard Communication Form

CH2MHILL

Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SSC shall verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to CH2M HILL and subcontractor personnel. Labeling and MSDS systems will also be explained

The SC shall field verify and modify the list below according to actual site conditions..

Project Name: St. Juliens Creek Annex/Site 2 Dynamic Work Plan **Project Number:** 181812

MSDSs will be maintained at the following location(s): Field Vehicle

Hazardous Chemical Products Inventory

Chemical	Quantity	Location	MSDS Available	Container labels	
				Identity	Hazard
Isobutylene	1 liter, compressed	Support Zone	x	x	
Hydrochloric acid	< 500 ml	Support Zone / sample bottles	x	x	
Nitric acid	< 500 ml	Support Zone / sample bottles			
Sulfuric Acid	< 500 ml	Support Zone / sample bottles			
Sodium hydroxide	< 500 ml	Support Zone / sample bottles			
Methanol	< 1 Gallon	Support/Decon Zones	x	x	
Alconox/Liquinox	< 1liter	Support/Decon Zones	x	x	

Refer to SOP HS-05 *Hazard Communication* for more detailed information.

CH2MHILL

Health and Safety Plan

Attachment 6

Chemical Specific Training Form

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

Location:	Project # : 181812
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.
Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

Initial Medical Treatment Form

Refer To Master HASP

CH2MHILL

Health and Safety Plan

Attachment 8

Applicable Material Safety Data Sheets

Section 1 - Product and Company Identification
ISOBUTYLENE

Product Identification: ISOBUTYLENE
Date of MSDS: 09/14/1989 **Technical Review Date:** 09/13/1995
FSC: 6830 **NIIN: LIIN:** 00N042744
Submitter: N EN
Status Code: C
MFN: 01
Article: N
Kit Part: N

Manufacturer's Information

Manufacturer's Name: SCOTT SPECIALTY GASES
Manufacturer's Address1: ROUTE 611
Manufacturer's Address2: PLUMSTEADVILLE, PA 18949
Manufacturer's Country: US
General Information Telephone: 215-766-8861
Emergency Telephone: 215-766-8861
Emergency Telephone: 215-766-8861
MSDS Preparer's Name: N/P
Proprietary: N
Reviewed: N
Published: Y
CAGE: 51847
Special Project Code: N

Contractor Information

Contractor's Name: SCOTT SPECIALTY GASES
Post Office Box: 310
Contractor's Address1: 6141 EASTON RD
Contractor's Address2: PLUMSTEADVILLE, PA 18949-0310
Contractor's Telephone: 215-766-8861
Contractor's CAGE: 51847

Section 2 - Composition /Information on Ingredients
ISOBUTYLENE

Ingredient Name: PROPENE, 2-METHYL-; (ISOBUTYLENE)
Ingredient CAS Number: 115-11-7 **Ingredient CAS Code:** M
RTECS Number: UD0890000 **RTECS Code:** M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: 100
% Environmental Weight:
Other REC Limits: N/K
OSHA PEL: N/K (FP N) **OSHA PEL Code:** M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: N/K (FP N) **ACGIH TLV Code:** M
ACGIH STEL: N/P **ACGIH STEL Code:**
EPA Reporting Quantity:
DOT Reporting Quantity:
Ozone Depleting Chemical: N

Section 3 - Hazards Identification, Including Emergency Overview
ISOBUTYLENE

Health Hazards Acute & Chronic: ACUTE:ASPHYXIANT. SYMPTOMS INCLUDE RAPID RESPIRATION, MUSCULAR INCOORDINATION, FATIGUE, NAUSEA & VOMITING. LOSS OF CONSCIOUSNESS & DEATH MAY OCCUR. CONTACT W/LIQUID MAY RESULT IN SYMPTOMS OF FROSTBITE . CHRONIC:NONE.

Signs & Symptoms of Overexposure:
SEE HEALTH HAZARDS.

Medical Conditions Aggravated by Exposure:
NONE

LD50 LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.

Route of Entry Indicators:

Inhalation: YES

Skin: NO

Ingestion: NO

Carcinogenicity Indicators

NTP: NO

IARC: NO

OSHA: NO
Carcinogenicity Explanation: NOT RELEVANT

Section 4 - First Aid Measures
ISOBUTYLENE

First Aid:
INGEST:CALL MD IMMED (FP N). INHAL:IMMED REMOVE VICTIM TO FRESH AIR. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN. SKIN:IMMED FLUSH W/ COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAM CLTHG. IF FROSTBITE OCCURS, WARM AFFECTED AREA W/WATER OR TOWEL. EYE:IMMED FLUSH W/COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES.

Section 5 - Fire Fighting Measures
ISOBUTYLENE

Fire Fighting Procedures:
USE NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N). FLAMMABLE HIGH PRESSURE LIQUID OR GAS.
Unusual Fire or Explosion Hazard:
DANGEROUS. VAP MAY TRAVEL CONSIDERABLE DIST TO SOURCE OF IGNIT & FLASH BACK. MAY FORM EXPLO MIXTS W/AIR. CAN REACT VIGOROUSLY W/OXIDIZING MATLS.

Extinguishing Media:
DO NOT EXTING BURNING GAS IF FLOW CANNOT BE SHUT OFF. USE WATER SPRAY TO KEEP FIRE EXPOS CYLS COOL. MOVE CYL (SUPDAT)
Flash Point: Flash Point Text: -105F,-76C

Autoignition Temperature:

Autoignition Temperature Text: N/A

Lower Limit(s): 1.8%

Upper Limit(s): 9.6%

Section 6 - Accidental Release Measures
ISOBUTYLENE

Spill Release Procedures:
EVACUATE & VENTILATE AREA. REMOVE LEAKING CYLINDER TO EXHAUST HOOD OR SAFE OUTDOORS AREA IF THIS CAN BE DONE SAFELY.

Section 7 - Handling and Storage
ISOBUTYLENE

Handling and Storage Precautions:

Other Precautions:

Section 8 - Exposure Controls & Personal Protection
ISOBUTYLENE

Respiratory Protection:
USE NIOSH/MSHA APPROVED SCBA IN CASE OF EMERGENCY OR NON-ROUTINE USE.
Ventilation:
PROVIDE ADEQUATE & LOCAL EXHAUST VENTILATION TO MAINTAIN CONCENTRATION BELOW EXPOSURE LIMITS.
Protective Gloves:
IMPERVIOUS GLOVES (FP N).
Eye Protection: SAFETY GOGGLES.
Other Protective Equipment: SAFETY SHOES WHEN HANDLING CYLINDERS.
Work Hygenic Practices: NONE SPECIFIED BY MANUFACTURER.
Supplemental Health & Safety Information: EXTING MEDIA:AWAY FROM FIRE IF THERE IS NO RISK. OTHER PREC:HAS NOT BEEN FILLED BY THE OWNER OR W/HIS WRITTEN CONSENT IS A VIOLATION OF FEDERAL LAW (49 CFR).

Section 9 - Physical & Chemical Properties
ISOBUTYLENE

HCC: G2
NRC/State License Number:
Net Property Weight for Ammo:
Boiling Point: Boiling Point Text: 19.6F,-6.9C
Melting/Freezing Point: Melting/Freezing Text: N/K
Decomposition Point: Decomposition Text: N/K
Vapor Pressure: 2.65@21.1C **Vapor Density:** 1.947
Percent Volatile Organic Content:
Specific Gravity: 0.588 (H_2O=1)
Volatile Organic Content Pounds per Gallon:
pH: N/K
Volatile Organic Content Grams per Liter:
Viscosity: N/P
Evaporation Weight and Reference: NOT APPLICABLE
Solubility in Water: SLIGHT
Appearance and Odor: COLORLESS, ETHEREAL ODOR.
Percent Volatiles by Volume: 100
Corrosion Rate: N/K

Section 10 - Stability & Reactivity Data
ISOBUTYLENE

Stability Indicator: YES
Materials to Avoid:
OXIDIZING MATERIALS.
Stability Condition to Avoid:
NONE SPECIFIED BY MANUFACTURER.
Hazardous Decomposition Products:
CARBON MONOXIDE, CARBON DIOXIDE.
Hazardous Polymerization Indicator: NO
Conditions to Avoid Polymerization:
NOT RELEVANT

Section 11 - Toxicological Information
ISOBUTYLENE

Toxicological Information:
N/P

Section 12 - Ecological Information
ISOBUTYLENE

Ecological Information:
N/P

Section 13 - Disposal Considerations
ISOBUTYLENE

Waste Disposal Methods:
DISP MUST BE I/A/W FED, STATE & LOC REGS (FP N). RETURN CYLS TO SUPPLIER FOR PROPER DISP W/ANY VALVE OUTLET PLUGS/CAPS SECURED & VALVE PROT CAP IN PLACE. DO NOT REUSE CYL. EMPTY CYL WILL CONTAIN HAZ R ESIDUE.

Section 14 - MSDS Transport Information
ISOBUTYLENE

Transport Information:
N/P

Section 15 - Regulatory Information
ISOBUTYLENE

SARA Title III Information:
N/P
Federal Regulatory Information:
N/P
State Regulatory Information:
N/P

Section 16 - Other Information
ISOBUTYLENE

Other Information:
N/P

HAZCOM Label Information

Product Identification: ISOBUTYLENE
CAGE: 51847
Assigned Individual: N
Company Name: SCOTT SPECIALTY GASES
Company PO Box: 310
Company Street Address1: 6141 EASTON RD
Company Street Address2: PLUMSTEADVILLE, PA 18949-0310 US
Health Emergency Telephone: 215-766-8861
Label Required Indicator: Y
Date Label Reviewed: 09/08/1993
Status Code: C
Manufacturer's Label Number:
Date of Label: 09/08/1993
Year Procured: N/K
Organization Code: G
Chronic Hazard Indicator: N
Eye Protection Indicator: YES
Skin Protection Indicator: YES
Respiratory Protection Indicator: YES
Signal Word: DANGER
Health Hazard: Moderate
Contact Hazard: Slight
Fire Hazard: Severe
Reactivity Hazard: None

MSDS Name: **Nitric Acid**, Reagent ACS

Synonyms: Azotic Acid, Engravers Nitrate, Hydrogen Nitrate.
Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410
For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

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2. Composition/Information on Ingredients

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

Hazard Symbols: O C
Risk Phrases: 35 8

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3. Hazards Identification

EMERGENCY OVERVIEW
Appearance: clear colorless to pale yellow.
Danger! Strong oxidizer. Contact with other material may cause a fire. Corrosive. Causes eye and skin burns. Causes digestive and respiratory tract burns. May be fatal if inhaled. Target Organs: None.
Potential Health Effects
Eye:
Causes severe eye burns. May cause irreversible eye injury.
Skin:
May cause severe skin irritation. Causes skin burns. May cause deep, penetrating ulcers of the skin.
Ingestion:
Causes gastrointestinal tract burns. May cause perforation of the digestive tract.
Inhalation:
May be fatal if inhaled. Effects may be delayed. May cause irritation of the respiratory tract with burning pain in the nose and throat, coughing, wheezing, shortness of breath and pulmonary edema.
Chronic:
Repeated inhalation may cause chronic bronchitis. Repeated exposure may cause erosion of teeth.

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4. First Aid Measures

Eyes:
Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid immediately. Do NOT allow victim to rub or keep eyes closed.

Skin:
Get medical aid immediately. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists. Wash clothing before reuse. Destroy contaminated shoes.

Ingestion:
If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately. Do NOT induce vomiting and seek IMMEDIATE MEDICAL ADVICE.

Inhalation:
Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid. DO NOT use mouth-to-mouth respiration.

Notes to Physician:
Treat symptomatically and supportively.

5. Fire Fighting Measures

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Strong oxidizer. Contact with combustible materials may cause a fire. Use water spray to keep fire-exposed containers cool. Substance is noncombustible. Containers may explode in the heat of a fire.

Extinguishing Media:
Substance is noncombustible; use agent most appropriate to extinguish surrounding fire. Do NOT get water inside containers. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water. For small fires, use dry chemical, carbon dioxide, sand, earth, water spray or regular foam. Cool containers with flooding quantities of water until well after fire is out.

Autoignition Temperature: Not available.
Flash Point: Not available.
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

6. Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Wear a self contained breathing apparatus and appropriate Personal protection. (See Exposure Controls, Personal Protection section). Neutralize spill with sodium bicarbonate. Use water spray to disperse the gas/vapor. Remove all sources of ignition. Use a spark-proof tool.

7. Handling and Storage

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Ground and bond containers when transferring material. Keep container tightly closed. Do not get on skin or in eyes. Do not ingest or inhale.
Storage:
Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Corrosives area.

8. Exposure Controls/Personal Protection

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

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs

Nitric acid	2 ppm ; 5.2 mg/m3; 4 ppm STEL; 10 mg/m3 STEL	2 ppm TWA; 5 mg/m3 TWA 25 ppm IDLH	2 ppm TWA; 5 mg/m3 TWA

OSHA Vacated PELs:
Nitric acid: 2 ppm TWA; 5 mg/m3 TWA

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin:
Wear appropriate protective gloves and clothing to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to prevent skin exposure.

Respirators:
Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

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9. Physical and Chemical Properties (Nitric Acid)

Appearance:	clear colorless to pale yellow liquid
Odor:	strong odor, acrid odor
Solubility:	Soluble in water
Density/Spec. Grav:	1.50
pH:	1.0
% Volatiles by volume @ 21C (70F):	Not available
Boiling Point:	72 deg C
Melting Point:	-42 deg C
Vapor Density (Air=1):	Not available
Vapor Pressure (mm Hg):	6.8 mm Hg
Evaporation Rate (Butyl Acetate=1):	Not available
Viscosity:	Not available

Molecular Formula: HNO_3
Molecular Weight: 63.0119

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10. Stability and Reactivity

Chemical Stability: Decomposes when in contact with air, light, or organic matter.
Conditions to Avoid: High temperatures, incompatible materials, moisture, reducing agents.
Incompatibilities with Other Materials: Reacts with over 150 chemical combinations. Refer to NFPA Fire Protection Guide for specifics. Reacts explosively with organic materials and combustibles.
Hazardous Decomposition Products: Nitrogen oxides.
Hazardous Polymerization: Has not been reported.

11. Toxicological Information

RTECS#:
CAS# 7697-37-2: QU5775000 QU5900000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 7697-37-2: Inhalation, rat: LC50 =67 ppm(NO2)/4H.
CAS# 7732-18-5: Oral, rat: LD50 = >90 mL/kg.
Carcinogenicity:
Nitric acid -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
No information available.
Teratogenicity:
Effects on newborn: biochemical and metabolic, Oral-rat TDLo=2345 mg/kg (female 18D post). Fetotoxicity: Stunted fetus, Oral-rat TDLo=21150 mg/kg (female 1-21D post).
Reproductive Effects:
No information available.
Neurotoxicity:
No information available.
Mutagenicity:
No information available.
Other Studies:
None.

12. Ecological Information

Ecotoxicity:
Mosquito fish: TLm=72 ppm/96H (fresh water) Cockle: LC50=330-1000 ppm/48H (salt water)
Environmental Fate:
No information reported.
Physical/Chemical:
No information available.
Other:
None.

13. Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: None listed.
RCRA D-Series Chronic Toxicity Reference Levels: None listed.
RCRA F-Series: None listed.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

16. Other Information

MSDS Creation Date: 2/01/1996 Revision #4 Date: 12/16/1997

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

MSDS Name: **Hydrochloric Acid**, Reagent ACS

Chlorohydric acid, hydrogen chloride, muriatic acid, spirits of salt.
Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410
For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

---

2. Composition/Information on Ingredients

CAS#	Chemical Name	%	EINECS#
7647-01-0	Hydrochloric acid, reagent ACS	37%	231-595-7
7732-18-5	Water	Balance	231-791-2

Hazard Symbols: C
Risk Phrases: 34 37

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3. Hazards Identification

Emergency Overview

EMERGENCY OVERVIEW
Appearance: Clear, colorless to faintly yellow.
Danger! Corrosive. Sensitizer. Causes eye and skin burns. May cause severe respiratory and digestive tract irritation with possible
burns.
Target Organs: None.
Potential Health Effects

<u>Eye:</u>
May cause irreversible eye injury. Vapor or mist may cause irritation and severe burns. Contact with liquid is corrosive to the eyes and causes severe burns. May cause painful sensitization to light. May cause conjunctivitis.

<u>Skin:</u>
May be absorbed through the skin in harmful amounts. Contact with liquid is corrosive and causes severe burns and ulceration. May cause photosensitization in certain individuals.
<u>Ingestion:</u>
May cause circulatory system failure. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death. May cause
corrosion and permanent tissue destruction of the esophagus and digestive tract.
<u>Inhalation:</u>
Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. May cause pulmonary edema and severe respiratory disturbances.
<u>Chronic:</u>
Prolonged or repeated skin contact may cause dermatitis. Repeated exposure may cause erosion of teeth. May cause conjunctivitis and photosensitization.

---

4. First Aid Measures

Eyes:
Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid
immediately. Do NOT allow victim to rub or keep eyes closed.

Skin:
Get medical aid. Rinse area with large amounts of water for at least 15 minutes. Remove contaminated clothing and shoes.

Ingestion:
Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately.

Inhalation:
Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:
Treat symptomatically and supportively.

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5. Fire Fighting Measures

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full
protective gear. Not flammable, but reacts with most metals to form flammable hydrogen gas. Use water spray to keep fire-exposed containers cool.
Extinguishing Media:
Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.
Autoignition Temperature: Not available.
Flash Point: Not available.
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

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6. Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Large spills may be neutralized with dilute alkaline solutions of soda ash, or lime. Absorb spill using an absorbent, non-combustible
material such as earth, sand, or vermiculite.

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7. Handling and Storage

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Do not get on skin
or in eyes. Do not ingest or inhale.
Storage:
Keep away from heat and flame. Do not store in direct sunlight. Store in a cool, dry, well-ventilated area away from incompatible substances.

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8. Exposure Controls/Personal Protection

Engineering Controls:
Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits
Chemical Name ACGIH NIOSH OSHA - Final PELs
Hydrochloric acid, reagent ACS C 5 ppm; C 7.5 mg/m3 50 ppm IDLH C 5 ppm; C 7 mg/m3
OSHA Vacated PELs:
Hydrochloric acid, reagent ACS:
No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin:
Wear appropriate protective gloves to prevent skin exposure.
Clothing:
Wear appropriate protective clothing to prevent skin exposure.
Respirators:
Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

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9. Physical and Chemical Properties (Hydrochloric Acid)

Appearance:	Clear, colorless to faintly yellow liquid
Odor:	Strong, pungent
Solubility:	823g/L water at 32F
Density:	1.16-1.19
pH:	1.1 (0.1N sol)
% Volatiles by volume @ 21C (70F):	Not available
Boiling Point:	230 deg F
Melting Point:	-101 deg F
Vapor Density (Air=1):	1.257
Vapor Pressure:	160 mm Hg
Evaporation Rate (Butyl acetate =1):	2.0

Molecular Formula: HCl
Molecular Weight: 36.46

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10. Stability and Reactivity

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Incompatible materials, light.
Incompatibilities with Other Materials:
Acetate, acetic anhydride, alcohols + hydrogen cyanide, 2-aminoethanol, ammonium hydroxide, calcium carbide, calcium phosphide, cesium acetylene carbide, cesium carbide, chlorosulfonic acid, 1,1-difluoroethylene, ethylene diamine, ethyleneimine, fluorine, lithium silicide, magnesium boride, mercuric sulfate, oleum, perchloric acid, potassium permanganate, b-propiolactone, propylene oxide, rubidum acetylene carbide, rubidum carbide, silver perchlorate + carbon tetrachloride, sodium, sodium hydroxide, sulfuric acid, uranium phosphide, vinyl acetate. Substance polymerizes on contact with aldehydes or epoxides.

Hazardous Decomposition Products:
Hydrogen chloride, chlorine, carbon monoxide, carbon dioxide, hydrogen gas.
Hazardous Polymerization: May occur.

11. Toxicological Information

RTECS#:
CAS# 7647-01-0: MW4025000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 7647-01-0: Inhalation, mouse: LC50 =1108 ppm/1H; Inhalation, rat: LC50 =3124 ppm/1H; Oral, rabbit: LD50 = 900 mg/kg.
CAS# 7732-18-5: Oral, rat: LD50 = >90 mL/kg.
Carcinogenicity:
Hydrochloric acid, reagent ACS -
IARC: Group 3 carcinogen
Epidemiology:
No information available.
Teratogenicity:
Embryo or Fetus: Stunted fetus, ihl-rat TCLo=450 mg/m3/1H Specific Developmental Abnormalities: homeostasis, ihl-rat TCLo=450 mg/m3/1H.
Reproductive Effects:
No information available.
Neurotoxicity:
No information available.
Mutagenicity:
No information available.
Other Studies:
None.

12. Ecological Information

Ecotoxicity:
Trout LC100=10 mg/L/24H Shrimp LC50=100-330 ppm Starfish LC50=100-330mg/L/48H Shore crab LC50=240 mg/L/48H Chronic plant toxicity=100 ppm
Environmental Fate:
Substance will neutralize soil carbonate-based components.
Physical/Chemical:
No information available.
Other:
None.

13. Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: None listed.
RCRA D-Series Chronic Toxicity Reference Levels: None listed.
RCRA F-Series: None listed.
RCRA P-Series: None listed.
RCRA U-Series: None listed

16. Other Information

MSDS Creation Date: 11/09/1995 Revision #4 Date: 4/28/1998

MSDS Name: **Sulfuric acid**, reagent acs

Synonyms: Hydrogen Sulfate, Oil of Vitriol, Vitriol Brown Oil, Matting Acid, Battery Acid
Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410
For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

2. Composition/Information on Ingredients

CAS#	Chemical Name	%	EINECS#
7664-93-9	Sulfuric acid	95-98.0%	231-639-5
7732-18-5	Water	Balance	231-791-2

Hazard Symbols: XI C
Risk Phrases: 35 36/38

3. Hazards Identification

EMERGENCY OVERVIEW
Appearance: colorless to brown.
Danger! Harmful if inhaled. Corrosive. Hygroscopic. Causes digestive and respiratory tract burns. Causes digestive and respiratory tract irritation. Causes severe eye and skin irritation and burns. Target Organs: None known.

Potential Health Effects

Eye:
May cause irreversible eye injury. Causes eye irritation and burns.

Skin:
Causes severe skin irritation and burns.

Ingestion:
Causes gastrointestinal tract burns.

Inhalation:
Harmful if inhaled. May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and delayed lung edema. Causes chemical burns to the respiratory tract.

Chronic:
Prolonged or repeated skin contact may cause dermatitis. Prolonged or repeated inhalation may cause nosebleeds, nasal congestion, erosion of the teeth, perforation of the nasal septum, chest pain and bronchitis. Prolonged or repeated eye contact may cause conjunctivitis.

4. First Aid Measures

Eyes:
Get medical aid immediately. Do NOT allow victim to rub or keep eyes closed. Extensive irrigation is required (at least 30 minutes).

Skin:
Get medical aid immediately. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. SPEEDY ACTION IS CRITICAL!

Ingestion:
Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.

Inhalation:
Get medical aid immediately. Remove from exposure to fresh air immediately. If breathing is difficult, give oxygen.

Notes to Physician:
Treat symptomatically and supportively.

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5. Fire Fighting Measures

General Information:
Wear appropriate protective clothing to prevent contact with skin and eyes. Wear a self-contained breathing apparatus (SCBA) to prevent contact with thermal decomposition products. Contact with water can cause violent liberation of heat and splattering of the material.

Extinguishing Media:
Do NOT use water directly on fire. Use water spray to cool fire-exposed containers. Use carbon dioxide or dry chemical.

Autoignition Temperature: Not available.
Flash Point: 340 deg C (644.00 deg F)
NFPA Rating: Not published.
Explosion Limits, Lower: Not available.
Upper: Not available.

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6. Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Cover with sand, dry lime or soda ash and place in a closed container for disposal.

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7. Handling and Storage

Handling:
Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well ventilated area. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Do not ingest or inhale. Do not allow contact with water. Discard contaminated shoes.
Storage:
Keep container closed when not in use. Store in a cool, dry, well-ventilated area away from incompatible substances. Corrosives area.

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8. Exposure Controls/Personal Protection

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

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Sulfuric acid	1 mg/m3; 3 mg/m3 STEL	1 mg/m3 TWA; 15 mg/m3 IDLH	1 mg/m3 TWA

OSHA Vacated PELs:
Sulfuric acid:1 mg/m3 TWA

Personal Protective Equipment
Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin:
Wear appropriate protective gloves to prevent skin exposure.
Clothing:
Wear appropriate protective clothing to prevent skin exposure.
Respirators:
Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

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9. Physical and Chemical Properties ()

Appearance:	colorless to brown liquid
Odor:	Odorless
Solubility:	
Density:	1.8400 g/cm3
pH:	Not available
% Volatiles by volume @ 21C (70F):	
Boiling Point:	280 deg C @ 760.00mm Hg
Melting Point:	3 deg C
Vapor Density (Air=1):	1.2 kg/m3
Vapor Pressure (mm Hg):	< 0.00120 mm Hg
Evaporation Rate:	Slower than ether
Viscosity:	Not available

Molecular Formula: H_2O_4S
Molecular Weight: 98.08

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10. Stability and Reactivity

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Contact with water, metals, excess heat, combustible materials,
organic materials.
Incompatibilities with Other Materials:
Acids (mineral, oxidizing, e.g. chromic acid, hypochlorous acid, nitric acid, sulfuric acid), alcohols and glycols (e.g. butyl alcohol, ethanol, methanol, ethylene glycol), aldehydes (e.g. acetaldehyde, acrolein, chloral hydrate, formaldehyde), amines (aliphatic and aromatic, e.g. dimethyl amine, propylamine, pyridine, triethylamine), azo, diazo, and hydrazines (e.g. dimethyl hydrazine, hydrazine, methyl hydrazine), caustics (e.g. ammonia, ammonium hydrozide, calcium hydroxide, potassium hydroxide, sodium hydroxide), cyanides (e.g. potassium cyanide, sodium cyanide), dithiocarbamates (e.g. ferbam, maneb, metham, thiram), fluorides (inorganic, e.g. ammonium fluoride, calcium fluoride, cesium fluoride), isocyanates (e.g. methyl isocyanate), metals (alkali and

alkaline, e.g. cesium, potassium, sodium), metals as powders (e.g. hafnium, raney nickel), metals and metal compounds (toxic, e.g. beryllium, lead acetate, nickel carbonyl, tetraethyl lead), nitrides (e.g. potassium nitride, sodium n.

Hazardous Decomposition Products:
Oxides of sulfur.

Hazardous Polymerization: Has not been reported.

---

11. Toxicological Information

RTECS#:
CAS# 7664-93-9: WS5600000
LD50/LC50:
CAS# 7664-93-9: Inhalation, mouse: LC50 =320 mg/m3/2H; Inhalation, rat: LC50 =510 mg/m3/2H; Oral, rat: LD50 = 2140 mg/kg.

Carcinogenicity:
Sulfuric acid -
ACGIH: A2 - Suspected Human Carcinogen
OSHA: Select carcinogen
IARC: Group 1 carcinogen

Epidemiology:
Workers exposed to industrial sulfuric acid mist showed a statistical increase in laryngeal cancer. This data suggests a possible relationship between carcinogenesis and inhalation of sulfuric acid mist.

Teratogenicity:
No data available.

Reproductive Effects:
No data available.

Neurotoxicity:
No data available.

Mutagenicity:
No data available.

Other Studies:
No data available.

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12. Ecological Information

Ecotoxicity:
Sulfuric acid is harmful to aquatic life in very low concentrations. It may be dangerous if it enters water intakes. The aquatic toxicity for bluegill in fresh water was 24.5 ppm/24 hr, which was lethal.

Environmental Fate:
Not available.

Physical/Chemical:
Not available.

Other:
Not available.

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13. Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: None listed.
RCRA D-Series Chronic Toxicity Reference Levels: None listed.
RCRA F-Series: None listed.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

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16. Other Information

MSDS Creation Date: 2/01/1996 Revision #3 Date: 10/01/1997
The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

MSDS: Sodium Hydroxide

HAZARDOUS ACCORDING TO WORKSAFE CRITERIA
Supplied by: Chemical Co.
UN Number: 1823
Dangerous Goods Class: 8
Hazchem Code: 2X
Other Names: Caustic Soda
Soda Lye
White caustic
Properties: White deliquescent crystalline flakes or pearls

Health Hazard Information Acute Health Effects Swallowed:

Ingestion of the substance causes severe burns of the mouth and the oesophagus, nausea, vomiting and edema of the pharynx. In the worst cases perforation of the gastrointestinal tract and heart failure may occur.
Eyes: Contact of this substance with the eyes may cause severe lesions and possible loss of sight.
Skin: Skin contact with this substance causes severe burns and necrosis.
Inhaled: Inhalation of dusts may cause pulmonary congestion with subsequent compromising of respiratory functionality followed by loss of consciousness. Extremely irritative to respiratory tract (including mucous membranes, throat and lungs). Slightly toxic.

Chronic Health Effects

Prolonged and reiterated inhalations of the dusts may cause chronic disturbance of the respiratory routes. May cause dermatitis.

First Aid Swallowed:

Contact a Doctor or the Poisons Information Centre immediately. Give patient 1 - 3 cups of water. DO NOT induce vomiting. Immediately transport to a hospital or doctor.
Eyes: Flood eyes with clean water for 15 minutes - retract eyelids often. Immediately transport to a hospital or doctor **Skin:** Remove all contaminated clothing including footwear. Wash affected areas thoroughly with mild soap and water. Seek medical advice.
Inhaled: Remove from contaminated area immediately; avoid becoming a casualty. If NOT breathing apply artificial resuscitation. Experienced person may administer oxygen if breathing is difficult. Immediately transport to a hospital or doctor.

Safe Handling Information PPE:

Goggles, face screen, rubber or PVC gloves. Acid-proof overalls for operations in which there is a risk of splashes. Avoid contact with skin and eyes. Do not eat, drink or smoke in storage areas or during handling. Wash hands and face thoroughly after handling and before work breaks, eating, drinking, smoking and using toilet facilities.
Storage and Transport: Transport or store in a cool, dry place. Transport or store away from strong acids. The drums must be stored in suitable storage rooms equipped with impermeable floors, eye wash fountains and water inlets for rinsing the floor in case of spills.

Spills and Disposal:

Spills
Clean-up personnel should wear full protective clothing. Prevent product access to rivers and canals. Absorb with sand or soil, scoop up and place in suitable containers for later treatment/disposal.
Disposal
Use very dilute acid for neutralisation. Dispose of in accordance with Local, State and Federal regulations at an approved waste disposal facility. Neutralise aqueous solutions by diluting with very diluted hydrochloric acid.

Drain effluent with plenty of water, keeping pH under control. Beware of heat and splashes caused by water reactions (dissolution heat) or neutralisation.

Fire/Explosion Hazard: Fire/Explosion

Generally all the reactions with acids and halogenated substances are strongly exothermic. It forms explosive products (Chloroacetylenic derivatives) by reacting with Trichloroethylene at warm temperatures. It can cause the decomposition of maleic anhydride at explosive speed. It causes violent polymerisation of acrolein and acrilonitrile. It reacts exothermically with alcohol and chloroform mixtures. Incompatible with strong oxidising agents and strong acids, organic materials, aluminum, tin, zinc and nitro compounds. Absorbs CO_2 from air. Decomposition products: nature of decomposition products not known. Material itself is not flammable or explosive but reactions with metals can generate hydrogen gas, which is flammable in air (between 4% and 75% volume). May start fires in contact with fuels.

Extinguishing Media

Evacuate area - move upwind of fire. Summon Fire Brigade immediately, DIAL 000.

DO NOT USE WATER. Fire-fighters should wear full protective clothing including self-contained breathing apparatus.

Fire Fighting: Keep containers cool, Water spray/fog, Foam-alcohol type

MSDS: METHANOL

HAZARDOUS ACCORDING TO WORKSAFE CRITERIA

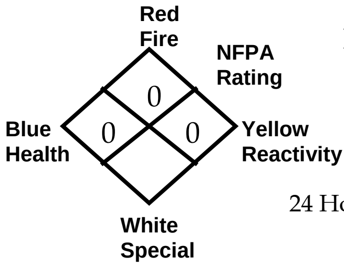
Supplied by Chemical Co. **Date:** 7/1/98 UN Number: 1230 Dangerous Goods Class: 3 3(6.1) Hazchem Code: 2WE Poisons Schedule S6
Other Names Methyl alcohol
Properties Liquid. Mixes with water.

Health Hazard Information Acute Health Effects:
Irritating to eyes.
Vapors may cause dizziness or suffocation.
Ingestion may produce health damage.
Chronic Health Effects: Cumulative effects may result following exposure (limited evidence).

First Aid Swallowed: Contact a Doctor or Poisons Centre. If more than 15 mins from a Doctor, induce vomiting (if conscious). Eyes: Wash with running water (for 15 mins). Seek medical attention. Skin: Remove contaminated clothing. Wash with water and soap. Inhaled: Fresh air. Rest and keep warm. If breathing shallow, give oxygen. Seek medical attention.

Safe Handling Information PPE:
Gloves, rubber or plastic
Goggles or face-shield
Laboratory coat, plastic apron if large quantities are handled
Fume cupboard
Respirator as required when vapors/aerosols generated.
Storage and Transport:
Keep container in a well ventilated place.
Keep away from sources of ignition.
Avoid heating. No smoking.
Store in a cool, dry protected area.
Incompatible with acid halides, alkaline earth metals, oxidising agents.
Spills and Disposal:
Turn off all sources of flame.
Inform others to keep a safe distance.
Consider evacuation if it is a major spill.
Prevent from entering drains.
Contain spillage by any means.
Mop up with plenty of water.
Control vapor with water spray/fog.
Absorb with dry agent.
Fire/Explosion Hazard: Highly flammable. Vapor/air mixture explosive. Fire Fighting:
Keep containers cool.
Water spray/fog. Full protective apparatus and contain.

Warning Signs F = Flammable; T=Toxic



Alconox ®

MATERIAL SAFETY DATA SHEET

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

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

I. IDENTIFICATION

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

II. HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

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

III. PHYSICAL/CHEMICAL CHARACTERISTICS

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

IV. FIRE AND EXPLOSION DATA

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

V. REACTIVITY DATA

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

VI. HEALTH HAZARD DATA

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

VII. PRECAUTIONS FOR SAFE HANDLING AND USE

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

VIII. CONTROL MEASURES

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

Liqui-nox® Material Safety Data Sheet

Alconox, Inc.
30 Glenn Street, Suite 309
White Plains, NY 10603
24 Hour Emergency Number - Chem-Tel (800) 255-3924

I. Identification

Product Name (shown on label): LIQUI-NOX

CAS Registry Number: Not Applicable

Effective Date: January 1, 2001

Chemical Family: Anionic Liquid Detergent

Mfr. Catalog #s for Sizes: 1232, 1201, 1215, 1255

II. Hazardous Ingredients/Identity Information

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

National Fire Protection
Association 704 Labeling:

NJTSRN: 1200

III. Physical/Chemical Characteristics

Boiling Point (F): 214°F
Vapor Pressure (mm Hg): No Data
Vapor Density (AIR=1): No Data
Specific Gravity (Water=1): 1.075
Evaporation Rate (Butyl Acetate=1): Slower
Melting Point: No Data
Solubility in Water: Completely soluble in all proportions
Appearance: Yellow liquid, nearly odorless
pH: 8.5 (1%)

IV. Fire and Explosion Data

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

V. Reactivity Data

Stability: Stable
Hazardous Polymerization: Will not occur.
Incompatibility (Materials to Avoid): Oxidizing agents.
Hazardous Decomposition or Byproducts: May release SO_2 on burning.

VI. Health Hazard Data

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

VII. Precautions for Safe Handling and Use

Steps to be Taken if Material is Released or Spilled: Material foams profusely. For small spills recover as much as possible with absorbent material and flush remainder to sewer. Material is biodegradable.

Waste Disposal Method: Small quantities may be disposed of in sewer. Large quantities should be disposed of in accordance with local ordnances for detergent products.

Precautions to be Taken in Storing and Handling: No special precautions in storing. Use protective equipment when handling undiluted material.

Other Precautions: No special requirements other than the good industrial hygiene and safety practices employed with any industrial chemical.

VII. Control Measures

Respiratory Protection (Specify Type): None Required
Ventilation: Local Exhaust-Normal
Special-Not Required
Mechanical-Not Required
Other-Not Required
Protective Gloves: Impervious gloves are recommended.
Eye Protection: Goggles and/or splash shields are recommended.
Other Protective Clothing or Equipment: Not required
Work/Hygienic Practices: No special practices required.

Project Specific Forms and Permits
Contaminant Fact Sheets

Arsenic Fact Sheet

Uses and Occurrences

The manufacture and transportation of arsenic compounds; use in the manufacture of herbicide, pesticide, fungicides, and defoliants; use in the manufacture and handling of calcium arsenate; use in the manufacture of electrical semiconductors, diodes, and solar batteries; as an additive for food and drinking water for animals; use as a preharvest desiccant, sugarcane ripener, soil sterilant, or for timber thinning; use as a bronzing or decolorizing addition in glass manufacturing; use in the production of opal glass and enamels; use as an addition to alloys to increase hardening and heat resistance; during smelting of ores; during the cleanup of soil contaminated with arsenic; military applications; and general handling, storage, and use of arsenic.

Physical Characteristics

Appearance:	Gray metal or white powder
Odor:	Garlic-like when heated
Flammable:	None
Flash Point:	None
Flammable Range:	None
Specific gravity:	5.73 for arsenic metal, 2.16 for arsenic trioxide
Stability:	Stable
Incompatibilities:	Heat, hydrogen gas, and oxidizing agents
Melting Point:	Sublimes at 613°C; -8.5°C for arsenic trioxide
Boiling Point:	Sublimes at 613°C; 130°C for arsenic trioxide

Signs and Symptoms of Exposure

Short term (Acute):	Nausea, vomiting, diarrhea, weakness, loss of appetite, cough, chest pain, giddiness, headache, and breathing difficulty.
Long term (Chronic):	Numbness and weakness in the legs and feet, skin and eye irritation, hyperpigmentation, thickening of palms and soles (hyperkeratosis), contact dermatitis, skin sensitization, warts, ulceration and perforation of the nasal septum

Modes of Exposure

Inhalation:	Dusts and Vapors
Absorption:	Liquid
Ingestion:	Dusts and Liquid

Exposure Limits

Action level	5 $\mu g/m^3$
PEL	10 $\mu g/m^3$
STEL	None
TLV	10 $\mu g/m^3$

Exposure Level vs. Regulatory Requirements

EXPOSURE LEVEL (EL)	REGULATORY REQUIREMENTS
EL < AL	Maintain exposure as low as reasonably achievable
AL > EL, EL < PEL	Implement portions of the OSHA Arsenic standard and Training
EL > PEL	Implement all portions of the OSHA Arsenic Standard including training, medical surveillance, engineering controls, establishment of work areas, etc.

PPE

Eye:	Safety Glasses; contact lenses should **not** be worn
Skin:	Chemical protective gloves and body protection
Respiratory:	Air purifying respirators and supplied air respirators, depending on the exposure

First Aid

Inhalation:	Move to fresh air; seek medical attention promptly
Skin:	Quick drenching with water; wash skin with soap and water; seek medical attention promptly
Eyes	Flush with water for 15 minutes, lifting the lower and upper lids occasionally; seek medical attention promptly
Ingestion:	Seek medical attention promptly

Cadmium Fact Sheet

Uses and Occurrences

Coatings on metals; nickel-cadmium storage batteries; power transmission wire; pigments in ceramic glazes, enamels, and fungicides; corrosion-resistant coatings on marine, aircraft, and motor vehicles; manufacture of nuclear reactor rods; and welding electrodes and solder.

Physical Characteristics

Appearance:	Soft, blue-white, malleable, lustrous metal or grayish-white powder; some compounds may appear as a brown, yellow, or red powdery substance.	
Odor:	None.	
Flammable:	Noncombustible.	
	Flash Point:	Not Applicable.
	Flammable Range:	Not Applicable.
	Specific gravity:	8.64 (metal dust).
	Stability:	Very stable.
Incompatibilities:	Nitric acid, boiling concentrated hydrochloric and sulfuric acids; contact of cadmium metal dust with strong oxidizers or with elemental sulfur, selenium, and tellurium may cause fires and explosion.	
	Melting Point:	321°C (metal dust).

Signs and Symptoms of Exposure

Short Term (Acute):	Dust and Fume: Irritation of nose and throat; inhalation may cause a delayed onset of cough, chest pain, sweating, chills, shortness of breath, and weakness. Death may occur. Dust: Ingestion may cause nausea, vomiting, diarrhea, and abdominal cramps.
Long Term (Chronic):	Dust and Fume: Repeated or prolonged exposure may cause loss of sense of smell, ulceration of the nose, shortness of breath (emphysema), kidney damage, and mild anemia. Exposure to cadmium has been reported to cause an increase incidence of cancer of the prostate in men.

Modes of Exposure

Inhalation:	Dusts and fumes.
Absorption:	None.
Ingestion:	Dusts and solids.

Exposure Limits

Action level	2.5 $\mu g/m^3$.
PEL	5.0 $\mu g/m^3$.
STEL	None.
PEL-C	None.
TLV	10.0 $\mu g/m^3$; 2.0 $\mu g/m^3$ (respirable fraction).

Exposure Level vs. Regulatory Requirements

EXPOSURE LEVEL (EL)	REGULATORY REQUIREMENTS
EL < AL	Maintain exposure as low as reasonable achievable
AL > EL, EL < PEL	Implement portions of the OSHA Cadmium standard and Training
EL > PEL	Implement all portions of the OSHA Cadmium Standard including training, medical surveillance, engineering controls, establishment of work areas, etc.

PPE

Eye: Splash proof or dust resistant goggles; face shield.

Skin: Protective coveralls, gloves, and footwear.

Respiratory: Air purifying respirators and supplied air respirators, depending on the exposure.

First Aid

Inhalation: Move to fresh air; seek medical attention immediately.

Skin: Remove clothing and shoes; wash with soap or mild detergent and large amounts of water.

Eyes Flush with water immediately, lifting the upper and lower eyelids; seek medical attention immediately.

Ingestion: Under no circumstances should therapeutic chelation be administered; seek medical attention immediately.

Lead Fact Sheet

Uses and Occurrences

Lead can be found in the following: construction materials for tank linings and piping; component of lead-acid storage batteries; lead solder; plastics; steel; and pigments for paints. Lead can also be found in waste rock associated with mining activities, wood debris or stock used for electrical co-generation activities, and soil and waste associated with manufacturing activities. Elevated levels of naturally occurring lead may also be found in the soil in certain parts of this country.

Physical Characteristics

Appearance:	Bluish-white, slivery, gray metal. Very soft and easily malleable
Odor:	None
Flammable:	Noncombustible
Flash Point:	Not Applicable
Flammable Range:	Not Applicable
Specific gravity:	11.35
Stability:	very stable
Incompatibilities:	hot nitric acid, boiling concentrated hydrochloric and sulfuric acids
Melting Point:	327^{o}C

Signs and Symptoms of Exposure

Skin and Eye: Irritation

Ingestion and Inhalation (Acute Overexposure): Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise that develops quickly to seizures, coma, and death from cardio-respiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects that take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease that arise after periods of exposure as short as days or as long as several years.

Ingestion and Inhalation (Chronic Overexposure): Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic, there may be severe abdominal pain.

Modes of Exposure

Inhalation:	Dusts and fumes
Skin Absorption:	None
Ingestion:	Dusts and solids

Exposure Limits

Action level	0.03 mg/m^3
PEL	0.05 mg/m^3
STEL	None
PEL-C	None
TLV	0.05 mg/m^3

Exposure Level vs. Regulatory Requirements

EXPOSURE LEVEL (EL)	REGULATORY REQUIREMENTS
EL less than Action Level (AL)	Maintain exposure as low as reasonably achievable
EL greater than AL and less than PEL	Implement portions of the OSHA Lead Standard (i.e., initial medical monitoring) and Training
EL greater than PEL	Implement all portions of the OSHA Lead Standard including training, medical surveillance, engineering controls, establishment of work areas, etc.

PPE

Eye:	Safety Glasses
Skin:	Coveralls or disposable coveralls to keep lead off clothing and to prevent the spread of lead contamination.
Respiratory:	Air purifying respirators and supplied air respirators, depending on the exposure.

First Aid

Inhalation:	Move to fresh air, contact a physician
Skin:	Wash with water
Eyes	Flush with water
Ingestion:	Contact a physician

Vinyl Chloride Fact Sheet

Uses and Occurrences—Polyvinyl chloride and copolymers, organic synthesis, adhesives for plastics, and as a precursor in the production of the common plastic polyvinyl chloride (PVC). It is often a degradation product of a number of chlorinated compounds, including tetra-chloroethylene and trichloroethylene, at hazardous waste sites in soils and groundwater. It can also be a breakdown product of the combustion of PVC or other chlorinated compounds.

Physical Characteristics

Appearance: Colorless gas

Odor: Sweet; Odor threshold: 3,000 ppm

Flammable: Class IA Flammable Liquid Gas; NFPA Rating: 4

Flash Point: -78 ^{o}C

Flammable Limits: 3.6% - 33.0% (% by volume in air)

Molecular Weight: 62.5

Vapor Pressure: 2530 mm Hg (at 20 ^{o}C)

Incompatibilities: Atmospheric oxygen and strong oxidizers may react to produce peroxide, which can initiate a violent polymerization reaction

Melting Point: -155.7 ^{o}C

Boiling Point: -14 ^{o}C

Signs and Symptoms of Exposure

Short Term (Acute): Dizziness, light-headedness, nausea, dullness of visual and auditory responses, drowsiness, and unconsciousness. Irritation of skin and eyes. Skin contact with liquid can cause frostbite.

Long Term (Chronic): Thickening of skin, contact and allergic dermatitis, fatigue, coughing and sneezing, abdominal pain, gastrointestinal bleeding, nausea, vomiting, indigestion, diarrhea, jaundice, weight loss, anorexia, and cold and tingling sensations of the hands and feet, carcinogen.

Modes of Exposure

Inhalation: Vapor

Absorption: Liquid causes frostbite

Ingestion: Ingestion of contaminated water

Exposure Limits

Action level	0.5 ppm
PEL	1 ppm
STEL	None
PEL-C	5 ppm (< 15 minutes)
TLV	1 ppm

Exposure Level vs. Regulatory Requirements

EXPOSURE LEVEL (EL)	REGULATORY REQUIREMENTS
EL < AL	Maintain exposure as low as reasonably achievable
EL > AL, EL < PEL	Implement portions of the OSHA Vinyl chloride standard and Training
EL > PEL	Implement all portions of the OSHA Vinyl Chloride Standard including training, medical surveillance, engineering controls, establishment of work areas, etc.

PPE

Eye:	Safety Glasses
Skin:	Tyvek or other full-body clothing, depending on the exposure.
Respiratory:	Air purifying respirators and supplied air respirators, depending on the exposure.

First Aid

Inhalation:	Move to fresh air, begin rescue breathing if breathing has stopped and CPR if heart action has stopped, transfer promptly to a medical facility.
Skin:	Immerse affected part in warm water. Seek medical attention.
Eyes	Flush with large amounts of water for at least 15 minutes.
Ingestion:	Contact a physician.

CH2MHILL

Health and Safety Plan

Attachment 10

Project Activity Self-Assessment Checklists

H&S Self-Assessment Checklist - DRILLING

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to hazards associated with drilling operations (complete Sections 1 and 3), and/or 2) CH2M HILL oversight of a drilling subcontractor is required (complete entire checklist).

SSC may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Completed checklists shall be sent to the health and safety manager for review.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ____________________ Title: __________________ Date: __________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling H&S requirements
Subcontractors Name: ______________________________________

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-204.

SECTION 1	Yes	No	N/A	N/O
PERSONNEL SAFE WORK PRACTICES (3.1)				
1. Only authorized personnel operating drill rig	☐	☐	☐	☐
2. Personnel cleared during rig startup	☐	☐	☐	☐
3. Personnel clear of rotating parts	☐	☐	☐	☐
4. Personnel not positioned under hoisted loads	☐	☐	☐	☐
5. Loose clothing and jewelry removed	☐	☐	☐	☐
6. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐
7. Smoking is prohibited around drilling operation	☐	☐	☐	☐
8. Personnel wearing appropriate PPE, per HSP/FSI	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (3.2.1)				
9. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
10. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
DRILL RIG PLACEMENT (3.2.2)				
11. Location of underground utilities identified	☐	☐	☐	☐
12. Safe clearance distance maintained from overhead powerlines	☐	☐	☐	☐
13. Drilling pad established, when necessary	☐	☐	☐	☐
14. Drill rig leveled and stabilized	☐	☐	☐	☐
DRILL RIG TRAVEL (3.2.3)				
15. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
16. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
17. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
18. Safe clearance distance maintained while traveling under overhead powerlines	☐	☐	☐	☐
19. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (3.2.4)				
20. Kill switch clearly identified and operational	☐	☐	☐	☐
21. All machine guards are in place	☐	☐	☐	☐
22. Rig ropes not wrapped around body parts	☐	☐	☐	☐
23. Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
24. Drill operation stopped during inclement weather	☐	☐	☐	☐
25. Air monitoring conducted per HSP/FSI for hazardous atmospheres	☐	☐	☐	☐
26. Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG MAINTENANCE (3.2.5)				
27. Defective components repaired immediately	☐	☐	☐	☐
28. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
29. Cathead in clean, sound condition	☐	☐	☐	☐
30. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
31. Fall protection used for fall exposures of 6 feet or greater	☐	☐	☐	☐
32. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
33. Good housekeeping maintained on and around rig	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (3.2.6)				
34. Waste disposed of according to HSP	☐	☐	☐	☐
35. Appropriate decontamination procedures being followed, per HSP	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Appendix B
Applicable SOPs

Standard Operating Procedure
Locating and Clearing Utilities Lines

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide a general guideline for Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to procure utility subcontracting services that meet the needs of individual activities and projects.

This SOP identifies the different utility locating scenarios Activity Managers may face at their activities and spells out the general approaches that should be followed under each scenario to maximize our ability to avoid hitting underground utilities and to minimize liabilities and health and safety risks to CH2M HILL and its subcontractors.
This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

The scope of CH2M HILL's utility locating work at each Activity will depend greatly on:

- The utility locating services provided by the Activity. The public works center (PWC) or similar organization at some Activities will provide some degree of utility locating services ranging from comprehensive geophysical surveying to simply providing maps. Most of these services are provided in the form of dig permits which are required before you can dig or drill.
- The degree of faith you can put on the quality/thoroughness of the utility-locating and mapping services provided by the Activity. (I.e.: Does the PWC simply rely on their maps to mark utilities or do they verify mapped locations with field geophysics or other surveys?)

Generally we will find ourselves in one of three scenarios at an Activity:

Scenario 1

The Activity provides very thorough utility locating services for our work and takes on the liability of repairs for damages that may occur if there services are inaccurate. An example of this is Patuxent River NAS.

Scenario 2

The Activity does not get involved in any utility locating processes aside from providing the most recent maps. Examples of this are Indian Head and Carderock.

Scenario 3

An intermediate situation where the Activity provides utility locating services but they (and/or we) do not have a very high level of confidence in their ability to identify everything (e.g.: they may want us to assume liability, they do not field verify and mark utilities, we notice mistakes in their work, etc.). An example of this is Washington Navy Yard.

The general procedures to be followed in each of these three situations are outlined in **Part IV. Procedures and Guidelines** of this SOP. Other qualifying factors that the PM needs to consider in determining what type of effort and budget will be required for utility locating are:

- What are the types and density of underground utilities in the area of the proposed work? (Are you drilling in an open field or a city street?). Utility locations would not be necessary in completely undeveloped areas such as woods. Although we need to be convinced (from historic air photos and site records) that these areas did not have historic uses that may have involved underground utilities.
- What is the history of the area? (A recently developed area of an Activity is likely to have more accurate mapping than an area that has been active for a long time.)
- How fixed are your drilling/digging points? (If you know exactly where you are going to be drilling ahead of time you can simply clear relatively small areas. If you will be revising locations in the field as an investigation progresses you will need to clearly mark larger areas or keep a utility location service on call (or at the site) to clear each location as it is identified.)

III. Services and Equipment

This section identifies provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should look for in the work done by PWC and what we should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment A provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment B provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being used by a subcontractor or PWC is adequate.

IV. Procedures and Guidelines

This section presents general procedures for each of the three scenarios identified above in Section II. This assumes that the Activity Manager has already met with PWC, established a contact and evaluated their procedures for identifying underground utilities.

Scenario 1 - Adequate Services are Provided by Activity PWC

1. Identify PWC's procedures, information needs, and time requirements for obtaining dig permits (or equivalent).

2. Obtain utility maps from the Activity and meet with PWC to identify what types of utilities are underground vs. aboveground at the Activity and in the areas you are working at in particular. Get a feeling for the accuracy of these maps by talking with PWC (ask: how often are they updated, how are they updated). Field proof the maps in the area of the proposed investigation to see if manholes, fire hydrants, meters, valves are where they are shown on the maps.

3. Provide PWC with information needed for obtaining dig permit.

4. Identify if there are any "utility-owned" utilities at the Activity that we should rely on Miss Utility (or similar) to mark. PWC would be the first contact for this, and then Miss Utility (or similar).

5. Perform a field check prior to drilling/digging to see if field utility markings coincide with locations on utility maps. If utilities shown on maps are not shown in field markings, notify PWC or Miss Utility.

Scenario 2 – Activity PWC Provides Little or No Services

1. Obtain utility maps from the Activity and meet with PWC to identify what types of utilities are underground vs. aboveground at the Activity and in the areas you are working at in particular. Get a feeling for the accuracy of these maps by talking with PWC (ask: how often are they updated, how are they updated). Field proof the maps in the area of the proposed investigation to see if manholes, fire hydrants, meters, valves are where they are shown on the maps. Determine if there are any unmapped utilities or public utilities on the base.

2. Identify if there are any "utility-owned" utilities at the Activity that we should rely on Miss Utility (or similar) to mark. PWC would be the first contact for this, and then Miss Utility (or similar).

3. If you know the locations of the borings beforehand and plan to use a locator subcontractor to clear the immediate vicinity of each proposed boring only, follow steps 3a through 3c then go to Step 5. If you need to clear or mark a large area (all or part of a site), skip Steps 3a through 3c and go to step 4.

3a. All known subsurface boring locations should be positioned on a map to avoid known underground utility lines at the site (based on the most accurate maps available). This positioning is accomplished by using figures that show all utilities. These maps should be used as working drawings and kept in the field for use during all intrusive activities.

3b. Field locate the proposed boring locations and mark and label them on the ground (e.g. with stakes, paint, or similar markers). In a well developed area with good maps, field locating can be done by measuring from surface features that appear on the maps (building corners, manholes, etc). Distances from at least two features should be recorded on the map to insure that boring locations can be relocated if stakes or other location markers are tampered with. In areas where there are few surface features to reference and measure from, and where we have maps/GIS with good horizontal controls, proposed boring locations should be identified and field located using horizontal coordinates. In this case, a GPS unit will be required to stake boring locations in the field.

3c. When you are in the field marking boring locations check to see if there is evidence that any nearby utilities (within 50 feet of the proposed boring) are where they are shown on the maps. Look for manholes to check storm sewer and sanitary sewer lines, valve boxes and fire hydrants to check water lines, lamp posts or lighted signs to check electrical lines. For utilities such as gas, telecommunications, and many electrical service lines there may be no evidence on the surface. In this case, identify horizontal coordinates of at least two points along the utility line on the map. (this assumes we have the utilities shown accurately on maps with coordinates that can be easily read - i.e.: GIS) and mark them in the field. This can serve as a check for the utility locator's work.

4. If you need to clear or mark a large area (all or part of a site), delineate the area to be cleared/marked on a site map that includes all known utilities. If the area is not easily distinguished in the field, it may be necessary to stake out the extent of the proposed clearance work with stakes, paint, or other suitable markings. Identify all known types of utilities that may be present in the area.

5. Procure a utility locating subcontractor using the guidelines provided in Attachments A. Provide the subcontractor with copies of the utility maps as part of the procurement package and clearly identify the types of underground utilities and areas that they will be required to identify/mark.

6. Using an appropriate geophysical method selected for the types of utilities or subsurface structures expected, have the subcontractor conduct a geophysical survey within an appropriate area (See steps 3 and 4) and using an appropriate traverse around and over the proposed subsurface boring location(s) to locate any underground utility lines or structures. If clearing of individual drilling/digging locations is desired, it is suggested that the geophysical survey focus on marking all mapped utilities within a 30 foot radius of each proposed location (by tracing lines) and doing a sweep for potentially undocumented utilities within a 10 foot radius of each proposed location. If all potential drilling/digging locations are not known up front, (such as with a typical Geoprobe investigation) the PM can either have the subcontractor sweep for and mark utilities

throughout the entire area that may be addressed by the investigation up front or, keep the subcontractor on call to clear/sweep individual drilling locations as they are identified. Costs will factor in to this decision.

In areas that have only recently been developed, and complete utility as-built maps are available, it may be adequate to simply do a geophysical trace and mark the mapped utilities in the field as opposed to sweeping the entire site of each specific location.

The subcontractor should be required to use the industry standard color codes for marking utilities. See Attachment C.

7. Make note of the apparent difference between the underground utility lines and structures staked by the land survey and the corresponding underground utility lines and structures located by the geophysical survey.
8. Adjust proposed sample locations in order to avoid all subsurface utilities detected during the survey. Conduct an additional confirmatory geophysical survey at the new proposed sample location, if necessary.
9. Obtain copies of all geophysical data recorded by the geophysical surveying subcontractor, along with the subcontractor's report, if necessary. At a minimum the subcontractor should be required to mark his findings on the ground in the field with paint and provide a markup of the utility map with notes identifying what was found and where, with ties to site features.
10. The Project Manager and the Activity Manager should decide how the geophysical data will be used, in addition to its use in adjusting the proposed subsurface boring locations in the field. Geophysical data may also be recorded by professional land survey and uploaded into the Activity's GIS. You may also request the subcontractor to survey in the located utilities and create a map for future use by CH2M HILL. However, Project Managers and Activity Managers should be aware of the inherent limitations of precision and accuracy of geophysical data. In particular, the differences in the precision and accuracy of geophysical data and professional land survey data must be considered before the best use of the geophysical data is determined. **If you are being scoped to make or correct utility maps that will be provided to the navy, special precautions need to be taken to avoid the misuse of the maps and avoid exposing CH2M HILL to unreasonable liability. Requests for this type of work must be reviewed by CH2M HILL's Navy CLEAN Project Delivery Manager and Contracts Administrator.**

Scenario 3 - Activity PWC Provides Some Services, but Quality is Questionable

Under this scenario we should follow the same procedures as we would for Scenario 2, particularly if the Activity does not accept liability for mismarked utilities. Less extensive procedures on our part may be acceptable in portions of the facility where we are convinced that PWCs records (mapping) or knowledge is likely to be good.

IV. Attachments

A - Services Available for Identifying and Marking Underground Utilities
B – Equipment Used for Identifying Underground Utilities
C – Utility Marking Color Codes

Attachment A - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by us)

Each are discussed below.

Navy Public Works Center

A Public Works Center (PWC) or Public Works Department (PWD) is usually present at each Activity. The PWC is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWC has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWC is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWC in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWC, the PWC may not have a written permit process in place, or the PWC may not take responsibility for utility locating and mark-outs. In these cases, the PWC should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWC should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWC, either directly or through the LANTDIV/EFACHES NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the “One Call” center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility “One Call” center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

A national listing of the “One Call” service centers for each state is presented on the web at http://www.underspace.com/refs/ocdir.htm. For the Mid-Atlantic region, the following “One Call” service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	www.onisi.com/onisi/msutil/default.htm	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.greensboro.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies. The level of geophysical surveying support needed for each project will vary depending on which of the three situations described in SOP we find ourselves in:

1. The Activity provides very thorough utility locating services for our work and takes on the liability of repairs for damages (Scenario 1 as described in the SOP).

   In this situation, CH2M HILL will normally not need to subcontract additional geophysical surveying support for utility-locating. However, the project manager and field personnel should work closely PWC to position proposed subsurface boring locations clear of all known active and inactive utilities.

2. The Activity does not get involved in any utility locating processes aside from providing the most recent maps. An example of this is NAB Little Creek (Scenario 2 as described in the SOP).

   In this situation, CH2M HILL will require geophysical surveying support for utility-locating and subsurface sample location clearance. The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

3. The Activity provides utility locating services but they (and/or we) do not have a very high level of confidence in their ability to identify everything (e.g.: they want us to assume liability, they do not field-verify and mark utilities, we notice mistakes in their work, etc.) (Scenario 3 in the SOP).

   In this situation, CH2M HILL may require geophysical surveying support for utility-locating, depending on the nature of the site. At sites where no utilities are expected to exist and the utility location effort is simple, this level of support from the Activity may be acceptable. However, it will be important for the project manager to be familiar with the exact services that were provided by the Activity. At more congested sites where several utilities are known to exist, the project manager may decide to procure the services of a geophysical surveying subcontractor to supplement the Activity's efforts. In this case, the liability issues for damage to subsurface utilities should be clearly defined. For projects where geophysical surveying services are being procured for field activities other than utility-locating, it may be relatively inexpensive and efficient to have the geophysical surveying subcontractor to include the necessary utility-locating effort in the scope of work for the project to supplement the Activity's effort.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment[1]					Other Services[2]		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

[1]Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2]Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.

B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.

C. Concrete/asphalt coring and pavement/surface restoration.

Attachment B – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being used by a subcontractor or PWC is adequate.

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most newer lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth’s magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth’s background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment C – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

Standard Operating Procedure
Preparing Field Log Books

Preparing Field Log Books

I. Purpose

To provide general guidelines for entering field data into log books during site investigation and remediation field activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement of much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, orange-covered logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.
2. On the inside cover of the log book the following information should be included:
    - Company name and address
    - Log-holders name if log book was assigned specifically to that person

- Activity or location
- Project name
- Project manager's name
- Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

5. Daily entries will be made chronologically.

6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

7. Each page of the log book will have a the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Talks: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified, and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data

obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier
    - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type
    - Sample date and time
    - Sample identifier
    - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
    - Number and type of sample containers collected
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
    - Parameters to be analyzed for, if appropriate
    - Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

Standard Operating Procedure
Volatiles Monitoring by OVM

STANDARD OPERATING PROCEDURE

Volatiles Monitoring by OVM

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for the calibration and use of an OVM Organic Vapor Monitor. This is a broad guideline for field use of an OVM; for specific instruction, refer to the operators manual.

II. Equipment and Materials

- Operations manual
- An OVM hand readout unit and side pack assembly
- 100 ppm isobutylene as calibration gas
- T-type feeder tube with 1.5 liter/min. regulator

III. Procedures and Guidelines

ONLY PROPERLY TRAINED PERSONNEL SHOULD USE THIS INSTRUMENT. FOR SPECIFIC INSTRUCTIONS, SEE OPERATIONS MANUAL.

OVM, Organic Vapor Monitor

1. Introduction

   The OVM Organic Vapor Monitor is designed to detect organic materials in air. It uses a photo-ionization detector (PID) as its detection principle. This detector allows the monitor to respond to a wide variety of organic compounds.

2. Operational Checks

   - See basic operating instructions in operations manual.

3. Calibration

   - See basic operating instructions in operations manual.

IV. Key Checks and Preventive Maintenance

- Check battery.
- Zero and calibrate.
- Verify sensor probe is working.
- Recharge unit after use.

A complete preventive maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual. Some key issues are discussed below:

- A complete spare instrument should be available whenever field operations require volatiles monitoring.
- Spare parts should be on hand so minor repairs may be made in the field.
- Batteries should be charged daily.
- Occasionally allow the batteries to totally discharge before recharging to prevent battery memory from occurring.

Standard Operating Procedure
Explosives Usage and Munitions Response

CLICK HERE TO GET TO ATTACHMENTS

CH2MHILL

Explosives Usage and Munitions Response (MR) Standard of Practice HSE&Q-610

1.0 Applicability and Scope

1.1 Applicability

This Standard of Practice (SOP) applies to:

(1) CH2M HILL employees who enter areas known or suspected of having munitions,

(2) Areas where explosives are used for construction or demolition purposes, and

(3) Managers who may be responsible for oversight of a subcontractor's explosives usage, MR operations, or Controlled Detonation Chamber (CDC) operations.

Explosives usage or MR operations may be conducted on active, inactive, closed, transferring, or transferred ranges; former battlefields; disposal sites; munitions manufacturing and storage sites; and construction sites.

1.2 Scope

This SOP provides information regarding the spectrum of hazards and issues to be addressed during each phase of a project associated with operations involving the use of explosives. Hazardous situations addressed in this SOP include exposure to explosives used for construction or demolition work; munitions and explosives of concern (MEC), which include unexploded ordnance (UXO), discarded military munitions (DMM), and material that presents a potential explosive hazard (MPPEH); chemical warfare materiel (CWM), or munitions constituents (MC) contaminated soil and groundwater; munitions demilitarization operations; Controlled Detonation Chamber (CDC) operations; and operations to locate, identify, remove, and dispose of munitions.

CH2M HILL employees who enter areas where explosives may be encountered or used must take precautions to avoid these hazards and be aware of associated safe work practices.

As described in SOP HSE&Q-215, Contracts, Subcontracts, & HSE&Q Management Practices, responsibilities for health, safety, and environmental (HS&E) protection are expressly defined through subcontract terms and conditions. CH2M HILL's HS&E practices in the field are determined on the basis of these defined responsibilities. Consistent with HSE&Q-215, the subcontractor must determine how to operate safely, comply with applicable HS&E regulations and industry standards, and correct any deficiencies.

1.3 Regulatory Review

Projects involving the use of explosives are often complex (may require the acquisition, receipt, storage, and use of explosives to include insurance, permits/license, public safety, etc.) and have a myriad of regulatory requirements to ensure safety. A brief description of the major requirements follows:

U.S. Department of Defense (DOD) Ammunition and Explosives Safety Standards, DOD 6055.9-STD, establishes uniform safety standards that apply to ammunition and explosives, to associated personnel and property, and to unrelated personnel and property exposed to the potential damaging effects of an accident involving ammunition and explosives during their development, manufacturing, testing, transportation, handling, storage, maintenance, demilitarization, and disposal. Additional regulatory requirements are: Title 18 U. S. Code, 842, Safe Explosives Act, 27 CFR Part 555.1 Explosives, 29 CFR 1910.109 Explosives and Blasting Agents, National Fire Protection Association 495 Explosive Materials Code, 49 CFR Parts 100–199, Hazardous Materials Transportation.

The U.S. Environmental Protection Agency (EPA) regulates the disposal of military munitions, and of waste that contains military munitions, through the Military Munitions Rule (MMR) (62 Federal Register [Fed. Reg.] 6621, February 12, 1997; 40 Code of Federal Regulations [CFR] Part 260 et seq.) under authority of the Resource Conservation and Recovery Act (RCRA). The rule has two functions: (1) it identifies when conventional and chemical military munitions become a solid waste, and (2) it provides criteria for storing and transporting such waste, including a conditional exemption if the munitions are managed under DOD rules.

This SOP incorporates by reference the guidelines and requirements for MR operations that are published by the U.S. Army Corps of Engineers (USACE) Engineering Support Center, Huntsville, Alabama. These are generally accepted industry standards, similar to voluntary consensus standards published by such organizations as the National Fire Protection Association (NFPA) and the American National Standards Institute (ANSI).

2.0 Project Planning

2.1 Planning Requirements

Compliance with the applicable governing laws and regulations is the responsibility of the Project Manager. The Project Manager will contact the MR Operations Manager, or in his absence the MR Safety Officer or the Munitions Response Market Segment Director, prior to and post MR ORE approval and subsequent GO/NO GO decision for determination of applicable governing laws and regulations and to assist with planning and executing support for such activities as blasting operations, hazardous toxic radiological waste (HTRW) support, construction support, MR actions, handling of CWM or explosive-contaminated soils, and munitions demilitarization. The following types of support may be needed for MR operations:

- For on-site visits with known or suspected MEC, an Abbreviated Accident Prevention Plan (AAPP) (See **Attachment 1**) must be prepared. This AAPP is to be used only for non-intrusive site visits, and it must be approved by the MR Safety Officer, or in his absence either the MR Operations Manager or MR Market Segment Director, before the field visit starts. All team members must read and comply with the AAPP and attend the safety briefings. The UXO Safety Officer (UXOSO) shall ensure that the Safety Briefing Checklist and the Plan Acceptance forms are filled out before the site visit begins.

- On an HTRW site with known or suspected MEC, MEC support involves implementing anomaly avoidance techniques to avoid any potential surface MEC and any subsurface anomalies. A Site Safety & Health Plan (SSHP) must be prepared. This SSHP is to be used only for non-intrusive anomaly avoidance activities, and it must be approved by the MR Safety Officer, or in his absence the MR Operations Manager or the MR Market Segment Director prior to the start of fieldwork. All team members must read and comply with the SSHP and attend the safety briefings. The UXOSO shall ensure that the Safety Briefing Checklist and Plan Acceptance Form are filled out prior to the start of the site work.

- On a construction site with known or suspected MEC, support must be provided by qualified UXO personnel during construction activities. The level of MEC support required depends on the probability of encountering MEC, determined on a project-by-project basis. This will be identified during the MR ORE.

- MR actions in which the intent is to locate, identify, excavate, remove, and dispose of MEC may require a Senior UXO Supervisor, UXO Safety Officer, and UXO Quality Control Specialist, to oversee UXO Teams performing operations.

- On an MR site that has MC contamination of soil or groundwater, MEC support may include both anomaly avoidance techniques and MEC construction support for excavating and/or treating MC-contaminated soil and groundwater.

- On ordnance demilitarization projects, MEC support is required to identify, handle, disassemble, process, certify, transport, and treat or dispose of munitions components.

- On projects where explosives waste is transported or disposed of off range, the MR Operations Manager and the BG Environmental Compliance Coordinator (ECC) may assist in identifying the applicable regulations and permits required.

- On projects where munitions debris (MD), material presenting a potential explosive hazard (MPPEH), or inert ordnance is recovered and processed for disposal as scrap, the MR Operations Manager and the BG ECC may determine whether treatment and certification is required, along with any permitting requirements.

- For drilling activities at project sites suspected of MEC contamination, the UXO team shall conduct a reconnaissance and MEC avoidance to provide clear access routes to each site before drilling crews enter the area. The procedures listed in HSE&Q-204, *Drilling*, apply and shall be implemented.

- For excavation activities at project sites suspected of MEC contamination, the UXO team shall conduct a reconnaissance and MEC avoidance to provide clear access routes to each site before excavation crews enter the area. The procedures listed in HSE&Q-307, *Excavations*, apply and shall be implemented.

- Safety and quality control (QC) audits shall be included in developing cost estimates for any MR or explosives usage project that will last more then two weeks.

- On projects that include intrusive activities to investigate MEC or use of explosives (blasting), an Explosive Safety Submission (ESS), an Explosive Siting Plan (ESP), and an Explosive Management Plan (EMP) may be required. The MR Operations Manager, or in his absence the MR Safety Officer or MR Market Segment Director, shall assist in evaluating project requirements and coordinate with others as appropriate.

The MR Operations Manager, or in his absence the MR Quality Control Manager, shall verify subcontractor training, personnel qualifications, and current medical examinations prior to the start of field operations. Any identified shortfalls in qualifications should be reported to the MR Operations Manager or in his absence to the MR Safety Officer or the Market Segment Director for resolution.

2.2 Opportunity and Risk Evaluation (ORE)

Every project or task involving the usage of explosives or a Munitions Response (MR) requires completion of paragraph 17 of the ORE form in **Attachment 2**. The most current form and assistance in filling out the form can be obtained from the MR Safety Officer, MR Operations Manager, or MR Market Segment Director. This document is a living form and should be updated as a project is developed and executed or upon change of scope of work (SOW), identification of previously unknown hazards, etc. Final acceptance of the MR portion (paragraph 17) of the ORE is done by the MR Safety Officer.

2.3 Alcohol, Tobacco, Firearms, and Explosives (ATF&E) Background Investigation

The "Safe Explosives Act of 2002" requires the employer (CH2M HILL) to submit to ATF&E identifying information, fingerprints, and photographs for all "Responsible Persons" and "Possessors of Explosives."

All personnel designated as Responsible Persons or Possessors of Explosives involved in explosives usage and MR projects must provide a 2-inch by 2-inch color picture and an ATF Form 5400.28 filled out for submission by the ATF&E License Holder (contact MR Operations for assistance) who will forward them to ATF&E so that a background investigation can be conducted to establish eligibility to work with explosives.

Under the "Safe Explosives Act," a "Responsible Person" and a "Possessor of Explosives" are defined as follows:

Responsible Person: An individual who has the power to direct the management and policies of the applicant pertaining to explosive materials. Generally the term includes partners, sole proprietors, project managers, site managers, corporate officers and directors, and majority shareholders.

Possessor of Explosives: An individual who has actual physical possession or constructive possession, which means the person has dominion or control over explosives. For example, persons who are physically handling explosive materials would be considered to be possessors of explosives. This would include employees who handle explosive materials in order to ship, transport, or sell them; and employees, such as blasters, who actually use explosive materials. Other examples of possessors include a supervisor at a construction site who keeps keys for magazines in which explosives are stored, or who directs the use of explosive materials by other employees; and an employee of a licensee or permittee transporting explosive materials from a licensed distributor to a purchaser.

Assistance in filling out required forms can be obtained from the MR Operations Manager, or in his absence the MR Safety Officer or the MR Market Segment Director. Submission of completed forms to ATF&E is the responsibility of the ATF&E License Holder. Upon submission of the required forms "responsible persons and possessors of explosives" may execute their duties pending completion of the background investigation.

ATF&E will notify employers in writing of the result of each background check and will supply the "responsible person" or "possessor of explosives" with a "Letter of Clearance" where appropriate. The custodian of the ATF&E records will request a copy of this certificate from the employee.

2.4 Training Requirements

2.4.1 MR Projects

CH2M HILL employees and subcontractors who work on projects that involve MR must complete the following training:

- A one-time, 40-hour Hazardous Waste Operations and Emergency Response course, and a minimum of three days' actual field experience under the direct supervision of a trained supervisor as specified in 29 CFR §1910.120(e).
- An annual 8-hour hazardous waste refresher course, as specified in 29 CFR §1910.120(e) (8).
- Hazardous waste supervisory training (required for managers and supervisors only) as specified in 29 CFR §1910.120(e)(4).

All UXO technicians must be graduates of one of the following:

- U.S. Army Bomb Disposal School, Aberdeen Proving Ground, MD;
- U.S. Naval Explosive Ordnance Disposal (EOD) School, Indian Head, MD;
- U.S. Naval EOD School, Eglin Air Force Base (AFB), FL;
- EOD Assistants Course, Redstone Arsenal, AL;
- EOD Assistant Course, Eglin AFB; or
- An equivalent course as identified in Department of Defense Explosives Safety Board (DDESB) Technical Publication (TP) 18

The project UXOQCS or in his/her absence the MR Operations Manager, MR Safety Officer or the MR Market Segment Director, must review subcontractor personnel qualifications.

2.4.2 Commercial Blaster Requirements

Commercial blasting is most often done in support of construction projects to remove or reduce obstacles that interfere with the construction of new roads, bridges, tunnels, harbors, or other facilities.

In order to be qualified as a "Blaster," the individual shall be able to understand and give written and oral orders; be in good physical condition and not be addicted to narcotics, intoxicants, or similar types of drugs; and be qualified by reason of training, knowledge, or experience in the field of transporting, storing, handling, and use of explosives, and have a working knowledge of state and local laws and regulations that pertain to explosives. A

“Blaster” will be required to furnish satisfactory evidence of competency in handling explosives and performing in a safe manner the type of blasting that will be required. A Blaster must also be knowledgeable and competent in the use of each type of blasting method used.

Depending on the type and location of work performed, personnel that transport explosives may need to have a commercial driver’s license (CDL) with a hazardous material endorsement in accordance with Department of Transportation Requirements specified in 49 CFR.

The following definitions provide an overview the types of explosives which may be used in commercial blasting:

Explosives -- any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, i.e., with substantially instantaneous release of gas and heat, unless such compound, mixture, or device is otherwise specifically classified by the U.S. Department of Transportation; see 49 CFR Chapter I. The term "explosives" shall include all material which is classified as Class A, Class B, and Class C explosives by the U.S. Department of Transportation, and includes, but is not limited to dynamite, black powder, pellet powders, initiating explosives, blasting caps, electric blasting caps, safety fuse, fuse lighters, fuse igniters, squibs, cordeau detonant fuse, instantaneous fuse, igniter cord, igniters, small arms ammunition, small arms ammunition primers, smokeless propellant, cartridges for propellant-actuated power devices, and cartridges for industrial guns. Commercial explosives are those explosives which are intended to be used in commercial or industrial operations.

(i) ***Class A explosives***. Possessing, detonating, or otherwise having maximum hazard, such as dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, blasting caps, and detonating primers.

(ii) ***Class B explosives***. Possessing flammable hazard, such as propellant explosives (including some smokeless propellants), photographic flash powders, and some special fireworks.

(iii) ***Class C explosives***. Includes certain types of manufactured articles which contain Class A or Class B explosives, or both, as components but in restricted quantities.

2.5 Medical Surveillance Requirements

All CH2M HILL employees who perform field work on MR sites must participate in a medical monitoring program in accordance with 29 CFR 1910.120 and HSE&Q 113, *Medical Monitoring*.

Employees who terminate employment and who have performed field work at MR project sites may be required to undergo an exit examination.

Subcontractors are responsible for ensuring that their employees are enrolled in a medical surveillance or monitoring program that meets the requirements of 29 CFR 1910.120.

2.6 Drug Free Workplace Requirements

CH2M HILL employees who perform or oversee MR operations are subject to the provisions of HSE&Q-105, *Drug-Free Workplace*.

Subcontractors are responsible for ensuring that their employees who perform MR operations on CH2M HILL projects are on a drug abuse surveillance program that meets the requirements of HSE&Q-105.

2.7 Competent Person Requirements

2.7.1 Munitions Response

MR subcontractors are responsible for providing a competent person to oversee MR operations. A competent person may be a Senior UXO Supervisor, UXO Safety Officer, UXO Quality Control Specialist, or UXO Technician III. The competent person must meet the following minimum qualifications:

- Be a graduate of one of the schools and courses listed for all UXO technicians in Section 2.4.1 above,
- Have at least 8 years of combined active-duty military EOD experience and contractor UXO experience, and
- Have experience in MR operations and supervision of personnel.

CH2M HILL-competent person requirements are the same as for a subcontractor.

The MR Operations Manager, the MR Market Segment Director, and the MR Safety Officer will compose the Ammunition & Explosive Personnel Qualification and Certification Board for employees of CH2M HILL. This Board will review individual qualifications and experiences for determining who will be allowed to perform those duties and assignments associated with SUXOS, UXOQC, UXOSO, and CDC Chamber Operator.

2.7.2 Blasting

Blasting subcontractors are responsible for providing a competent person to oversee blasting operations. A competent person may be a state licensed blaster. The competent person must be qualified through a license or permit issued by a state or local jurisdiction based on testing, extensive knowledge, training, and experience with an ability to solve or resolve problems related to blasting, and must meet the following requirements:

- Able to understand and give written and oral orders.
- In good physical condition and not be addicted to narcotics, intoxicants, or similar types of drugs.
- Required to furnish satisfactory evidence of competency in handling explosives and performing in a safe manner the type of blasting that will be required.
- Knowledgeable and competent in the use of each type of blasting method used.

2.8 Safety Equipment

Subcontractors are responsible for providing all necessary personal protective equipment (PPE) for their employees. CH2M HILL will provide PPE only for its own employees. Other safety equipment will be provided as delineated in the subcontract and documents referenced by the subcontract. The MR Safety Officer, or in his absence the MR Operations Manager or the MR Market Segment Director, must review subcontractor work plans and site-specific HS&E plans to ensure that appropriate safety equipment has been included to meet the requirements of the scope of work (SOW).

Personnel who will be handling explosives will not wear outer or inner garments having static electricity-generating characteristics. These include clothing made of 100 percent polyester, nylon, silk, and wool, which are all highly static producing.

Protective shoes worn by personnel performing explosives operations should be constructed of nonferrous materials (e.g., fiberglass) to prevent interference with sensitive geophysical instruments.

UXO Technicians are required to wear hard hats when an overhead hazard exists or when specified in the site-specific HS&E plan. Hard hats should *not* be worn, however, when investigating suspect MEC. A hard hat can create an unsafe condition by falling off the technician's head at a critical moment. Also, if a MEC is accidentally detonated (the worst-case accident scenario), the hard hat will not protect the technician from fragments and may worsen the injury by reflecting fragments into the head of the technician. This is consistent with safety guidance from the Corps of Engineers, Huntsville Center, Military Munitions Center of Expertise (MM-CX).

2.9 Subcontractor Selection

Subcontractors are selected based on their past performance in working for CH2M HILL, safety record, experience, and compliance with federal, state, and local jurisdiction licensing and permitting.

Additional criteria may be developed, depending upon the specific SOW requirements for the subcontractor. When oversight is required by HSE&Q-215, the CH2M HILL MR Safety Officer, or in his absence the MR Operations Manager or MR Market Segment Director, shall use these developed criteria to review the explosives procedures submitted by the sub-contractor.

3.0 Definitions

Please see **Attachment 3** for definitions.

4.0 Project Execution

4.1 Safe Work Practices

Management is responsible to control and eliminate unsafe work conditions through training and engineering out the hazard. The requirements of this section are to be followed by all personnel where explosives are used, regardless of the company performing the operations. These requirements also pertain to subcontractor personnel.

4.2 MR Operations

On MR project sites, the MR Operations Manager will be contacted to establish requirements.

4.3 Regulations and Industry Standards

As described in HSE&Q-215, the MR Safety Officer or MR Quality Control Manager may be required to oversee a subcontractor's field activities. Subcontractors retain control over their practices, and CH2M HILL's oversight does not relieve them of their own responsibility for effective implementation and enforcement of HS&E requirements. The following subsections provide the minimum regulatory and industry standards for operations.

The Military Munitions Response Program (MMRP) is a maturing program with different levels of regulatory oversight within each service component. Unless a service component has issued written regulations/guidance for execution of MR actions, then the default regulations/guidance followed will be those issued by the Department of Defense Explosive Safety Board (DDESB) and the U.S. Army Corps of Engineers. For commercial blasting operations, the following guidelines shall apply: ATF&E federal explosive laws and regulations (ATF P5400.7); ANSI A10.7, Safety Requirements for Transportation, Storage, Handling and Use of Explosives; and NFPA 495, Explosive Material Code.

4.3.1 General Safety Concerns and Procedures

Operations, including site visits, shall not be conducted until a complete plan for the site is prepared and approval for use is given by the CH2M HILL MR Safety Officer, MR Operations Manager, or MR Market Segment Director. These plans will be based upon the cardinal rule of explosive safety which is to limit exposure to the minimum number of personnel, for the minimum amount of time, to the least amount of explosives hazards consistent with safe and efficient operations.

Only UXO-qualified personnel shall perform MEC procedures. Non-UXO personnel may be used to perform MEC-related procedures when supervised by a UXO Technician III. All personnel engaged in field operations shall be thoroughly trained and capable of recognizing the specific hazards of the procedures being performed. To ensure that these procedures are performed to standards, all field personnel shall be under the direct supervision of a UXO Technician III or a Senior UXO Supervisor (SUXOS).

4.3.2 Explosives Safety Precautions

Comply with the cardinal rule for explosives safety: expose the minimum number of people to the minimum amount of explosives for the minimum amount of time. Project-specific explosives safety precautions shall be developed prior to field activities and included in Work Plans and Health & Safety Plans that must be reviewed and approved by the MR Safety Officer and the MR Operations Manager, or in their absence the MR Market Segment Director.

4.3.3 Recognize, Retreat, and Report MEC

Any CH2M HILL project located on a present or former Department of Defense (DOD) facility, even if it is now under the control of a city, state, or private owner, should plan on the potential to encounter MEC/MPPEH. A contingency plan developed during pre-mobilization that addresses the three Rs of MEC/MPPEH (recognize the potential hazard, retreat upwind a safe distance, and report in accordance with approved plans) will lesson the impact to the project and enhance employee safety if MEC/MPPEH is encountered. Assistance in developing this contingency plan should be obtained from the MR Safety Officer, or in his absence the MR Operations Manager or the MR Market Segment Director.

4.3.4 Explosives Management

Management of explosives material under the "Safe Explosives Act of 2002" implements stringent requirements that must be followed. Management of explosives is a process that, if in compliance with federal, state, and local jurisdiction, will reduce, control, or eliminate civil and criminal penalties, disciplinary actions, and potential risk to personnel, the public, and the environment. Details of explosives management are developed on a site-specific basis and included in a site-specific explosives management plan. These details are based on federal, state, and local jurisdiction requirements and on contractual specifications by the client.

4.3.5 Explosives Security

Security of explosives will conform to the requirements set forth by federal, state, and local jurisdictions. Provisions for explosives security during interstate or intrastate shipment will be performed by transportation vendors. Project site and overnight explosives security will conform to 49 CFR 171-173, transportation security requirements. Details of explosives security requirements are included in the explosives management plan for each project.

4.3.6 Controlled Detonation Chamber Operations

A Controlled Detonation Chamber (CDC) is capable of repeated controlled detonations of a suite of energetic materials that are currently demilitarized by open burn/open detonation (OB/OD). On CDC projects, the MR Operations Manager will be contacted to establish requirements.

4.3.7 Explosive Waste Disposal

When used or fired munitions are managed off range (i.e., transported off range and stored, reclaimed, treated, or disposed) or disposed of on range (i.e., buried without treatment), it is subject to regulation as a solid waste under RCRA. This means it may also be subject to regulation as a hazardous waste. Also, munitions that land off range and are not promptly retrieved are solid wastes. Table 4-1 describes how solid wastes may be characterized as hazardous in these situations. All characterization must be based on field observations by qualified MR personnel who are trained to properly identify waste munitions items and meet the requirements for an emergency response expert under RCRA. In the event that the explosive waste is regulated as hazardous waste, refer to SOP HSE&Q-409, Waste Handling: Hazardous Waste for RCRA hazardous waste management requirements.

TABLE 4-1
Waste Characterization

Item	Characterization	Waste Code
Uncontaminated metal debris	If visual inspection determines that the item does not contain waste residue, then waste is non-hazardous scrap metal excluded from RCRA regulation under 40 CFR §261.6(a)(3). Waste may be subject to further incineration and certification requirements.	None
Contaminated metal debris	If visual inspection determines that the item contains hazardous waste residue, then manage it as potential hazardous waste.	Potential D003 and/or D008
Ordnance items less than 0.50 caliber	Small-arms ammunition is not considered reactive hazardous waste in accordance with EPA policy (November 30, 1984 Memorandum, John Skinner, OSWER Director).	None
Ordnance items greater than 0.50 caliber	Untreated MEC is presumed to be reactive hazardous waste using generator knowledge under 40 CFR §261.23.	D003

4.3.8 Forms and Permits

(1) **Type-20 Manufacturer of High Explosives License/Permit** issued by the ATF&E is required to purchase, store, and use high explosives including on-site use of binary explosives in support of MR operations, construction projects, and demolition and deactivation (D&D) projects. The following must be done prior to execution of field activities:

- Explosives will not be ordered, shipped, stored, or used without the review and approval of the ATF&E License Holder.
- The ATF&E License Holder must review and approve all Explosive Siting Plans (ESPs) and Explosives Management Plans (EMPs) to ensure compliance with ATF&E regulations.
- Following compliance with the above, the ATF&E License Holder will provide procurement/contracting with a certified copy of our Type 20 license and the authorization letter (responsible persons & possessors of explosives) to procure explosives.
- Written authorization designating the "Responsible Persons" and "Possessors of Explosives" who can order, receive, store, and use explosives must be provided by the ATF&E License Holder to explosives supplier.
- A copy of the CH2M HILL ATF&E Type 20 Manufacturer of High Explosives license must be posted on the project site.
- A copy of the ESP must be provided through the ATF&E License Holder to the ATF&E Office that inspects the CH2M HILL records and to the nearest ATF&E Office to the project site.

Additional details are provided in **Attachment 4**, Explosives Management Check List, including required records that must be forwarded to the CH2M HILL ATF&E Type 20 License Holder upon completion of work.

(2) State and local explosives permits may be required for CH2M HILL and individuals to purchase, store, and use explosives in support of MR operations, CDC operations, construction projects, and D&D projects. In addition there may be local requirements to notify law enforcement or fire department agencies when establishing explosives storage.

5.0 Attachments

The following attachments are included with this SOP:

Attachment 1	Abbreviated Site Safety and Health Plan (ASSHP)
Attachment 2	Opportunity Risk Evaluation (ORE)
Attachment 3	Glossary, Acronyms, and Abbreviations
Attachment 4	Explosives Management Check List

CH2MHILL

Explosives Usage and Munitions Response (MR)
Standard of Practice HSE&Q-610

Attachment 1: Abbreviated Accident Protection Plan (AAPP)

For:

Site name ______________________________

Site location ______________________________

Purpose of visit ______________________________

AAPP prepared by ______________________________

Office ______________________________

Address ______________________________

Telephone ______________________________

Date prepared ______________________________

Signature and date ______________________________

AAPP reviewed and approved by:

Safety office: ______________________________ Date: __________

NOTE: This AAPP is to be used only for non- intrusive site visits or for intrusive activities (e.g. geophysical prove-outs) where anomaly avoidance is to be performed prior to intrusive activity. All team members must read and comply with this AAPP and attend the safety briefings. The UXO escort shall ensure that the Safety Briefing Checklist and Plan Acceptance Form are filled out prior to the start of the site visit.

I. Site Description and Previous Investigation

A. Site Description

□ **Size: _______ acres**

□ **Present usage:**

( ) Military	( ) Recreational	( ) Other
( ) Residential	( ) Commercial	( )__________________
( ) Natural area	( ) Industrial	( ) __________________
( ) Agricultural	( ) Landfill	( ) __________________
( ) Secured	( ) Active	( ) Unknown
( ) Unsecured	( ) Inactive	

B. Past Uses

All members of the site visit team have been provided with a copy of the ASR.

Yes No –

C. Surrounding Population

( ) Rural	( ) Residential (outside base fence)	( ) Other (specify)
( ) Urban	( ) Industrial	( ) __________________
	( ) Commercial	( ) __________________

D. Previous Sampling and Investigation Results

1. MEC Encountered within anticipated boundaries of site

2. Samples (air, water, soil, and/or vegetation)

Chemical	Concentration	Medium	Location

II. Description of On-Site Activities

( ) Walk-through	( ) Drive-through	( ) Other
( ) On-road	( ) Off-road	( )______________
( ) On-path	( ) Off-path	( ) ______________
( ) Other	( ) Other	( ) ______________

III. Site Personnel and Responsibilities

Project Manager –

Office ____________________

Address ____________________

Phone ____________________

Responsibilities ____________________

Team Leader –

Office ____________________

Address ____________________

Phone ____________________

Responsibilities Responsible for documenting site visit.

UXO Safety Officer –

Office ____________________

Address ____________________

Phone ____________________

Responsibilities Responsible for all aspects of site safety during operations covered under this AAPP

IV. Hazard Analysis

A. Safety and Health Hazards Anticipated

( ) Chemical (be specific and include warning signs and symptoms of overexposure)

( ) Ordnance (specify)

( ) Heat stress	( ) Cold stress	( ) Tripping hazard
( ) Noise	( ) Electrical	( ) Falling objects
( ) Foot hazard	( ) Biological	( ) Overhead hazard
( ) Radiological	( ) Confined space	( ) Water hazard
( ) Explosive	( ) Climbing hazard	( ) Sunburn
( ) Flammable	( ) Other	

B. Overall Hazard Evaluation

( ) High ( ) Moderate ( ) Low ( ) Unknown

Justification

V. Accident Prevention

A. General Precautions

Before the on-site visit, all team members are required to read this AAPP and sign the form acknowledging that they have read and will comply with it. In addition, the UXO Safety Officer (escort) - shall hold a brief tailgate meeting in which site-specific topics regarding the day's activities are discussed. The buddy system shall be enforced at all times. If unanticipated hazardous conditions arise, team members are to stop work, leave the immediate area, and notify the UXO Safety Officer.

VI. Standard Operation Safety Procedures, Engineering Controls, and Work Practices

A. Site Rules and Prohibitions

At any sign of unanticipated hazardous conditions, stop tasks, leave the immediate area, and notify the UXO Safety Officer. Smoking, eating, and drinking are allowed in designated areas only.

B. Material-Handling Procedures

Do not handle.

C. Drum-Handling Procedures

Do not handle.

D. Confined Space Entry

Do not enter.

E. Ignition Source and Electrical Protection

Smoke in designated areas only. Team members are not to carry matches or lighters into the site.

F. Spill Containment

N/A

G. Excavation Safety

N/A

H. Illumination

Work during daylight hours only.

I. Sanitation

Use existing sanitary facilities.

J. Buddy System

Two persons shall be on site maintaining constant contact with each other; this shall be adhered to at all times.

K. Engineering Controls

N/A

L. Heat Stress

Dress appropriately, take sufficient breaks, and drink plenty of fluids. Watch for signs and symptoms of heat stress.

M. Poisonous Snakes or Insects

(1) Do NOT handle any snakes even those that appear to be dead.

(2) Avoid areas of limited visibility such as tall grass or heavy vegetation.

(3) Roll sleeves down and use insect repellant.

N. Material Potentially Presenting an Explosive hazard (MPPEH).

1. General Information

a. The cardinal principle to be observed involving explosives, ammunition, severe fire hazards, or toxic materials is to limit the exposure of a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material, consistent with a safe and efficient operation.

b. The age or condition of an ordnance item does not decrease its effectiveness. MPPEH that has been exposed to the elements for extended periods of time becomes more sensitive to shock, movement, and friction because the stabilizing agent in the explosive may be degraded.

c. When chemical agents may be present, further precautions are necessary. If the munitions item has green markings, leave the area immediately, since it may contain a chemical filler.

d. Consider MPPEH that has been exposed to fire as extremely hazardous. Chemical and physical changes may have occurred to the contents which render it more sensitive than it was in its original state.

2. On-Site Instructions

a. DO NOT touch or move MPPEH regardless of the marking or apparent condition.

b. DO NOT visit an MPPEH site if an electrical storm is occurring or approaching. If a storm approaches during a site visit, leave the site immediately and seek shelter.

c. DO NOT use radio or cellular phones in the vicinity of suspected MPPEH.

d. DO NOT walk across an area where the ground cannot be seen. If dead vegetation or animals are observed, leave the area immediately due to the potential of contamination by a chemical agent.

e. DO NOT drive a vehicle into a suspected MPPEH area; use clearly marked lanes.

f. DO NOT carry matches, cigarettes, lighters, or other flame-producing devices into an MPPEH site.

g. DO NOT rely on color code for positive identification of ordnance items or their contents.

h. Always assume that MPPEH contains a live charge until it can be determined otherwise.

3. Specific Actions upon Locating MPPEH

a. DO NOT touch, move, or jar MPPEH regardless of its apparent condition.

b. The UXO Safety Officer may approach the item cautiously; take photographs and a full description. Take notes of the markings or any other identifiers.

c. DO NOT be misled by markings on the item stating "practice bomb," "dummy," or "inert." Even practice bombs have explosive charges that are used to mark or spot the point of impact; or the item could be miss-marked.

d. DO NOT roll the item over or scrape the item to identify the markings.

e. The location of any MPPEH found during site investigation should be clearly marked so it can be easily located and avoided.

f. Notify PM upon location of any MPPEH. See Section VIII for phone number.

O. Other

Specify: ____________________

VII. Site Control and Communications

A. Site Map

Attach copy.

B. Site Work Zones

N/A

C. Buddy System

To be adhered to at all times.

D. Communications

1. On Site

Use verbal communications among team members to communicate to each other on site. If this communication is not possible, develop and use hand signals. Here are some examples:

Hand gripping throat:	"Breathing problems, can't breathe."
Thumbs up:	"OK, I'm all right, I understand."
Thumbs down:	"No, negative."
Hand(s) on top of head:	"Need assistance."
Grab buddy's wrist:	"Evacuate site now, no questions."
One long horn blast:	"Evacuate site to assembly point."
Two short horn blasts:	"Condition under control, return to site."

2. Off Site

Off-site communications shall be established on every site. Communications may be established by using an on-site cellular phone or by locating the nearest public or private phone that may be readily accessed. Mark the appropriate box:

( ) Cellular phone
( ) Public or private phone
( ) Other: ________________

3. Emergency Signals

In the case of small groups, a verbal signal for emergencies shall suffice. The emergency signal for large groups (i.e., air horn) should be incorporated at the discretion of the UXO Safety Officer. Mark the appropriate box:

( ) Verbal
( ) Nonverbal (specify) ____

VIII. Emergency Response

A. Alert Procedures

Team members are to be alert to the hazards associated with the site at all times. If an unanticipated hazardous condition arises, stop work, evacuate the immediate area, and notify the UXO Safety Officer. Practice MEC avoidance. If a suspected MEC is encountered during field activities, the team leader will contact local authorities and USACE Project Manager. The local authorities will contact military EOD. The suspected item will be marked with colored tape (or equivalent) by on-site UXO Safety Officer (escort).

B. First Aid

A first aid kit and emergency eyewash (as applicable) will be located in the UXO Safety Officer's field car. If qualified persons (i.e., a fire department, medical facility, or physician) are not accessible within five minutes of the site, at least one team member shall be qualified to administer first aid and cardiopulmonary resuscitation (CPR).

C. Emergency Telephone Numbers

1. Medical Facility
2. Fire Department

   ____

3. Police Department

   ____

4. Poison Control Center:

   (800) 222-1222

5. Local EOD

   ____

6. Project Manager(s)

   ____

D. Hospital and Medical Facility Information

Route to hospital: (Attach a map with the route to the hospital marked; if a map is not available, then provide clear, written instructions.)

IX. Monitoring Equipment and Procedures

A. Exposure Monitoring

For non-intrusive on-site activities such as site visits, air monitoring is typically not required. However, if the site situation dictates the need for monitoring, then complete the following information on a separate page and attach the page to this AAPP.

Monitoring equipment to be utilized

Documentation of equipment calibration and results

Action levels

B. Heat and Cold Stress Monitoring

If heat stress monitoring is necessary, the monitoring criteria published in Chapter 8 of *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (NIOSH/OSHA/USCG/EPA, October 1985) shall be followed. If cold stress monitoring is necessary, it shall be conducted in accordance with the most current American Conference of Governmental Industrial Hygienists (ACGIH) cold stress standard.

X. Personal Protective Equipment

A. General

Typically, for non-intrusive site visits, Level D PPE is required. Hard hats shall be worn if an overhead hazard exists, safety shoes if a foot hazard exists, and safety glasses if an eye hazard exists. If a higher level of protection is to be used initially or as a contingency, attach a brief discussion.

B. Non-intrusive Site Visit

Level of Protection

Initial:	( ) C	( ) D	( ) Modified (specify)
Contingency:	( ) C	( ) D	( ) Modified (specify)
	( ) Evacuate site if higher level of protection is needed.		

XI. Decontamination Procedures

If decontamination is required, attach an additional sheet with the requirements.

Decontamination procedures are not anticipated for this site investigation. Team members are cautioned not to walk, kneel, or sit on any surface with potential leaks, spills, or contamination.

XII. Training

All site personnel shall have completed the training required by EM 385-1-1 and 29 CFR §1910.120 (e). The Project Manager shall ensure, and the UXO Safety Officer shall verify, that all on-site persons have completed appropriate training prior to submitting the plan to the safety office for review. Additionally, the UXO Safety Officer shall inform personnel, before they enter the site, of any potential site-specific hazards and procedures.

XIII. Medical Surveillance Program

The Project Manager shall ensure, and the UXO Safety Officer shall verify, that all on-site personnel are in the Medical Surveillance Program meeting the requirements of 29 CFR §1910.120.

XIV. Logs, Reports, and Recordkeeping

A Site Log will be maintained by the team leader. This record will include historical data, personnel authorized to visit the site, all records, standard operating procedures, the AAPP submitted, any air monitoring logs, SOPs, and attachments to plans. All logs are to be maintained and available for inspection.

XV. General

The number of persons visiting the site shall be held to a minimum. No more than 8 people per UXO Safety Officer shall be allowed on-site. The more persons on site, the greater the potential for an accident. The UXO Safety Officer may modify this AAPP if site conditions warrant it and if it does not risk the safety and health of the team members. This modification shall be coordinated with the team members, and the UXO Safety Officer shall notify PM of the change as the situation allows.

XVI. Natural Resources

The following is a list of threatened and endangered species:

Safety Briefing Checklist
(Check subjects discussed)

Location: ______________________________ Date: ____________________________

General Information

Purpose of visit: ____

Identify key site personnel: ____

Training and medical requirements: ____

Specific Information

Site description and past uses: ____

Results of previous studies: ____

Potential site hazards: ____

MEC safety procedures: ____

Site SOPs: ____

Site control and communications: ____

( ) Emergency Hand Signals

Emergency Response: ____

( ) Location of First Aid Kit

( ) Emergency Phone Numbers and Location

( ) Location of Nearest Medical Facility and Location of Map to Facility

PPE and Decontamination: ____

Note: Stress the following during the briefings: If an unanticipated hazardous condition arises, stop work, evacuate the immediate area, and notify the UXO Safety Officer.

Plan Acceptance Form:
Abbreviated Accident Prevention Plan

For:

I have read and agree to abide by the contents of this Abbreviated Accident Prevention Plan and I have attended the Safety Briefing for the aforementioned site.

Name (printed)	Office	Signature	Date

Person presenting the safety briefing:

____

Signature   Date

Equipment List

(The following items may be necessary to support the site visit)

1. Boots or sturdy leather work shoes.
2. First aid kit.
3. Sun screen lotion.
4. Bug and/or insect repellant.
5. Rain / cold weather protection.
6. Potable water.

Attachment 2: Opportunity Risk Assessment (ORE)

1.0 Projects Involving or Potentially Involving the Use of Explosives, Materials Potentially Presenting an Explosive Hazard (MPPEH), Munitions and Explosives of Concern (MEC) and Related Activity.

Administrative Information

Project Name:
Project Number:
Project Location: (Address, City, State, Zip Code, Country)
Address:
City:
State:
Zip Code:
Country:
Project Manager - CH2M HILL:
Contracting Organization:
Client Organization:
☐Department of Defense
☐Department of State
☐Department of Energy
☐Department of Interior
☐Other
Client Organization Name:
Contract Type
☐ Time and Materials (T&M)
☐ Cost Plus (CP)
☐ Firm Fixed Price (FFP)
☐ Target Cost Incentive Fee (TCIF)
☐ Guaranteed Fixed Price with Insurance (GFPI)
☐Other

Brief Outline of the Scope of Work.

Number and Type of MR Personnel Needed to Support Project.

Any point value of 3, 4 or 5 in Sections A, B, C or D requires that you provide a risk management strategy as indicated. If unable to do so, you may wait until the formal MR ORE is conducted, then add the agreed to strategy at that time. Examples of strategies include, engineering controls, contractual protections, procedures, insurance and bonding, etc.

Level of effort should include MR Group Safety/Quality Control Audits for project over two weeks in field.

If you are unsure of which answer to use, leave blank and the question will be evaluated at length during the MR ORE process.

Upon completion of this form, email to those identified and schedule a telephonic conference call with them to review this document.

Part A:

Common Questions for Explosives Usage, Munitions Response (MR) and Controlled Detonation Chamber (CDC) Projects

Scoring Criteria

0 = none, 1 - 2 = Low Risk 3 Moderate Risk 4 - 5 High Risk

17.A1 Type of Reactive Materials?

Project Risk Category?	Check (x)	Point Value
Small Arms (<.50 cal) Ammunition	☐	1
Commercial Explosives	☐	3
Military Explosives (bulk)	☐	3
Energetics	☐	4
Munitions and Explosives of Concern (MEC)	☐	5
Pyrotechnics (including fire-works, etc.)	☐	5

RISK MANAGEMENT STRATEGY:

17.A2 Client – End Land Use

Which factor best describes the project end land use?	Check (x)	Point Value
Like Use -	☐	0
Not Yet Determined -	☐	1
Limited Public Access - livestock grazing/wildlife preserve/historic area	☐	2
Public Access - Farming/Agriculture	☐	3
Unrestricted - Commercial	☐	4
Unrestricted - Residential	☐	5

RISK MANAGEMENT STRATEGY:

17.A3 Chemical Warfare Material (CWM)

Which factor best describes this risk factor?	Check (x)	Point Value
None	☐	0
No-specific reference - but possible	☐	3
CWM Known or Suspected	☐	5

RISK MANAGEMENT STRATEGY:

)

17.A4 Who will write the Work & Safety Plans?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
CH2M HILL	☐	1
Don't Know	☐	3
Client / Subcontractor	☐	5

RISK MANAGEMENT STRATEGY:

17.A5 Does Client acknowledge that it will retain ownership of, and responsibility for MEC & wastes?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

17.A6 Does the Project Delivery Team have a history of successful execution of this type of project?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know?	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

17.A7 Is the Client responsible for obtaining necessary permits such as utility locator, state authorizations, rights of entry, etc.?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

17.A8 Will there be a range debris, munition debris, etc., recovery effort?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17. A9 Will CH2M HILL subcontract MR or explosive operational actions?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No.	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.A10 For "removal" activities, will "blow-in-place" (BIP) be permitted?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No.	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.A11 Is CH2M HILL responsible for the preparation of client-owned solid waste and hazwaste? (with Client's manifest)?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.A12 Will we need to order explosives for this project?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.A13 Is explosives storage required and/or available on site?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.A14 Could weather conditions effect this project?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes.	☐	5

RISK MANAGEMENT STRATEGY:

17.A15 Is geophysical prove-out required on this project?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.A16 Are there public transportation routes, airport, mariners operations, rail roads, etc., within 2000 ft. to the site? If so, provide distances in feet.

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.A17 Are two types of communications available on this project site?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes	☐	1
Don't Know	☐	3
No	☐	5

RISK MANAGEMENT STRATEGY:

17.A18 Are there emergency response services in close (5 minutes) proximity to project site (e.g., fire, hospital)?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

17.A19 Are there sensitive environment issues that need to be considered?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

PART B:

Explosives Usage Project Questions

17.B1 Source of explosives

Which factor best describes the source?	Check (x)
Vendor - Authorized ATF&E Dealer	☐
Government Furnished	☐
Client Furnished	☐
Subcontractor Provided	☐
Transferred from another CH2M HILL project	☐

RISK MANAGEMENT STRATEGY:

17.B2 Explosive operations general RISK requirements/concerns

Which factors apply to regulatory conformance risk factor?	Check (x)
State Blasting License (Individual)	☐
State Blasting License (Corporation)	☐
State Explosive Storage Permit (Fire Marshal Inspection)	☐
Vehicle Inspection (state of registration) for hazard materials transportation	☐
Hazard Materials License (federal and or state)	☐
Operator – Commercial Drivers License with Hazmat Endorsement	☐
Airport/flight paths – Notice to Airmen (NOTAM) – Airspace	☐
Navigable Waterways – Notice to Mariners (NOTM)	☐
Power lines/ Radar/ Microwave tower/Antenna – Electro Magnetic Radiation Hazards	☐
Military - training corridor/area/test area/research and development area	☐
Need to establish a Temporary Open Detonation Area	☐
Need to establish an Explosive Holding Area	☐
Need to establish an Explosive Inspection Area for MPPEH/MD	☐
Need to establish a storage area for MEC	☐
Need to establish a storage area for MPPEH	☐

RISK MANAGEMENT STRATEGY:

17.B3 Explosive storage risk factors

Which factor best describes this risk factor - Magazine Condition?	Check (x)	Check (x)
Not Applicable.	☐	0
Fire Inspector Permit/electrical grounding tests, ventilator and doors and locks and hasps IAW NFPA Code 495	☐	1
Do Not Know	☐	3
Unknown construction (material, etc.)	☐	5

RISK MANAGEMENT STRATEGY:

17.B4 Explosive transportation

Which factor best describes this risk factor?	Check (x)	Check (x)
Not Applicable.	☐	0
Within project area – private roads	☐	1
Public Roads	☐	3
Federal Roads (interstate - DOT) or over water (USCG)	☐	5

RISK MANAGEMENT STRATEGY:

17.B5 Explosive security

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Provided by Military	☐	1
Provided by Others	☐	3
Don't Know	☐	3
Provided by CH2M HILL	☐	5

RISK MANAGEMENT STRATEGY:

17.B6 Is underwater work required?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

PART C:

Munitions Response Project Questions

17.C1 Type of Munitions Response (MR) project.

Which factor best describes this risk factor?	Check (x)	Point Value
Desk top studies – no site visit	☐	0
Escort and/or Avoidance Activities – (site visit, reconnaissance, sediment sampling, develop wells, perform O&M, land survey, area preparation, design work, etc.)	☐	1
Construction Support – Direct Push, Trenching, Excavation, Soil Sifting, Insitu-treatment, Demolition, Land Clearing/grubbing etc.)	☐	2
Demilitarization/ MPPEH/ Blasting/	☐	3
Removal Action	☐	4
Demining, Improvised Explosive Devices (IED)	☐	5

RISK MANAGEMENT STRATEGY:

17.C2 Is "over water" (on boat, bridge, etc.) work required?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Unknown	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.C3 Type of Munitions Constituents (MC) contaminated soil and/or groundwater

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Low concentrations of explosives measured in ppb/ppm.	☐	1
High Concentrations of explosives measured in ppb/ppm.	☐	2
High Concentrations of explosives measured in ppb/ppm - No explosive hazard.	☐	3
Soil with 5% to 10% Energetic Material by Weight - Initiation Hazard.	☐	4
Soil with >10% Energetic Material by Weight - Explosive Hazard.	☐	5

RISK MANAGEMENT STRATEGY:

17.C4 Type of munitions demilitarization.

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Discarded Military Munitions (DMM).	☐	1
MEC Unfuzed.	☐	2
MEC Fuzed	☐	3
Munitions requiring disassembly prior to demilitarization.	☐	4
Deteriorated material.	☐	5

RISK MANAGEMENT STRATEGY:

17.C5 Are we to submit an Explosive Safety Submition (ESS) for the Client? (CSS for RCWM).

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
No	☐	1
Don't Know	☐	3
Yes	☐	5

RISK MANAGEMENT STRATEGY:

17.C6 Is the Munitions Response Area (MRA) secured?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes	☐	1
Don't Know	☐	3
No	☐	5

RISK MANAGEMENT STRATEGY:

PART D:

Controlled Detonation Chamber (CDC) Project Questions

17.D1 Type of MEC Hazard

Which factor best describes this risk factor?	Check (x)	Point Value
Small Arms Ammunition < 0.50 cal.	☐	0
Demilitarization	☐	1
MPPEH/MEC/Bulk Explosives	☐	3
Fireworks/pyrotechnics	☐	4
CWM	☐	5

RISK MANAGEMENT STRATEGY:

17.D2 Quality and Completeness of Inventory

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Inspection and Verification by CH2M HILL.	☐	1
Inspection/Certification/Verification by Others	☐	3
Client Statement.	☐	5

RISK MANAGEMENT STRATEGY:

17.D3 MPPEH/MEC

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Meets CDC ESS limitations	☐	1
CWM	☐	3
Munitions requiring disassembly (i.e., water cutting, etc.)	☐	5

RISK MANAGEMENT STRATEGY:

17.D4 Will CH2M HILL provide CDC operator services?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

17.D5 If CDC leased to Owner, will CH2M HILL train Client operators?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

17.D6 Will Owner accept CH2M HILL rejection of MEC deemed unsuitable for CDC destruction?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

17.D7 Are all items of type, size and condition previously destroyed in CDC?

Which factor best describes this risk factor?	Check (x)	Point Value
Not Applicable.	☐	0
Yes.	☐	1
Don't Know	☐	3
No.	☐	5

RISK MANAGEMENT STRATEGY:

Attachment 3: Glossary, Acronyms, and Abbreviations

Active munitions inventory (or stockpile): The supply of chemical and conventional military munitions that is available for issue and use for combat, training, demonstrations, research, development, testing, or evaluation. (See **munitions stockpile** and **demilitarization inventory**.)

Active range: An operational military range that is currently in service and being regularly used for training, demonstrations, research, development, testing, or evaluation.

AEDA: ammunition, explosives, and dangerous articles.

Anomaly avoidance: Techniques employed by EOD or UXO personnel at sites with known or suspected MEC to avoid any potential surface MEC or subsurface anomalies. This usually occurs at mixed-hazard sites when HTRW investigations must occur before an MEC removal action is executed. Intrusive anomaly investigations are not authorized during ordnance avoidance operations.

Anomaly: Any item that is seen as a subsurface irregularity after geophysical investigation. This irregularity should deviate from the expected subsurface ferrous and nonferrous material at a site.

AP: armor piercing: Munitions that may or may not contain HE and are designed to penetrate hard targets.

APERS: antipersonnel munitions: May be loaded with high explosives or incendiary fillers and are designed to kill, wound, or obstruct personnel.

APT: armor-piercing tracer: Munitions, designed to penetrate hard targets, that contain a pyrotechnic element that produces bright light and/or smoke to aid in visual tracking of the munitions in flight.

ATV: all-terrain vehicle.

Authorized Visitors: Government or contractor personnel conducting project or mission related functions, e.g., Quality Assurance Representatives (QAR's) safety and quality inspectors (including geophysicists performing quality assurance functions) and project management. Authorized visitors must be escorted while in the EZ and be approved for entry into the EZ. No more than two visitors will be permitted in the EZ at any one time.

BD: base detonating: Impact fuse designed to function when the projectile comes in contact with the surface of the target. The fuse is located in the base or tail of the munitions.

bgs: below ground surface.

BRAC: Base Realignment and Closure.

CAD: cartridge-actuated device: An explosive device designed to produce gas pressure to expel or eject an item.

Cal: caliber: The diameter of a projectile or the bore of a weapon (i.e., .50-cal, 3-inch, 90-millimeter).

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act.

Chemical warfare materiel (CWM): An item configured as ammunition, containing a chemical substance intended to kill, seriously injure, or incapacitate a person through its physiological effects. Also includes V- and G-series nerve agents, H-series blister agent, and lewisite in other-than-munitions configurations. Due to their hazards, prevalence, and military-unique application, chemical agent identification sets (CAIS) are also considered CWM. CWM does not include riot control agents, chemical herbicides, smoke- and flame-producing items, or soil, water, debris, or other media contaminated with a chemical agent.

Closed range: A military range that has either been taken out of service as a range and has been put to new uses that are incompatible with range activities, or that is no longer considered to be a potential range area. A closed range is still under the control of a DOD component.

Construction support: Support provided by qualified UXO personnel during construction activities at potential MR sites to ensure the safety of construction personnel from the harmful effects of MEC. When it is determined that the probability of encountering MEC is low (current or previous land use leads to a determination that MEC may be present), a two-person UXO team will stand by in case the construction contractor encounters a suspected MEC. When it is determined that the probability of encountering a MEC is moderate to high (current or previous land use leads to a determination that MEC was employed or disposed of in the parcel of concern, e.g., open burn and open detonation areas), UXO teams are required to conduct subsurface MEC clearance for the known construction footprint, either in conjunction with the construction contractor or before construction.

Controlled detonation chamber (CDC): Also known as the Donovan Blast Chamber (DBC), the CDC is a system for controlled detonation of MEC and MEC-related materials. It is capable of repeated controlled detonations of a suite of energetic materials that are currently demilitarized by OB/OD. This offers the DOD an alternative to OB/OD while at the same time increasing throughput, efficiency, and safety and controlling air, soil, water, and noise pollution. The CDC system meets all state and federal air discharge regulations.

CQC: Contractor Quality Control.

CTT: closed, transferring, and transferred (refers to a subset of military ranges).

DAC: Defense Ammunition Center.

DDESB: Department of Defense Explosives Safety Board.

DERP: Defense Environmental Restoration Program.

Demilitarization ("demil"): The process that removes the military characteristics from unused munitions that are either unsuitable for continued storage, excess to DOD needs, or about to be released from DOD control. Demilitarization applies equally to munitions in unserviceable or serviceable condition. Used (i.e., fired) munitions items also sometimes undergo demilitarization. There are many demilitarization methods, such as recovery, recycling, remanufacture, disassembly, reclamation, mutilation, alteration, melting, burning, detonating, destruction, treatment, and disposal. Methods involving R3 currently constitute approximately two-thirds of the DOD demilitarization programs.

Demilitarization (demil) inventory: The demilitarization inventory consists of excess, obsolete, and unserviceable munitions. Munitions are moved from the active inventory to the demilitarization inventory after it is determined that they are not economically repairable, they are obsolete, or they are excess to DOD needs and cannot be sold under the Foreign Military Sales program. (Also see **active munitions inventory** and **munitions stockpile**.)

DENIX: Defense Environmental Network and Information Exchange.

Department of Defense Components: The Office of the Secretary of Defense, the Military Departments and Services, the Joint Staff, the Unified and Specified Combatant Commands, the Defense Agencies, the DOD Field Activities, and the National Guard.

Department of Defense Explosives Safety Board (DDESB): A Joint Service board comprising a chairperson, voting representatives from each of the Armed Services, and a permanent military and civilian secretariat to perform operational and administrative functions. The DDESB provides impartial and objective advice to the Secretary of Defense and DOD components on explosives safety matters. (See DOD 6055.9-STD for a detailed assignment of DDESB functions.)

DGPS: differential global positioning system.

Discarded military munitions (DMM): Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include unexploded ordnance, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (10 U.S.C. 2710(e)(2))

DLA: Defense Logistics Agency.

DMM: discarded military munitions.

DOD: U.S. Department of Defense.

DODD: Department of Defense Directive.

DODIG: Department of Defense Inspector General.

DOI: U.S. Department of Interior.

DRMO: Defense Reutilization and Marketing Office.

DRMS: Defense Reutilization and Marketing Service.

EBS: environmental baseline survey.

Emergency response (to munitions- or explosives-related or UXO emergencies): An immediate response by explosives and munitions emergency response personnel (i.e., DOD EOD personnel) to control, mitigate, or eliminate the actual or potential threat encountered during an explosives or munitions emergency. The response action may include in-place or on-site render-safe procedures, treatment, or destruction of the explosives or munitions or their transport to another location where these operations may be conducted. (See 40 CFR Part 260 et seq., the Military Munitions Rule.)

Energetic material: A component or item of ammunition that is designed to produce the necessary energy required for ignition, propulsion, detonation, fire, or smoke, thus enabling the item to function. Also a material (e.g., corrosive or oxidizer) that is inherently dangerous and capable of causing serious damage and that requires regulated handling to avoid accidents in connection with its existence and use.

EOD: explosive ordnance disposal.

EPA: U.S. Environmental Protection Agency.

EPCRA: Emergency Planning and Community Right-to-Know Act.

ERGM: extended-range guided munitions.

ESCA: Environmental Services Cooperative Agreement.

ESOH: Environmental, Safety, and Occupational Health.

ESOHPB: Environmental, Safety, and Occupational Health Policy Board.

Essential personnel. Personnel whose duties require them to remain within an ESQD arc for one or more of the following reasons:

a. Government and project personnel necessary for the safe and efficient completion of field operations conducted in an EZ. This is limited to: contractor work teams members including the Unexploded Ordnance (UXO) Safety Officer (UXOSO), UXO Quality Control Specialist, Senior UXO Supervisor and a USACE Ordnance and Explosives (OE) Safety specialist.

b. Personnel not UXO qualified must be identified in the work plan by name and/or position.

ESTCP: Environmental Security Technology Certification Program.

Exclusion zone (EZ): A safety zone established around an MR work area. Only project personnel and authorized, escorted visitors are allowed within the EZ. Examples of EZs are safety zones around MEC-intrusive activities and safety zones where MEC is intentionally detonated. (See DDESB-KO, 27 January 1990.)

Explosive Equivalent. The amount of a standard explosive which, when detonated, will produce a blast effect comparable to that which results at the same distance from the detonation or explosion of a given amount of the material for which performance is being evaluated. It is usually expressed as a percentage of the total net weight of all reactive materials contained in the item or system. For the purpose of this manual, TNT is used for comparison.

Explosive Ordnance Disposal (EOD): Includes detecting, identifying, field evaluating, rendering safe, and final disposing of MEC.

Explosive Ordnance Disposal (EOD) Personnel: Military members who have graduated from the Naval School, EOD. They have received highly specialized training to provide time-critical MEC hazard mitigation services during both peacetime and wartime. EOD personnel are trained and equipped to perform render-safe procedures (RSP) on nuclear, biological, chemical, conventional, and improvised explosive devices. (Note that EOD personnel are distinguished from UXO Technicians, who are civilian contractor or government personnel with specialized training and qualifications in the long-term remediation of MEC.)

Explosive Safety Quantity Distance (ESQD): The prescribed minimum distance between sites storing or handling hazard Class 1 explosive material and specified exposures (i.e., inhabited buildings, public highways, public railways, other storage or handling facilities, or ships, aircraft, etc.) to afford an acceptable degree of protection and safety to the specified exposure. The size of the ESQD arc is proportional to the NEW present.

Explosive Safety Submission (ESS): The document that serves as the specifications for conducting work activities at the project. The ESS details the scope of the project, the planned work activities, potential hazards, and the methods for their control.

Explosive Siting Plan (ESP): The document that serves as a DDESB Permit approving the site-specific storage locations, quantities, and safe distances for explosive operations.

Explosive soil: Mixtures of explosives in soil, sand, clay, or other solid media at concentrations such that the mixture itself is explosive. The following also defines an explosive soil: The concentration of a particular explosive in soil necessary to present an explosion hazard depends on whether an explosive is classified as "primary" or "secondary." Primary explosives are those extremely sensitive explosives (or mixtures thereof) that are used in primers, detonators, and blasting caps. They are easily detonated by heat, sparks, impact, or friction. Examples of primary explosives include lead azide, lead styphnate, and mercury fulminate. Secondary explosives are bursting and boostering explosives (i.e., they are used as the main bursting charge or as the booster that sets off the main bursting charge). Secondary explosives are much less sensitive than primary explosives. Soil containing 10 percent or more by weight of any mixture of secondary explosives is considered "explosive soil." Soil containing propellants (as opposed to primary or secondary high explosives) may also present explosion hazards.

°F: degrees Fahrenheit.

FAR: Federal Acquisition Regulations.

FFA: Federal Facilities Agreement.

FFCA: Federal Facilities Compliance Act.

FOST: finding of suitability to transfer.

Frag: fragment or fragmentation: Munitions material projected away from the point of detonation at a high velocity.

Free from explosive hazard: Material that has been inspected for explosives and determined not to present a danger of explosion or combustion from explosive or energetic materiel.

FUDS: formerly used defense site.

GIS: geographic information system.

GPS: global positioning system.

Hazardous waste: A solid waste that meets the following criteria: (1) is or contains a hazardous waste listed in 40 CFR Part 261, or (2) exhibits characteristics of ignitability, corrosivity, reactivity, and/or toxicity. (Refer to 40 CFR § 261.3 for further explanation.)

HE: high explosive: Explosive that normally detonates rather than burns.

HEAT: high-explosive antitank: Ordnance designed to defeat armor by the use of a shaped charge.

HEI: high-explosive incendiary: High-explosive-filled ordnance with additional ingredients to give a fire-producing effect.

HQMC: Headquarters, U.S. Marine Corps.

ICM: improved conventional munition.

Impact area: The identified area within a range intended to capture or contain ammunition, munitions, or explosives and resulting debris, fragments, and components from various weapon system employments. In simple terms, normally the target area where live-fire rounds or bombs impact the earth.

Improved conventional munition (ICM): ICMs or submunitions, cluster bombs, and cargo rounds are considered sensitive-fused munitions and require special authority to enter contaminated areas.

Inactive range: An operational military range that is not currently being used but is still under military control, and which the military both considers to be a potential range area and has not put to a new use that is incompatible with range activities. A potential range area is defined as meeting one of three criteria:

(1) Mobilization and force projection: ranges that are held by a DOD component for the purpose of preparing individuals and units for worldwide deployment, redeployments, or demobilization in response to war, stability, and support operations or projected training requirements that would exceed current active range capabilities;

(2) Force structure: ranges held as inactive during realignment, reorganization, stationing, or reequipping of units projected to use these ranges under new training requirements; or

(3) Future: ranges that are held by DOD components for future use in support of National Security Policy or DOD component doctrine that ensures the capability to produce, establish, and maintain conditions needed for operational success.

Inhabited Building Distance (IBD): The minimum distance permitted between an inhabited building and an ammunition or explosives location for the protection of administration, quarters, industrial, and other similar areas within a naval shore establishment. Inhabited building distances shall be provided between ammunition or explosives locations and the boundary of a shore establishment of the nearest point beyond the boundary where such inhabited structures could be erected.

Integrated Training Area Management (ITAM): A U.S. Army program designed to improve range conditions by inventorying and monitoring land conditions, determining carrying capacity of the land in terms of the training requirements, and providing for land rehabilitation and maintenance measures.

Intentional detonation: An intentional detonation is a planned, controlled detonation.

Intrusive activity: An activity that involves or results in the penetration of the ground surface at an area known or suspected to contain MEC. Intrusive activities can be of an investigative or removal action nature.

IR: Installation Restoration.

ITAM: Integrated Training Area Management (a U.S. Army program).

JOCG: Joint Ordnance Commanders Group.

JUXOCO: Joint UXO Coordination Office.

Material that presents a potential explosive hazard (MPPEH): Military munitions, including: their components; munitions packaging material; residues from research, development, testing, and evaluation (RDT&E), production, use (to include range scrap), operational and quality testing, or demilitarization of munitions; or any other materials, equipment, or facilities potentially contaminated with explosives. MPPEH includes both end items and residues derived from processing end-items within United Nations Organization (UNO) Hazard Class (HC). It also includes munitions-related items, pieces, models, training aids, etc., that are suspected but not confirmed to be wholly inert.

Maximum credible event (MCE): The worst single event that could occur at any time with maximum release of a chemical agent from a munition, container, or process as a result of an unintended, unplanned, or accidental occurrence.

MEC: munitions and explosives of concern. Distinguishes specific categories of military munitions that may pose unique explosives safety risks means: (A) Unexploded Ordnance (UXO), (B) Discarded military munitions (DMM), (C) Munitions Constituents (MC).

MIL SPECS/STDS: military specifications and standards.

Military munitions: All ammunition products and components produced or used by or for the DOD or the U.S. Armed Services for national defense and security, including military munitions under the control of the DOD, the U.S. Coast Guard, the U.S. DOE, and the National Guard. The term includes confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries used by DOD components, including bulk explosives and chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof. It does not include: wholly inert items; improvised explosive devices; and nuclear weapons, devices, and components thereof. However, it does include nonnuclear components of nuclear devices, managed under DOE's nuclear weapons program after all required sanitation operations under the Atomic Energy Act of 1954, as amended, have been completed.

Military range: A designated land or water area set aside, managed, and used to conduct research on, develop, test, and evaluate military munitions and explosives, other ordnance, or weapon systems, or to train military personnel in their use and handling. Ranges include firing lines and positions, maneuver areas, test pads, detonation pads, impact areas, and buffer zones with restricted access and exclusionary areas.

MLLW: mean lower low water.

Most probable event (MPE): The most likely event, as a result of an accidental, unplanned, or unintended detonation of an item of ordnance, that could occur during MR activities. The event must be realistic, with reasonable probability of occurrence.

MPPEH: munitions that present a potential explosive hazard.

MT: mech time or mechanical time: fuses designed usually for airburst. MT fuses are located in the nose of the munition.

Munitions and explosives of concern (MEC): Military munitions that are UXO or have been abandoned, as defined in the EPA Munitions Rule. Also includes soil, facilities, equipment, or other materials contaminated with a high enough concentration of explosives that it presents an explosive hazard.

Munitions constituents (MC): Any materials originating from military munitions, including explosive and/or non-explosive materials, and emission, degradation, or breakdown products. [The following additional explanation is offered for purposes of this SOP: Munitions constituents are the substances or chemical residues that result from the proper functioning or use of munitions (e.g., residues created and remaining in the soil, water, or air from the burning or explosion of energetic material) or that are present in MEC. Such constituents may or may not present an immediate risk of acute physical injury from fire or explosion resulting from accidental or unintentional detonation or ignition of MEC or energetic materials. Similarly, such constituents may or may not result in environmental contamination requiring a response (i.e., response action).]

Munitions Debris (MD): Metal fragments resulting from the intended use of munitions or detonations.

Munition with the Greatest Fragmentation Distance (MGFD). The munition with the greatest fragment distance that is reasonably expected (based on research or characterization) to be encountered in any particular munition response area (MRA) or munitions response site (MRS).

Munitions Response Area (MRA): Any area on a defense site that is known or suspected to contain UXO, DMM, or MC. Examples include former ranges and munitions burial areas. A munitions response area is comprised of one or more munitions response sites.

Munitions Response Site (MRS): A discrete location within a MRA that is known to require a munitions response.

Munitions Rule Implementation Policy: Detailed guidance and procedures issued by the Services that explains how DOD will implement and comply with the EPA Military Munitions Rule.

Munitions stockpile: Munitions in the active and demilitarization inventories as well as unused waste munitions as defined in the EPA's Military Munitions Rule (MMR). (See **active munitions inventory** and **demilitarization inventory**.)

Munitions: see **military munitions**.

Net Explosive Weight (NEW): The actual weight of explosive mixture or compound including the TNT equivalent of other energetic material which is used in the determination of explosive limits and ESQD arcs.

Non-stockpile chemical warfare materiel: CWM (defined above) that is not included in the chemical stockpile. Non-stockpile CWM is divided into five categories: (1) buried CWM; (2) recovered chemical weapons (items recovered during range clearing operations, from chemical burial sites, and from research and development testing); (3) former chemical weapon production facilities; (4) binary chemical weapons; and (5) miscellaneous CWM (unfilled munitions and devices and equipment specially designed for use directly in connection with employment of chemical weapons).

OB: open burn.

OCR: Office(s) of Collateral Responsibility.

OD: open detonation.

ODEP: Office of Defense Environmental Programs.

ODUSD (I&E): Office of the Deputy Under Secretary of Defense (Installations and Environment).

OE Safety Specialist: a USACE employee involved in the execution, supervision, or oversight of ordnance-related activities inside the exclusion zone who has graduated from the U.S. Naval EOD School, Indian Head, MD. An OE Safety Specialist shall be on-site each day during intrusive and MEC destruction activities. The OE Safety Specialist is on-site to ensure that the contractor establishes the appropriate daily safety routines at the beginning of UXO field operations, to perform quality assurance oversight, to verify contractor employee UXO qualifications, to advise the contractor on UXO procedures, to coordinate with the PM, and to facilitate EOD response when needed.

OEESCM: Operational and Environmental Executive Steering Committee for Munitions.

Open burn (OB): A controlled open-air process by which excess, unserviceable, and obsolete munitions are destroyed to eliminate their inherent explosives safety hazards. DOD OB units contain the munitions with pans or pads to minimize environmental contamination. DOD OB units are permitted as "miscellaneous units" in EPA's environmental permitting process.

Open detonation (OD): A process used for the treatment of unserviceable, obsolete, and/or waste munitions whereby an explosive donor charge initiates the munitions to be detonated. Although surface detonations can be performed under certain circumstances, most munitions are treated in 4- to 6-foot-deep pits for safety purposes. Most OD sites are permitted as miscellaneous units as part of the EPA environmental permitting process. DOD's units are generally permitted as combined OB/OD facilities.

Operational range: A military range that is currently under military control and management; includes both active ranges (currently in service or use) and inactive ranges (not in current use or service).

OPR: Office(s) of Primary Responsibility.

OSD: Office of the Secretary of Defense.

OU: Operable Unit.

OUSD (AT&L): Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics).

PD: point detonating: impact fuse, designed to function when the projectile comes in contact with the surface of a target; located in the nose of the munition.

Potential Explosion Site (PES): The location of a quantity of explosives that will create a blast, fragment, thermal, and/or debris hazard in event of an accidental explosion of its contents. Quantity limits for ammunition/explosives at a PES are determined by the distance to an exposed site.

POL: petroleum, oil, and lubricants.

PPE: personal protective equipment.

Primer: Small, sensitive explosive component used as the first element in the explosive train.

Proj: projo or projectile: A weapon that is projected through a tube or barrel into the air toward a target.

PSE: preliminary source evaluation.

PTT: powder train time fuse: Fuses designed usually for airburst, normally used with illumination rounds to light up the battlefield.

QA: quality assurance.

QC: quality control.

Quantity-distance (Q-D): the quantity of explosives material and distance separations that provide defined types of protection. These relationships are based on levels of risk considered acceptable for the stipulated exposures and are tabulated in the appropriate Q-D tables provided in DOD 6055.9-STD. Separation distances are not absolute safe distances but are relative protective safe distances. Greater distances than those shown in the Q-D tables shall be used whenever possible.

R&D: research and development.

RAB: Restoration Advisory Board.

RAC: Remedial Action Contract.

Range clearance: An operation or procedure conducted to remove and properly dispose of munitions or munitions fragments. (e.g., MEC, "duds," etc.). Several types or degrees of clearance may be conducted (e.g., surface clearance based on visual inspection of the surface; shallow clearance where an area is systematically swept with detectors—normally to a depth of 20-24 inches; etc.) Range clearance, though technically applicable to any range category (closed, transferred, active, etc.) is often considered as occurring only at active, operational ranges. Clearance operations at these active ranges are normally conducted as part of range maintenance activities to maintain or enhance operational safety conditions at the range facility. Even though it is possible for MEC to cause environmental contamination (pollution of soil, surface water, groundwater, etc., from the chemical constituents present in munitions), range clearance is focused on removing and safely disposing of munitions/ordnance items or fragments—not the removal or treatment of any chemical residues or constituents from the munitions or associated environmental contamination. Cleanup of environmental contamination or pollution is normally achieved by removal or remedial actions.

Range: see **military range**.

RCRA: Resource Conservation and Recovery Act.

RCWM: recovered chemical warfare material.

RDT&E: research, development, test, and evaluation.

Regional Environmental Coordinator (REC): A senior military officer or DOD civilian assigned to one of ten EPA regions who is responsible for the dissemination of information and coordination of environmental matters and public affairs among military installations and environmental regulatory organizations within their respective region. RECs have a liaison role and fully adhere to the Services' chain of command.

Remedial actions/remediation/remedial action process: Longer-term activities that complete the cleanup of contamination (or a contaminated site or location) if a removal action has not achieved or cannot achieve the required degree of cleanup for the contamination problem. A distinction is sometimes made between the control or cleanup measures to be implemented, which are called "remedial actions," and the identification, evaluation, decision-making, and design and construction steps required to implement the control measures. These steps collectively are called the "remedial action process."

Removals/removal action(s): Relatively quick actions designed to address imminent threats to human health and the environment posed by releases or spills of hazardous substances. Removals should satisfy one or more of the following tests:

(1) **Imminent threat:** the site or situation poses an imminent threat to public health.

(2) **Source control:** the removal action either removes the source of contamination off-site or effectively contains it on-site so that continuing releases to the environment are prevented or reduced.

(3) **Access limitation:** the removal action substantially reduces the possibility of human exposure to hazardous substances. The EPA has categorized removal actions as emergency, time-critical, and non-time-critical. Each of these categories possesses its own criteria and procedural requirements.

Resource recovery and recycling (R3): Technologies and processes used by DOD to demilitarize military munitions. These include reuse, sale "as is" (e.g., Foreign Military Sales), conversion to a commercial product for sale or industrial use, or disassembly, modification, and partial or whole use for a military application.

Response(s) or response action(s): Responses or response actions are broadly defined in environmental law and regulations as any scientific or engineering investigation, evaluation, decision-making, design, or implementation step taken in response to (i.e., to clean up) a release or spill of hazardous substances. Removals and remedial actions (or remedial action processes) are subcategories of response actions. Procedural requirements (established in environmental regulations) for these two types of actions differ substantially, but their definitions are almost as broad as for "responses," allowing the terms to be used almost interchangeably. The various terms are best defined by the procedural requirements imposed on them by the applicable environmental regulations.

RI/FS: remedial investigation/feasibility study.

ROD: Record of Decision.

Senior UXO Supervisor (SUXOS): Supervises all contractor on-site UXO activities. This individual must be a graduate of the U.S. Army Bomb Disposal School, Aberdeen Proving Ground, MD, or the U.S. Naval EOD School, Indian Head, MD. Must have at least 15 years of combined active-duty military EOD and contractor UXO experience, to include at least 10 years in supervisory positions.

SERDP: Strategic Environmental Research and Development Program.

SHPO: State Historic Preservation Officer.

Single Manager for Conventional Ammunition (SMCA): A DOD executive agent responsibility performed by the U.S. Army Operations Support Command. The Secretary of the Army is DOD's SMCA. The U.S. Army OSC is the day-to-day operator of the SMCA and serves as the central program manager for the execution of most of DOD's demilitarization requirements. The objectives and responsibilities of the SMCA can be found in DOD Directive 5160.65.

Sustainable range management: Management of a military range in a manner that supports national security objectives and maintains the operational readiness of the Armed Forces and ensures the long-term viability of the range while protecting human health and the environment. [The following additional explanation is offered for purposes of this SOP: A comprehensive DOD approach that develops and implements the policies, plans, practices, and procedures necessary to achieve sustainable ranges. Sustainable ranges are managed and operated in a manner that supports their long-term viability and utility to meet the national defense mission. Sustainable ranges will implement the planning, management, coordination, and public outreach necessary to ensure viable continuity of test and training operations and long-term coexistence with neighboring communities and natural ecosystems.]

Sustainable use: Actions taken to ensure that ranges maintain the ability to conduct training, research, development, testing, and evaluation of munitions in support of the national defense mission while minimizing adverse effects to human health and the environment.

SUXOS: Senior UXO Supervisor.

SWMU: solid waste management unit.

TNT equivalent: Considering the peak overpressure produced by detonation of a given weight of TNT as 100 percent, the TNT equivalency of an explosive is the amount of overpressure produced by detonation of an identical quantity of propellant under comparable conditions, expressed as a percentage.

Transferred range: A military range that is no longer under the control of a DOD component and has been leased, transferred, or returned to another entity (including other federal, non-DOD entities) for use.

Transferring range: A military range that is proposed to be leased or transferred from DOD to another entity or disposed of by conveying title to a non-federal entity. An active range will not be considered a “transferring range” until the transfer is imminent.

TRI: Toxic Release Inventory (required by the EPCRA).

Unexploded ordnance (UXO): Military munitions that have been primed, fused, armed, or otherwise prepared for use and that have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or materiel and that remain unexploded by malfunction, design, or any other cause. UXO presents an immediate risk of acute physical injury from fire or explosion resulting from accidental or unintentional detonation.

Unintentional detonation: A detonation not planned in advance.

USACE: U.S. Army Corps of Engineers.

Used or fired military munitions: Those military munitions that meet the following criteria: (1) have been primed, fused, armed, or otherwise prepared for use, and have been fired, dropped, launched, projected, placed, or otherwise used; (2) munitions fragments, (e.g., shrapnel, casings, fins, and other components, to include arming wires and pins) that result from the use of military munitions; or (3) malfunctions or misfires (e.g., fail to properly fire or detonate).

USFWS: U.S. Fish and Wildlife Service.

USGS: U.S. Geological Survey.

UST: underground storage tank.

UTM: Universal Transverse Mercator.

UXO: unexploded ordnance.

UXO personnel: Contractor personnel who have completed specialized military training in EOD methods and have satisfactorily performed the EOD function while serving in the military. Various grades and contract positions are established based on skills and experience.

UXO Quality Control Specialist (UXOQCS): Contractor personnel with the responsibility of enforcing the contractor's Quality Control Program for all MR-related evolutions; conducting quality control inspections of all UXO and explosives operations for compliance with established procedures; and directing and approving all corrective actions to ensure that all MR-related work complies with contractual requirements.

UXO Safety Officer (UXOSO): Contractor personnel with the responsibility of enforcing the contractor's SSHP. This individual must, therefore, be in the field whenever possible to observe operations. Must have the same minimum qualifications as the UXO Technician III. In addition, must have the specific training, knowledge, and experience necessary to implement the SSHP and verify compliance with applicable safety and health requirements.

UXO Technician II: must be a graduate of the U.S. Army Bomb Disposal School, Aberdeen Proving Ground, MD; the U.S. Naval EOD School, Indian Head, MD; U.S. Naval EOD School, Eglin AFB, FL; or a DOD-equivalent certified course. Must have a minimum of five years of military EOD or contractor UXO experience.

UXO Technician III: supervises a UXO team. Must be a graduate of the U.S. Army Bomb Disposal School, Aberdeen Proving Ground, MD; the U.S. Naval EOD School, Indian Head, MD; U.S. Naval EOD School, Eglin AFB, FL; or a DOD-equivalent certified course. This individual must have a minimum of ten years of military EOD or contractor UXO experience.

UXO: unexploded ordnance.

UXOQCS: UXO Quality Control Specialist.

UXOSO: UXO Safety Officer.

Waste military munitions: A military munition that is a solid waste per 40 CFR §266.202. Such a waste military munition may also be a hazardous waste if it meets the definition found in 40 CFR §261.3. Waste munitions are hazardous wastes when they exhibit the hazardous waste characteristic of ignitability, corrosivity, reactivity, or toxicity, or are listed as hazardous wastes.

WP: white phosphorus: A screening smoke that burns on contact with air and can be used as an incendiary.

Attachment 4: Explosives Management Check List

Date	Check List Item	PM Date Completed	MR Ops Review Date	MR QC NTP Date
	Contract Terms and Conditions			N/A
	Scope of Work			N/A
	Completed: Opportunity Risk Evaluation (ORE), Paragraph 17 MR Projects and CDC Projects			
	Explosive Management Plan (*)			
	Explosive Siting Plan (*)			
	Obtain State/local (if required) Explosive Permit* for CH2M HILL to use high explosives within the state and or local jurisdiction.			
	Obtain State/local (if required) Permit* for CH2M HILL to site explosives magazine within the state and or local jurisdiction.			
	Identify CH2M HILL HILL HILL licensed Blaster* (if self-performing)			
	CH2M HILL ATF&E “Request to Order Explosives” form for Review and obtain authorization signature of ATF Permittee			
	Original signature of ATF&E Type 20 Explosives Manufacture License* from CH2M HILL License Holder			
	“Authorization Letter*” identifying “Responsible Persons” and “Possessor of Explosives” that are authorized to order, receive, store, and use explosives under the CH2M HILL ATF&E Type 20 Explosives Manufacturer License			
	Vender Identified by contracting (If sole source - justification is required)			N/A
	Vender required to provide a copy of their ATF&E License* to CH2M HILL ATF&E files			
STOP!!! MANDATORY MUNITIONS RESPONSE QC CHECK				
	Purchase Order* provided to vender with a copy of ATF&E Type 20 Manufacturer of High Explosives License, with endorsement			

Date	Check List Item	PM Date Completed	MR Ops Review Date	MR QC NTP Date
	Purchase Order* provided to vender with Authorization Letter for Responsible Persons and Employee Possessor of Explosives			
	Award the purchase order to the selected vender - - Hold authorization for Vendor to ship explosives			
	Notify Vendor of CH2M Possessor of Explosives authorized to receive explosives at the project site, telephone number and address of receiving location			
	Vender accepts purchase order and holds for contracting release of explosives shipment			
	Vender identifies carrier and provides a shipment schedule with copy of manifest* to CH2M HILL contracting and contracting notifies the Project Manager			
	Establish Explosives Storage Area (Security, Lightening Protection, Grounding)			
	Schedule State and or local jurisdiction site inspection for "Explosive Storage" (Magazines) if required.			
	Magazine storage area inspected and approved* for storage by local jurisdictions (if required).			
	CH2M HILL contracting notifies vender to release explosives shipment			
	Notify ATF&E servicing office for CH2M HILL ATF&E License*, local ATF&E office*, and local jurisdictions* of storage of explosives and provide an Explosives Siting Plan that includes ATF Form 5400.13/5400.16, Explosives Storage Magazine Description Worksheet* (as required).			
	Post CH2M HILL ATF&E Type 20 License on the project site			
	CH2M HILL "Responsible Person" or Possessor of Explosives" person receives shipment (presents identification to transporter, verifies manifest, and inventories shipment to ensure accuracy between purchase order and manifest. Discrepancies should be resolved IAW the project Explosive Management Plan)			
	Explosive materials are properly inventoried (date shift codes, acquisition dealer, license address, POC), and stored IAW project Explosives Management Plan			
	Material Safety Data Sheets (MSDS) for explosives materials are on-site			

Date	Check List Item	PM Date Completed	MR Ops Review Date	MR QC NTP Date
	Magazine Data Cards (Daily Summary of Magazine Transactions*) are completed and maintained IAW project Explosives Management Plan			
	Magazine has two mortise type 5 (or equivalent) pin high security locks			
	Security Checks conducted a minimum of every 72 hours and documented or IAW work plan approved methods*			
	Responsible person or possessor of explosives has control of keys to magazines (IAW local procedures).			
	Daily Usage (Shot) Log* maintained for expenditure of explosive materials including target materials			
	Weekly inventories of all explosives materials conducted and documented*			
	PM to notify local jurisdictions and ATF&E offices when explosives materials are no longer being stored*			
	*Project Manager to provide to the ATF&E License Holder completed purchase orders, manifest documents, inventories, magazine data cards, usage logs, and any other associated information for ordering, storage and use of explosives material along with an end user certification that all explosives materials have been accounted for.			
	MR Safety Officer shall conduct a quality control audit of the project explosives management plan with ATF&E requirements and report on the conformance of the Project Manager & License Holder.			
	* Indicates documents that upon completion of project will be forwarded to the License Holder and copy to Safety Office			

REQUEST to ORDER EXPLOSIVES		
Instructions: Enter information for the procurement of one (1) Explosive Class/Product Trade Name per request form.		
Block 1.	Block 2.	Block 3.
Project Name	Project Number	Date of Request mm/dd/yyyy
Block 4.	Block 5.	Block 6.
Project Manager (First, Middle, Last)	Office Location/Symbol	Project Manager Telephone Number
Block 7.	Block 8.	Block 9.
Delivery Date mm/dd/yyyy	Delivery Address	Delivery Telephone Number
Street		Block 10.
City		Receiving Person (First, Middle, Last)
County/province		
State		Block 11.
Postal Code		Receiving Person Telephone Number
Country		
Block 12.	Block 13.	Block 14.
Vendor/Supplier/Organization	Vendor ATF License	Vendor ATF License
Block 15.	Block 16.	Block 17.
Vendor/Supplier/Organization		Vendor Telephone Number
Street		
City		Block 18.
County/province		Vendor Point of Contact Person
State		
Postal Code		Primary Tel. #:
Country		2nd Tel.#:
Block 19.	Block 20.	Block 21.
Product Trade Name	Product Unit of Issue (EA, LB, FT, RL,BX)	Product Quantity Requested (Number)
Block 22.	Block 23.	Block 24.
Vendor Lot Number	Vendor Date Shift Code	Vendor MSDS Product Name
Block 25.	Block 26.	Block 27.
DOT EX Number	UN Number	DOT Hazard Class/Division
Block 28.	Block 29.	Block 30.
Estimated Product Cost	Estimated Shipping Cost	Estimated Total Cost
AUTHORIZATION FOR PURCHASING TO ORDER EXPLOSIVES		
ATF Licensee Signature		
Date		

Standard Operating Procedure
Drilling

CH2MHILL

Drilling
Standard of Practice HSE-35

1.0 Applicability and Scope

1.1 Applicability

This Standard of Practice (SOP) applies to: 1) CH2M HILL employees who are potentially exposed to hazards associated with drilling operations because of their proximity to the drilling work location, and/or 2) CH2M HILL Safety Coordinators (SCs) who may be responsible for providing oversight of a drilling subcontractor's operation. This SOP is applicable to all forms of drilling activities, including cable tool, rotary, geo-probe, rotosonic, and hollow-stem auger drilling. Drilling is defined as any man-made boring of holes in hard materials or an earth surface, usually by rotating abrasion or repeated blows.

1.2 Scope

This SOP provides information regarding the spectrum of hazards and issues to be addressed during each phase of a project associated with drilling operations. Drilling hazards addressed in this SOP include contacting overhead powerlines, masts acting as lightning rods, overturning because of top-heavy configuration and poor footing, drilling into underground utilities or structures, catching persons in rotating parts of the drill equipment and drilling operations in areas with known or potential Ordnance Explosives (OE)/Unexploded Ordnance (UXO) hazards (HSE-91). CH2M HILL employees who work in proximity to drilling activities must take precautions to avoid these hazards and be aware of associated safe work practices.

As described in the "Subcontractor, Contractor, and Owner" SOP HSE-55, responsibilities for health and safety (HS&E) are expressly defined through the subcontract terms and conditions, and CH2M HILL's HS&E practices in the field are determined based on these defined responsibilities. Consistent with HSE-55, drilling subcontractors must determine how to drill safely and in compliance with applicable HS&E regulations and industry standards, and how to correct deficiencies. CH2M HILL employees shall not direct the means and methods of safe drilling operations or details of corrective actions.

1.3 Regulatory Review

There are no Occupational Safety and Health Administration (OSHA) regulations specific to drilling activities; however, OSHA has authority to issue citations for unsafe and/or unhealthful conditions based on failure to comply with established industry standards.

2.0 Project Planning

2.1 Training Requirements

CH2M HILL employees who work on projects that involve only drill rigs or earthmoving equipment used for the purpose of moving earth or lifting underground objects (Level 2 construction projects) are required to complete either the CH2M HILL Drilling/Excavating

Construction Safety training course or the CH2M HILL 10-Hour Construction Safety Awareness training course. The 10-Hour course was developed for Level 1 construction projects, but covers the necessary information for Level 2 construction projects.

CH2M HILL employees who work on projects involving construction, renovation/ modification, or demolition of a structure, building, and/or facility; or projects involving heavy equipment, other than drill rigs or earthmoving equipment (Level 1 construction projects) are required to complete the CH2M HILL 10-Hour Construction Safety Awareness training course.

Additional information regarding construction training requirements may be found in the "Frequently Asked Questions: Construction Safety Training" document.

Waste management training is required where waste streams (e.g., drill cuttings, purge water, decontamination water, PPE) will be generated.

Drilling subcontractors are responsible for complying with all applicable HS&E training requirements and for providing the training necessary to complete their tasks safely.

Drilling activities that are performed at hazardous waste projects also require hazardous waste training. Subcontractors are responsible for ensuring their employees have received hazardous waste training.

CH2M HILL employees and subcontractors who work on projects that involve OE must complete the additional training requirements and provide qualified UXO technicians as described in HSE-91.

2.2 Medical Surveillance Requirements

There are no medical surveillance requirements specific to drilling activities; however, locations that involve toxicological (HS-65-70) or OE/UXO (HSE-91) hazards or respiratory protection (HS-08) may require medical surveillance. Subcontractors are responsible for ensuring their employees receive medical surveillance as required.

2.3 Competent Person Requirements

Drilling subcontractors shall provide a competent person to inspect the drill rig and associated equipment and to oversee all drilling activities. The competent person shall be capable of identifying drilling hazards and have the authority to take corrective actions to eliminate the hazards.

CH2M HILL employees and subcontractors who work on projects that involve OE are responsible for providing a competent person to oversee OE operations as described in HSE-91.

2.4 Safety Equipment

Drilling subcontractors are responsible for providing all personal protective equipment (PPE) necessary for its employees. CH2M HILL shall provide PPE only for its own employees. Other safety equipment shall be provided as delineated in the subcontract and referenced documents.

- Detection equipment shall be provided if the exact location of underground utilities cannot be determined.
- Air monitoring instruments shall be provided if the potential for a hazardous atmosphere exists within the drilling location.
- High-visibility warning vests should be provided when personnel are exposed to public vehicular traffic.
- Minimum PPE includes safety-toed shoes/boots, hard hats, safety glasses, and hearing protection. Body protection (such as gloves, coveralls, or Tyvek) and respirators may be needed when chemical hazards exist.
- Fall protection shall be provided when personnel are exposed to a fall of 6 feet or greater. This includes individuals climbing the drill rig mast.
- Lockout/tagout devices may be required for on-the-job maintenance of equipment.
- Adequate supplies of first aid materials should be available at the work site.

2.5 Subcontractor Selection

Drilling subcontractors are selected as described in the "Subcontractor, Contractor, and Owner" SOP HSE-55. The "Subcontractor Safety Procedure Criteria - Drilling" found in Attachment 1 provides the minimum criteria for drilling safety procedures. These criteria shall be used by the Health and Safety Manager (HSM) to review subcontractor drilling procedures submitted when CH2M HILL oversight is required by SOP HSE-55.

OE/UXO subcontractors are selected as described in the "Subcontractor, Contractor, and Owner" SOP HSE-55 and Ordnance Explosives (OE) Standard of Practice HSE- 91. These criteria shall be used by the UXO Safety Officer (UXOSO) to review subcontractor OE/UXO procedures.

2.6 Planning Activities

The exact location of underground utilities and structures must be identified. Many states have a one-call phone number for locating underground utilities (refer to the project's written safety plan). The party responsible for this action shall be delineated in the subcontract.

Drilling subcontractors shall determine the safest drilling location based on topography and location of utility lines, both underground and overhead. It may be necessary for the subcontractor to contact the utility company to deenergize and ground the powerlines when safe clearance distances cannot be maintained from overhead lines.

Subcontractor training and current medical examinations (when required) shall be verified prior to the start of field operations.

Determine if the aquifer is designated as a sole source aquifer, if the project is located near water wells or "well fields" supplying public water systems, or if the project will require withdrawals of large amounts of water. The Environmental Compliance Coordinator (ECC) can determine if these conditions require a permit (see Section 3.3).

Drilling activities that are performed on sites with known or potential Ordnance Explosives (OE) hazards must implement OE/UXO avoidance during access, setup and drilling operations as described in Section 3.2.8 and HSE-91. Subcontractors are responsible for ensuring qualified UXO technicians provide OE/UXO avoidance support (HSE-91).

3.0 Project Execution

3.1 Safe Work Practices

The requirements of this section shall be followed by CH2M HILL employees who are potentially exposed to hazards associated with drilling activities, regardless of the company performing the drilling operation. These requirements also pertain to drilling subcontractor personnel when CH2M HILL is providing oversight.

- Only authorized personnel are permitted to operate drill rigs. Drilling subcontractors shall ensure that each drill rig operator is qualified to safely operate the specific equipment through appropriate training and/or experience.
- Personnel shall be cleared from areas surrounding drill rigs during every startup.
- Personnel shall stay clear of the rotating augers and other rotating components of drill rigs.
- Personnel shall stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel.
- Personnel shall not wear loose-fitting clothing or other items such as rings or watches that could get caught in moving parts. Individuals with long hair should have it restrained.
- If equipment becomes electrically energized, personnel shall be instructed not to touch any part of the equipment or attempt to touch any person who may be in contact with the electrical current. The utility company or appropriate party shall be contacted to have line deenergized prior to approaching the equipment.
- Smoking around drilling operations is prohibited.
- Personnel shall wear the appropriate PPE. Minimum protection includes safety-toed shoes/boots, hard hats, safety glasses, and hearing protection. Gloves, coveralls, Tyvek, and respirators may also be required based on the chemical hazards (refer to the project's written safety plan).

3.2 Regulations/Industry Standards

The following subsections provide the minimum regulatory and industry standard requirements pertaining to drilling operations. Drilling subcontractors are responsible and accountable for implementing these requirements as well as requirements established in their own safety procedures.

As described in the "Subcontractor, Contractor, and Owner" SOP HSE-55, CH2M HILL's project SC may be required to provide oversight of a drilling subcontractor. The following subsections are provided to inform the SC of established regulations and industry standards so that an appropriate level of oversight may be provided. Subcontractors retain control over their practices, and CH2M HILL's oversight does not relieve them of their own responsibility for effective implementation and enforcement of HS&E requirements.

3.2.1 General

- A daily safety briefing/meeting should be conducted with all drilling personnel to discuss the work planned for the day and the HS&E requirements to be followed.
- The drill rig and associated equipment should be inspected each day, before use, to ensure safe operational condition. This inspection should include, at a minimum, the "kill" switch, cathead, ropes, hoses, pressurized lines, operator controls, and drilling tools.

3.2.2 Drill Rig Placement

- The location of underground utilities such as electric, fuel, water, cable, telephone, and sewer either in service or abandoned shall be identified before drilling is permitted. Utility companies and/or installation owners shall be contacted for exact location. When the exact location cannot be identified, detection equipment or other acceptable means of locating the utility lines shall be used before drilling.
- Safe clearance distances shall be maintained between overhead powerlines and any part of the drill rig unless the powerlines have been deenergized and grounded or where insulating barriers have been installed to prevent physical contact. To avoid physical contact and potential arcing from the powerline to the drill rig, rigs shall remain at least 10 feet from overhead powerlines for voltages of 50 kV or less and 10 feet plus ½ inch for every 1 kV over 50 kV. When it is difficult for the drill rig operator to maintain the safe clearance distance, a person shall be designated to observe the clearance and warn the operator.
- Drilling pad preparation is recommended, particularly on steep slopes or areas that are covered with dry dead grass and weeds. Clean fill or gravel can be brought in to cover areas with surface contamination and to construct a relatively level work surface. Care should be taken in constructing pads if extensive cutting into existing slopes or surfaces is required to level the area. Areas in which extensive fill is required should be avoided. Compaction is recommended if significant amounts of fill are needed.
- The drill rig should be leveled and stabilized with jacks and adequate cribbing before raising the mast and during drilling operations. Cribbing materials should be made from materials that are capable of supporting the weight of the rig. Care should be taken in muddy, soggy soils, or partially frozen areas. In addition to cribbing, guy wires should be used to improve stability if the rig is located on wet, partially frozen ground, or in areas with loose, caving soil, or in an area subject to frequent gusty winds.

3.2.3 Drill Rig Travel

- The drill rig should be shut down and the mast lowered and secured prior to moving.
- All tools and equipment should be securely stowed before the drill rig is moved.

- Only personnel in the drill rig cab are permitted to ride the rig.
- The following safe clearance distances shall be maintained while traveling under overhead powerlines with the mast lowered: 4 feet for voltages less than 50 kV, 10 feet for voltages between 50 kV and 345 kV, and 16 feet for voltages between 346 kV and 750 kV.
- A backup alarm or spotter shall be used when backing the drill rig.

3.2.4 Drill Rig Operation

- The drill rig should be provided with a "kill" switch, which, when activated, will shut down the rig. The switch should be clearly identified and tested daily to confirm operational status. All drilling crew members should be made aware of the location and purpose of this switch.
- All machine guards shall be in place while the rig is in operation.
- The rope, wire rope, or cable on the drill rig should never be wrapped around any part of the body.
- Pressurized lines and hose connections should be secured together to prevent whipping. These connections should be inspected daily.
- The drill rig should not be operated during severe inclement weather such as during lightning storms, high winds, or severe rain. The mast should be lowered during these conditions.
- When the potential exists for hazardous atmospheres to develop within the drilling location, air monitoring shall be conducted to ensure it is safe to continue drilling operations (refer to the project's written safety plan).
- The drill gear boxes (transmission for rotary drive, feed control, etc.) should be placed in neutral while an operator is not at the controls. The operator should shut down the rig engine prior to leaving the immediate vicinity of the drill rig.

3.2.5 Drill Rig Maintenance

- Components found to be in defective condition during inspections or during rig operation should be repaired immediately.
- Rig maintenance shall only be performed after appropriate lockout/tagout procedures have been implemented.
- The cathead should be kept clean and free of rust, oil, and grease. The cathead should be cleaned with a wire brush if it becomes rusty. Should the rope "grab" the cathead or otherwise become tangled in the drum, the operator should release the rope and sound an appropriate alarm for all personnel to rapidly back away and stay clear. The operator should also back away and stay clear.
- Clean, dry, and sound rope should be used. A wet or oily rope may "grab" the cathead and cause drill tools or other items to be rapidly hoisted to the top of the mast, where the rope will often break, releasing the tools. If the rope does not break, personnel should be

instructed to stay clear of the drill rig until the operator cautiously returns to turn off the drill rig engine and appropriate action is taken to release the tools. The operator should keep careful watch on the suspended tools and should back away after turning off the engine. The rope should always be protected from contact with all chemicals. Chemicals can cause deterioration of the rope.

- Drilling operations may require repair or disentanglement of wire rope on the mast while it is raised. Fall protection shall be used when personnel are exposed to a fall of 6 feet or greater.
- Augers should be cleaned only when the drill rig is in neutral and the augers have stopped rotating. Hands or feet should not be used to move cuttings away from the auger.
- All work areas, platforms, walkways, scaffolding, and other accessways should be maintained free of materials, debris, obstructions, and substances such as ice, grease, or oil.

3.2.6 Drilling Waste Management

Drill cuttings and purge water where no soil or groundwater contamination shall be managed in accordance with HSE-81 (Non-hazardous Waste Management) and HSE-89 (Wastewater/Storm Water).

3.2.7 Drilling at Hazardous Waste Sites

The Environmental Compliance Coordinator (ECC) shall be consulted on proper evaluation, disposal, and decontamination procedures involving potential hazardous waste.

- All wastes generated shall be evaluated for appropriate disposal (see HSE-78, Waste Analysis and Characterization), HSE-79 (On-site Waste Management) and HSE-80 (Off-site Waste Management).
- If drilling involves hazardous wastes, HSE-13 (Decontamination) shall be followed. No potentially contaminated equipment shall be permitted to leave the work site.

3.2.8 Drilling at Potential OE Sites

If the project site is suspected of OE contamination, the UXO team will conduct a reconnaissance and OE avoidance to provide clear access routes to each site prior to drilling crews entering the area. The following procedures will be implemented:

- Drilling operations on OE sites will not be conducted until a complete plan for the site is prepared and approved by CH2M HILL EE&SBG UXOSO. OE/UXO avoidance must be conducted during drilling operations on known or suspect OE sites (HSE-91).
- The UXO team will identify, and clearly mark the boundaries of a clear approach path for the drilling crews, vehicles, and equipment to enter the site. This path will be, at a minimum, twice the width of the widest vehicle. No personnel will be allowed outside any marked boundary.
- If OE is encountered on the ground surface, the UXO team will clearly mark the area where it is found, report it to the proper authorities, and divert the approach path around it.
- The UXO team will conduct an access survey using the appropriate geophysical instrument over the approach path for avoidance of OE that may be in the subsurface. If a magnetic anomaly is encountered, it will be assumed to be OE and the approach path will be diverted

around the anomaly. UXO personnel only will operate the appropriate geophysical instrument and identify OE.

- An incremental geophysical survey of the drill hole location(s) will be initially accomplished by the UXO team using a hand auger to install a pilot hole. If OE is encountered or an anomaly cannot be positively identified as inert material, HTRW sampling personnel will select a new drill hole location.
- Once a drilling site has been surface cleared and a pilot hole established as described above, the drilling contractor will be notified that the site is available for subsurface drilling.

3.3 Forms/Permits

There are no CH2M HILL forms or permits required for drilling activities.

The following permits and notifications may be required, depending on state or local requirements. The ECC should be contacted to determine applicability.

- Well driller's license/certification or Professional Geologist requirements. Subcontractors are required to submit copies of licenses/certifications prior to subcontract award.
- Drill rig permit.
- Well installation or abandonment notification. Submittal of well log or inventory may be required after installation or abandonment.
- A groundwater withdrawal permit may be required for large water withdrawals in some states. Check with the ECC for specific requirements.
- A "dig permit" may be required at certain client facilities.

3.4 Self-Assessment Checklists

The "HS&E Self-Assessment Checklist - Drilling" found in Attachment 2 is provided as a method of verifying compliance with established safe work practices, regulations, and industry standards pertaining to drilling operations. CH2M HILL's project SC shall use this checklist when: 1) CH2M HILL employees are potentially exposed to hazards associated with drilling operations, and/or 2) CH2M HILL oversight of a drilling subcontractor is required by the "Subcontractor, Contractor, and Owner" SOP HSE-55. The HSM shall specify the frequency in which this checklist shall be completed and provide this information in the project's written safety plan. Completed checklists shall be sent to the HSM for review. The HSM shall assist the SC in resolving any deficiencies identified during the self-assessment. This SOP may be used to clarify checklist questions.

4.0 Attachments

Attachment 1: Subcontractor Safety Procedure Criteria - Drilling

Attachment 2: HS&E Self-Assessment Checklist - Drilling

Attachment 1

Subcontractor Safety Procedure Criteria - Drilling

CH2MHILL

Subcontractor Safety Procedure Criteria - Drilling

The following criteria are not intended to be all inclusive, but are provided as a tool to facilitate development and review of subcontractor safety procedures. Subcontractors are expected to address the following items, at a minimum, in their safety procedures.

Minimum Acceptable Criteria for Subcontractor Drilling Safety Procedures:

1 Provide name and qualifications of the drilling "competent person" responsible for drilling (years and type of experience, training background, etc.):

2 Describe drill rig and equipment inspection criteria or procedures (frequency of inspections, visual vs. written inspections, items that are inspected):

3 Describe methods of identifying underground utilities (contacting utility companies, detection equipment):

4 Describe methods of avoiding contact with overhead powerlines (deenergizing and grounding, insulating, safe clearance distances):

5 Describe methods to identify hazardous atmospheres and controls used to eliminate (detection equipment and controls):

6 Describe leveling and stabilizing methods of drill rig (drilling pad, jacks, cribbing, guy wires):

7 Verify that rig equipment is in good operational condition (including, "kill" switch, cathead, ropes, pressurized hoses and lines, operator controls, machine guards, and drilling tools):

8 Describe procedures for operating in inclement weather, including lightning, high winds, severe rain storms:

9 Describe other safe work practices for equipment operation (drill rig, equipment, tools, rig transportation, rig travel):

10 Describe on-the-job maintenance procedures, including lockout/tagout:

11 Describe safe work practices for other activities to be performed during this project (use of ladders, fall protection, use of electrical power tools, use of personal protective equipment, etc.):

12 Describe methods for disposal of non-hazardous drill cuttings and purge water (including accumulation, transport and disposal):

13 If hazardous waste project, provide documentation of hazardous waste worker training and medical surveillance records for all project personnel (40-hour or 24-hour training, 8-hour refresher training) and describe methods of hazardous waste management (including accumulation, transport and disposal):

14 Submit a copy of drilling license/certification and drill rig permit.

15 Describe methods and responsibilities for submittal of notifications and logs:

16 Complete the Waste Subcontractor Qualification Form for each proposed transport and disposal facility.

17 Describe procedures for OE avoidance, identification and marking the boundaries of a clear approach path and work site for the sampling crews, vehicles, and equipment to enter the site. (HSE-91

18 If this is an OE project, provide documentation of UXO qualifications, hazardous waste worker training and medical surveillance records for all project personnel (40-hour or 24-hour training, 8-hour refresher training) for review by the CH2M HILL EE&SBG UXOSO (HSE-91).

19 Describe the procedures for drilling, monitoring and process for encountered OE. (HSE-91)

Drilling
Standard of Practice HSE-35
Attachment 2

HS&E Self-Assessment Checklist - Drilling

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to hazards associated with drilling operations (complete Sections 1 and 3), and/or 2) CH2M HILL oversight of a drilling subcontractor is required (complete entire checklist).

SC may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Completed checklists shall be sent to the health and safety manager for review.

Project Name: __Site 3 Delineation/Confirmation Sampling Event_________ Project No.: 138804.CI.FS_____

Location: St. Julians Creek Annex, Chesapeake VA_____ PM: __William Friedmann____

Auditor: ____________________________________ Title: _________________________________ Date: _____________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards
X Evaluate a CH2M HILL subcontractor's compliance with drilling HS&E requirements
Subcontractors Name: ____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-35.

SECTION 1	Yes	No	N/A	N/O
PERSONNEL SAFE WORK PRACTICES (3.1)				
1. Only authorized personnel operating drill rig	☐	☐	☐	☐
2. Personnel cleared during rig startup	☐	☐	☐	☐
3. Personnel clear of rotating parts	☐	☐	☐	☐
4. Personnel not positioned under hoisted loads	☐	☐	☐	☐
5. Loose clothing and jewelry removed	☐	☐	☐	☐
6. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐
7. Smoking is prohibited around drilling operation	☐	☐	☐	☐
8. Personnel wearing appropriate PPE, per HSP/FSI	☐	☐	☐	☐
9. OE/UXO avoidance provided, ,routes and boundaries cleared and marked	☐	☐	☐	☐
10. OE sites, Initial pilot hole established by UXO technician with hand auger.	☐	☐	☐	☐

SECTION 2	**Yes**	**No**	**N/A**	**N/O**
GENERAL (3.2.1)				
11. Aquifer evaluated for contamination, sole source and wellhead protection	☐	☐	☐	☐
. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
14. Approved OE/UXO plan utilized on site	☐	☐	☐	☐
DRILL RIG PLACEMENT (3.2.2)				
12. Location of underground utilities identified	☐	☐	☐	☐
13. Safe clearance distance maintained from overhead powerlines	☐	☐	☐	☐
14. Drilling pad established, when necessary	☐	☐	☐	☐
15. Drill rig leveled and stabilized	☐	☐	☐	☐
DRILL RIG TRAVEL (3.2.3)				
16. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
17. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
18. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
19. Safe clearance distance maintained while traveling under overhead powerlines	☐	☐	☐	☐
20. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (3.2.4)				
21. Kill switch clearly identified and operational	☐	☐	☐	☐
22. All machine guards are in place	☐	☐	☐	☐
23. Rig ropes not wrapped around body parts	☐	☐	☐	☐
24. Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
25. Drill operation stopped during inclement weather	☐	☐	☐	☐
26. Air monitoring conducted per HSP/FSI for hazardous atmospheres	☐	☐	☐	☐
27. Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG MAINTENANCE (3.2.5)				
28. Defective components repaired immediately	☐	☐	☐	☐
29. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
30. Cathead in clean, sound condition	☐	☐	☐	☐
31. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
32. Fall protection used for fall exposures of 6 feet or greater	☐	☐	☐	☐
33. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
34. Good housekeeping maintained on and around rig	☐	☐	☐	☐
DRILLING WASTE MANAGEMENT (3.2.6)				
35. Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (3.2.7)				
36. Waste disposed of according to HSP and RCRA regulations	☐	☐	☐	☐
37. Appropriate decontamination procedures being followed, per HSP	☐	☐	☐	☐
FORMS/PERMITS (3.3)				
38. Driller license/certification and drill rig permit obtained	☐	☐	☐	☐
39. Well development/abandonment notifications and logs submitted and in project files	☐	☐	☐	☐
40. Water withdrawal permit obtained, where required	☐	☐	☐	☐
41. Dig permit obtained, where required	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked “No” in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Standard Operating Procedure
General Guidance for Monitoring Well Installation

STANDARD OPERATING PROCEDURE

General Guidance for Monitoring Well Installation

I. Purpose

To provide site personnel with a review of the well installation procedures that will be performed. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

II. Scope

Monitoring well installations are planned for shallow and/or deep unconsolidated aquifers and/or for bedrock aquifers. The SOPs *Installation of Shallow Monitoring Wells, Installation of Surface-Cased Monitoring Wells, Installation of Bedrock Monitoring Wells,* and *Installation of Monitoring Wells Using Sonic Drilling* provide more specifics.

III. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Development equipment

IV. Procedures and Guidelines

1. Wells will be installed in accordance with standard EPA procedures. Note that USEPA Region III requires any well penetrating a confining layer to be double cased.
2. The threaded connections will be water-tight.
3. Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments. The exact slot size and length will be determined by the field team supervisor. Stainless steel may be required under certain contaminant conditions.
4. Wells will be surrounded by four concrete-filled, 3-inch diameter guard posts.

5. A record of the finished well construction will be compiled.
6. All soils and liquids generated during well installations will be drummed for proper disposal.

Monitoring Well Installation

- Monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.
- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).
- Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC screen with threaded bottom plug and riser.
- Screens will be filter packed with a proper sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The primary filter sand pack (typically Morie #1 or #2) will extend from 1 to 2 feet below the base to 2 feet above the top of the screen; filter pack will be allowed to settle and hydrate before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed using a tremie pipe and flowing water.
- A secondary filter sand pack (typically Morie #00) 1 foot thick will be placed above the primary sand pack.
- Annular well seals will consist of 2 feet of pelletized or granular bentonite clay placed above the filter pack. If necessary the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry introduced with a side-discharging tremie pipe will be used for the bentonite seals in wells greater than 30 feet deep. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape. High-solids slurries will have solids content of at least 20 percent.
- The top of the annular seal will be measured after the pellets have been allowed to hydrate and before the grout is applied. The pellets will be allowed to hydrate for at least 30 minutes before work in the well continues.

- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.
- The grout mixture consists of 94 pounds (lbs) of cement (1 bag) per 6 gallons of water and 2 to 3 lbs of powdered bentonite per bag of cement to reduce shrinkage.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the bottom of the space to be grouted to the surface.
- After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.
- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade, and will be painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least-contaminated well first.
- Development will include surging the well by abruptly stopping flow and allowing water in the well column to fall back into the well.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.
- The air-lift method may be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums. CH2M HILL will label and date the drums, and transport the drums to a designated site for storage.

V. Attachments

None.

VI. Key Check and Items

Ensure that all equipment is properly decontaminated as needed. Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well. Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

Standard Operating Procedure
Installation of Shallow Monitoring Wells

STANDARD OPERATING PROCEDURE

Installation of Shallow Monitoring Wells

I. Purpose and Scope

The purpose of this guideline is to describe methods for drilling and installation of shallow monitoring wells and piezometers in unconsolidated or poorly consolidated materials. Methods for drilling and installing bedrock monitoring wells are presented in SOP Installation of Bedrock Monitoring Wells.

II. Equipment and Materials

Drilling

- Drilling rig
- Hollow-stem augers

Well Riser/Screen

- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded riser; alternatively, stainlesss steel riser
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted screen; alternatively, stainless steel screen.

Bottom Cap

- PVC, threaded to match the well screen; alternatively, stainless steel
- Centering Guides (if used)

Well Cap

- Above-grade well completion: PVC, threaded or push-on type, vented
- Flush-mount well completion: PVC, locking, leak-proof seal
- Stainless steel to be used as appropriate

Sand

- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse) filter pack, and secondary (fine) filter pack. Grain size determined based on sediments observed during drilling.

Bentonite

- Pure, additive-free bentonite pellets
- Pure, additive-free powdered bentonite

- Coated bentonite pellets; coating must biodegrade within 7 days
- Cement-Bentonite Grout: proportion of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage

Protective Casing

- Above-grade well completion: 6-inch minimum ID steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate
- Flush-mount well completion: Morrison 9-inch or 12-inch 519 manhole cover, or equivalent; rubber seal to prevent leakage; locking cover inside of road box

Well Development

- Double surge block with solid bottom, top open, separated by 2 feet of slotted pipe
- Well-development pump, and associated equipment
- Containers (e.g., 55 gallon drums) for water produced from well.

III. Procedures and Guidelines

A. Drilling Method

Continuous-flight hollow-stem augers with a minimum 6-inch inside diameter (ID) will be used to drill shallow monitoring well boreholes. Split-spoon samples will be collected at selected intervals for chemical analysis and/or lithologic classification. Soil sampling procedures are detailed in SOP Shallow Soil Sampling.

The use of water to assist in hollow-stem auger drilling for monitoring well installation will be avoided, unless required for such conditions as running sands.

Hollow-stem augers, rods, split-spoon samplers, and other downhole drilling tools will be properly decontaminated prior to the initiation of drilling activities and between each borehole location. Split-spoon samplers and other downhole soil sampling equipment will also be properly decontaminated before and after each use. SOP Decon details proper decontamination procedures.

Drill cuttings and decontamination fluids generated during well drilling activities will be contained according to the procedures detailed in the Field Sampling Plan.

B. Monitoring Well Installation

Shallow monitoring wells will be constructed inside the hollow-stem augers, once the borehole has been advanced to the desired depth. If the borehole has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or a bentonite-cement slurry to a depth approximately 1 foot below the intended well depth. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight and lowered inside the augers to the bottom of the borehole. Centering guides, if used, will be placed at the bottom of the screen and above the interval in which the bentonite seal is placed.

Selection of the filter pack and well screen intervals for the shallow monitoring wells shall be made in the field. Based on lithologic samples previously obtained at the site, and comparison with samples to be obtained in the well borings, standard well screen slot of 0.010-inch and silica sand gradations conforming to Morie No. 1 are anticipated.

A primary sand pack (Morie No. 1) consisting of clean silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. The augers will be raised gradually during sand pack installation to avoid caving of the borehole wall; at no time will the augers be raised higher than the top of the sand pack during installation. During placement of the sand, the position of the top of the sand will be continuously sounded. The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary, finer-grained, sand pack will be installed for a minimum of 1 foot above the coarse sand pack. Heights of the coarse and fine sand packs and bentonite seal may be modified in the field to account for the shallow water table and small saturated thickness of the surficial aquifer.

A bentonite pellet seal at least 2 feet thick will be placed above the sand pack. The pellets will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface through a tremie pipe. The tremie pipe must be plugged at the bottom and have small openings along the sides of the bottom 1-foot length of pipe. This will allow the grout to diffuse laterally into the borehole and not disturb the bentonite pellet seal.

For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend at least 3 feet into the ground and 2 feet above ground but should not penetrate the bentonite seal. The concrete pad will be square or round, with a minimum radius of approximately 3.5 feet. The concrete will be sloped away from the protective casing.

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing, within the edges of the concrete pad. Guard posts will be concrete-filled, at least 2 inches in diameter, and will extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 3 feet per side, will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12-inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

C. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include two surge blocks separated by approximately 2 feet of coarsely slotted pipe. The lower surge block will be solid; the upper surge block will be open and attached to riser pipe leading to the ground surface. Water will be pumped continuously from the surge block screened interval throughout the surging process. The pumping will be accomplished by airlift induction methods or using a centrifugal pump or equivalent.

Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone.

Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP Decontamination of Personnel and Equipment. Water generated during well development will be contained and managed as detailed in the Field Sampling Plan Investigation Denied Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring well construction

PROJECT NUMBER	WELL NUMBER SHEET 1 OF 1

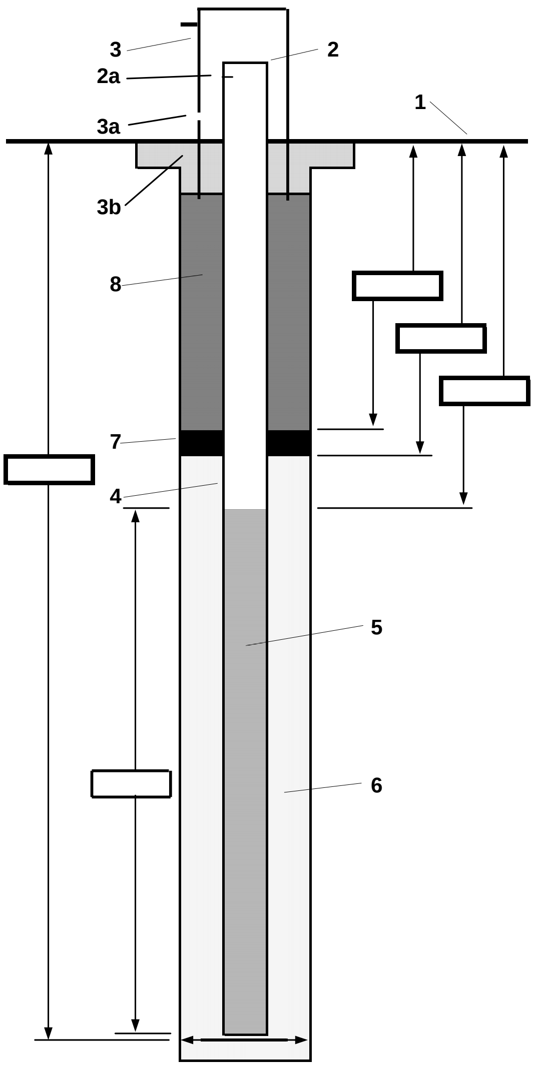
WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well ____________________

2- Top of casing elevation ____________________
a) vent hole? ____________________

3- Wellhead protection cover type ____________________
a) weep hole? ____________________
b) concrete pad dimensions ____________________

4- Dia./type of well casing ____________________

5- Type/slot size of screen ____________________

6- Type screen filter ____________________
a) Quantity used ____________________

7- Type of seal ____________________
a) Quantity used ____________________

8- Grout
a) Grout mix used ____________________
b) Method of placement ____________________
c) Vol. of well casing grout ____________________

Development method ____________________

Development time ____________________

Estimated purge volume ____________________

Comments ____________________

Standard Operating Procedure
Water-Level Measurements

STANDARD OPERATING PROCEDURE

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in monitoring wells, where a second phase of floating liquid (e.g., gasoline) is not encountered. This SOP includes guidelines for discrete measurements of static water levels.

II. Equipment and Materials

A. Discrete Measurements of Static Water Level

- Electronic water level meter, Solinst or equivalent, with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less

III. Procedures and Guidelines

A. Measurement of Static Water Level

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Sight across the top of the locking well casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface. The measuring point will be a standardized surveyed location on the top of each well casing, adjacent to the lock hasp, indicated by a notch, paint mark, or similar method. Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the log book.

Measure and record the three following additional readings: (1) the depth of the well; (2) the depth from the top of the casing to the top of the well riser; and (3) the distance to the surface of the concrete pad or to ground. Measurements are to be taken with respect to the measuring point on the top of the well casing. The depth of the well may be measured using the water-level probe with the instrument turned off.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

A. Discrete Measurements of Static Water Level

Prior to each use, verify that the battery is charged by pressing the test button on the water-level meter. Verify that the unit is operating correctly by testing the probe in distilled or deionized water. Leave the unit turned off when not in use.

Standard Operating Procedure
Soil Sampling

STANDARD OPERATING PROCEDURE

Soil Sampling

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using hand and drilling-rig mounted equipment.

II. Equipment and Materials

- Stainless-steel trowel, shovel, scoopula, coring device, trier, hand auger, or other appropriate hand tool
- Stainless-steel, split-spoon samplers
- Thin-walled sampling tubes
- Drilling rig or soil-coring rig
- Stainless-steel pan or bowl
- Sample bottles

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP *Decontamination of Drilling Rigs and Equipment*. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed; soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. A stainless-steel or dedicated wooden tongue depressor is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

More details are provided in the SOP *Shallow Soil Sampling.*

B. Split-Spoon Sampling

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight (``hammer'') dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for samples for all other parameters should be removed to a decontaminated stainless steel tray. The sample for semivolatile organic and inorganic analyses should be homogenized in the field by breaking the sample into small pieces and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the sample and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

C. Thin-Walled Tube Sampling

Undisturbed samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24- to 36 inches long and 3- to 4-inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax and then sealed with end caps and heavy tape. The sample designation, data and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing, which could disrupt the undisturbed nature of the sample. Samples for analysis normally are not collected from thin-walled tube samples.

IV. Attachments

ASTM D 1586.

ASTM D 1587

V. Key Checks and Preventative Maintenance

Check that decontamination of equipment is thorough. Check that sample collection is swift to avoid loss of volatile organics during sampling.

Designation: D 1586 – 84 (Reapproved 1992)$^{\epsilon 1}$

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. Consult the DOD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

ε1 Note—Editorial changes were made throughout October 1992.

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.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[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]

3. Terminology

3.1 *Descriptions 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 ± 2 lb (63.5 ± 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 widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

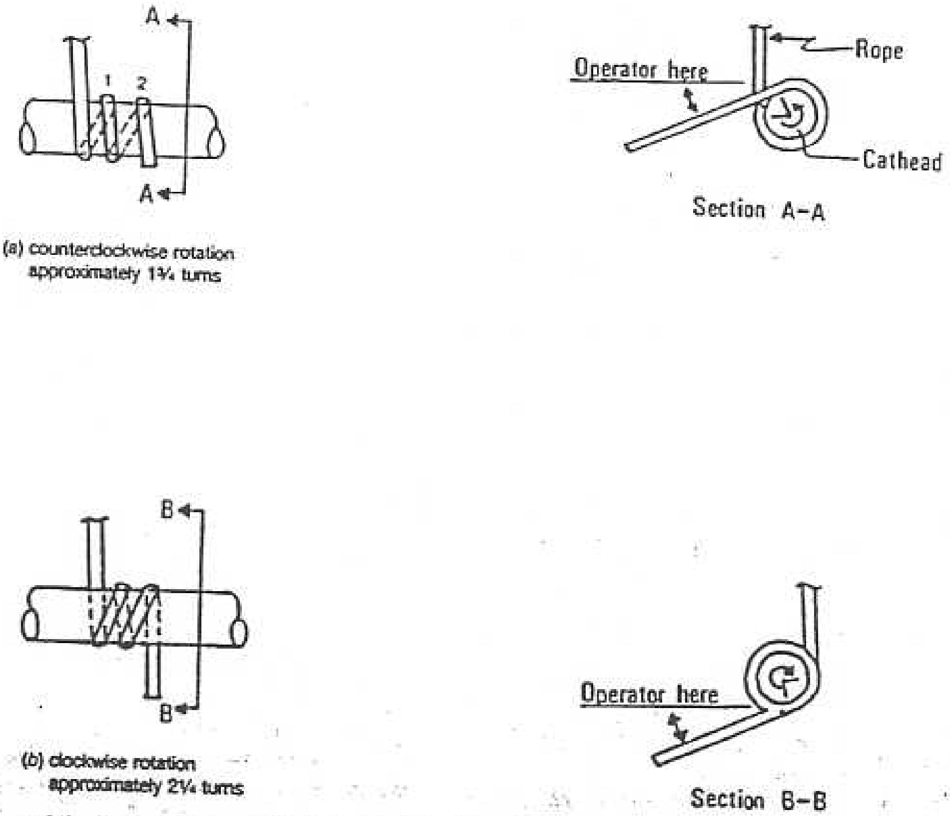
5. Apparatus

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

[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.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 67 (1974).

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



(*a*) counterclockwise rotation approximately $1\frac{3}{4}$ turns

(*b*) clockwise rotation approximately $2\frac{1}{4}$ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

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 $1\frac{5}{8}$ in. (41.2 mm) and an inside diameter of $1\frac{1}{8}$ in. (28.5 mm).

NOTE 1—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 $1\frac{3}{8}$ 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.

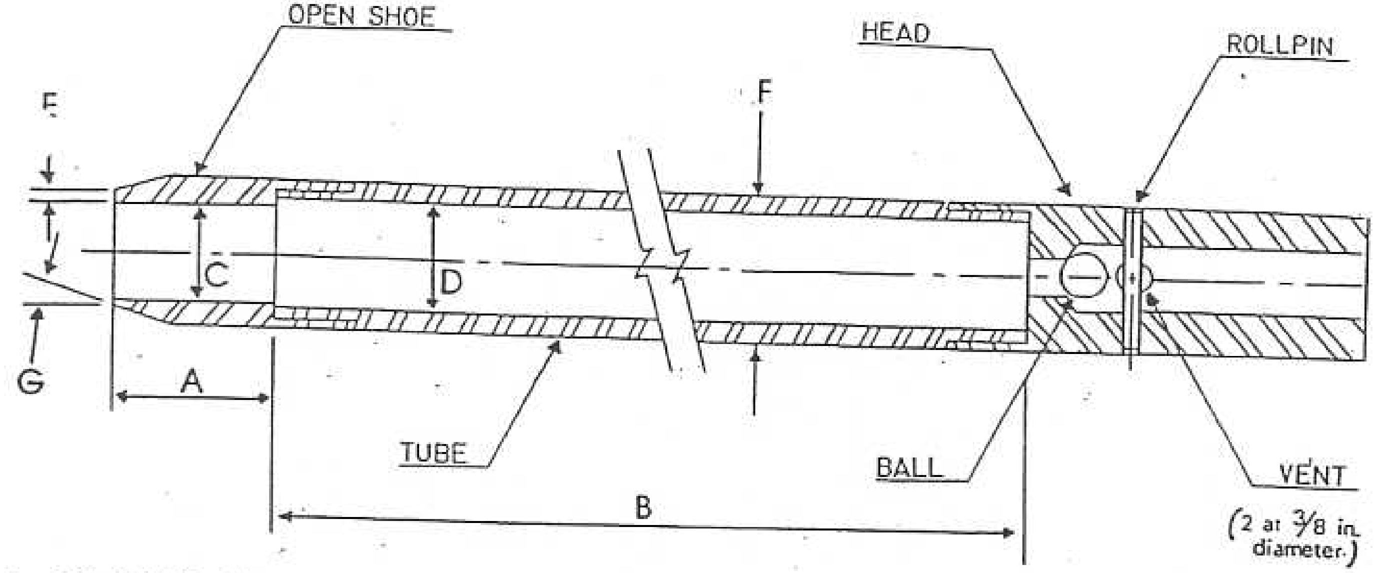
NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

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 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 3—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



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

the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, ...le 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 ... or below the upper confining bed of a confined ...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 4—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 2¾ or 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 ; designation, boring number, sample depth, and the bl 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 ro 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 extreme massive or damaged anvil, a rusty cathead, a low sp cathead, an old, oily rope, or massive or poorly lubrica 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 hammer energy delivered into the drill rods from the ...pler 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

Standard Practice for Thin-Walled Tube Sampling of Soils[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 practice has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

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 structural properties. Thin-walled tubes used in piston, plug, or rotary-type samplers, such as the Denison or Pitcher, must comply with the portions of this practice which describe the thin-walled tubes (5.3).

NOTE 1—This practice does not apply to liners used within the above samplers.

2. Referenced Documents

2.1 *ASTM Standards:*

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 4220 Practices for Preserving and Transporting Soil mples[2]

3. Summary of Practice

3.1 A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the in-situ soil, removing the soil-filled tube, and sealing the ends to prevent the soil from being disturbed or losing moisture.

4. Significance and Use

4.1 This practice, or Practice D 3550, is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of structural properties or other tests that might be influenced by soil disturbance.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment may be used that provides a reasonably clean hole; that does not disturb 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.

5.2 *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.

5.3 *Thin-Walled Tubes,* should be manufactured as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. and be made of metal having adequate strength for use in the soil and formation intended. Tubes shall be clean and free of all surface irregularities including projecting weld seams.

5.3.1 *Length of Tubes*—See Table 1 and 6.4.

5.3.2 *Tolerances,* shall be within the limits shown in Table 2.

5.3.3 *Inside Clearance Ratio,* should be 1 % or as specified by the engineer or geologist for the soil and formation to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled. See Fig. 1 for definition of inside clearance ratio.

5.3.4 *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. Tubes which will contain samples for more than 72 h shall be coated. The type of coating to be used may vary depending upon the material to be sampled. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, and others. Type of coating must be specified by the engineer or geologist if storage will exceed 72 h. Plating of the tubes or alternate base metals may be specified by the engineer or geologist.

5.4 *Sampler Head,* serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a suitable check valve and a venting area to the outside equal to or greater than the area through the check valve. 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.

6. Procedure

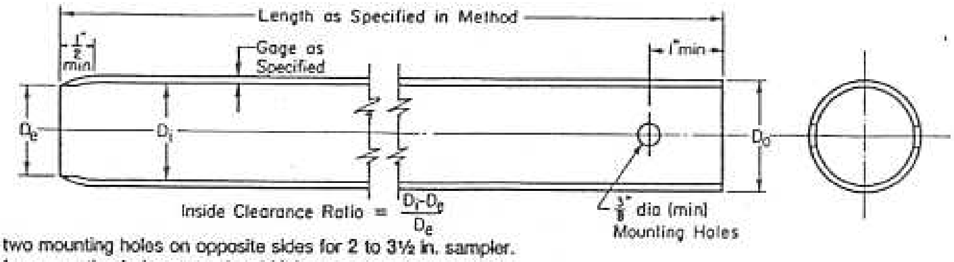
6.1 Clean out the borehole to sampling elevation using whatever method is preferred that will ensure the material to be sampled is not disturbed. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the sampling operation.

6.2 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. Remove loose material from the center of a casing or hollow stem auger as carefully as

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and R[illegible]nd is the direct responsibility of Subcommittee D18.02 on Sampling and I[illegible] Field Testing for Soil Investigations.

[illegible]ent edition approved Aug. 17, 1983. Published October 1983. Originally published as D 1587 – 58 T. Last previous edition D 1587 – 74.

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



NOTE 1—Minimum of two mounting holes on opposite sides for 2 to 3½ in. sampler.
NOTE 2—Minimum of four mounting holes spaced at 90° for samplers 4 in. and larger.
NOTE 3—Tube held with hardened screws.
NOTE 4—Two-inch 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 Equivalents

in.	mm
¼	6.77
½	12.7
1	25.4
2	50.8
3½	88.9
4	101.6

FIG. 1 Thin-Walled Tube for Sampling

TABLE 1 Suitable Thin-Walled Steel Sample Tubes[A]

Outside diameter:			
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
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

Size Outside Diameter	Nominal Tube Diameters from Table 1[A] Tolerances, in. 2	3	5
Outside diameter	+0.007 −0.000	+0.010 −0.000	+0.015 −0.000
Inside diameter	+0.000 −0.007	+0.000 −0.010	+0.000 −0.015
Wall thickness	±0.007	±0.010	±0.015
Ovality	0.015	0.020	0.030
Straightness	0.030/ft	0.030/ft	0.030/ft

[A] Intermediate or larger diameters should be proportional. Tolerances shown are essentially standard commercial manufacturing tolerances for seamless steel mechanical tubing. Specify only two of the first three tolerances; that is, O.D. and I.D., or O.D. and Wall, or I.D. and Wall.

possible to avoid disturbance of the material to be sampled.

NOTE 2—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.

6.3 Place the sample tube so that its bottom rests on the bottom of the hole. Advance the sampler without rotation by a continuous relatively rapid motion.

6.4 Determine the length of advance by the resistance and condition of the 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.

NOTE 3—Weight of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 1.

6.5 When the formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. Other methods, as directed by the engineer or geologist, may be used. If driving methods are used, the data regard weight and fall of the hammer and penetration achie must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

6.6 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. for sludge-end cuttings.

NOTE 4—The tube may be rotated to shear bottom of the sample after pressing is complete.

6.7 Withdraw the sampler from the formation as carefully as possible in order to minimize disturbance of the sample.

7. Preparation for Shipment

7.1 Upon removal of the tube, measure the length of sample in the tube. Remove the disturbed material in the upper end of the tube and measure the length again. Seal the upper end of the tube. Remove at least 1 in. 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 if so directed by the engineer or geologist.

NOTE 5—Field extrusion and packaging of extruded samples under the specific direction of a geotechnical engineer or geologist is permitted.
NOTE 6—Tubes sealed over the ends as opposed to those sealed with expanding packers should contain end padding in end voids in order to prevent drainage or movement of the sample within the tube.

7.2 Prepare and immediately affix labels or apply m... ings as necessary to identify the sample. Assure that the

:ings or labels are adequate to survive transportation storage.

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| The appropriate information is required as follows:

1.1 Name and location of the project,

1.2 Boring number and precise location on project,

1.3 Surface elevation or reference to a datum,

1.4 Date and time of boring—start and finish,

1.5 Depth to top of sample and number of sample,

1.6 Description of sampler: size, type of metal, type of ing,

1.7 Method of sampler insertion: push or drive,

8.1.8 Method of drilling, size of hole, casing, and drilling fluid used,

8.1.9 Depth to groundwater level: date and time measured,

8.1.10 Any possible current or tidal effect on water level,

8.1.11 Soil description in accordance with Practice D 2488,

8.1.12 Length of sampler advance, and

8.1.13 Recovery: length of sample obtained.

9. Precision and Bias

9.1 This practice does not produce numerical data; therefore, a precision and bias statement is not applicable.

Standard Operating Procedure
Shallow Soil Sampling

STANDARD OPERATING PROCEDURE

Shallow Soil Sampling

I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless steel, teflon, or glass materials should be used. The only exception is split spoons, which are most commonly available in carbon steel; these are acceptable for use only if they are not rusty.
- A stainless steel spatula should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Vermiculite
- Fiberglass measuring tape (at least 200 feet in length)

IV. Procedures and Guidelines

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

1. For samples on a grid:

   a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

b. Proceed to sample the points on the grid line.

c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

d. Proceed to sample the points on the grid line as described in Section C below.

e. Repeat 1c and 1d above until all samples are collected from the area.

2. For non-grid samples:

a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

c. Proceed to sample as described in Section C below.

d. Repeat 2a through 2c above until all samples are collected from the area.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of rooves, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Supervisor (FTS). If the FTS concurs, the sampling point will be deleted from the program. The FTS will contact the CH2M HILL project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples:

1. Use a decontaminated stainless steel scoop/trowel to scrape away surficial organic material (grass, leaves, etc.) adjacent to the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:

a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.

b. Subsurface soil. Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Take an OVM reading of the sampled soil and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.

4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan.

5. Repeat this procedure until sufficient soil is collected to meet volume requirements.

6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel/ scoop and cap immediately upon filling. DO NOT HOMOGENIZE.

7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless steel utensil in accordance with SOP Decon.

8. Transfer sample for analysis into appropriate containers with a decontaminated utensil.

9. Backfill the hole with vermiculite. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

V. Attachments

None.

VI. Key Checks and Items

- Phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.

Standard Operating Procedure
Logging of Soil Borings

STANDARD OPERATING PROCEDURE

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCl, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification

III. Procedures and Guidelines

This section covers several aspects of the soil characterization: instructions for completing the CH2M HILL soil boring log Form D1586, field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

B. Heading Information

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If stationing, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first initial and full last name.

C. Technical Data

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1 foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as "WOH."

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons.

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below. `

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488-93, Visual-Manual Procedure for Description and Identification of Soils.

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests (ASTM D 2487). It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488-93, attached). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488-93 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488-93.

E. Soil Name

The basic name of a soil should be the ASTM D 2488-93 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488-93. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488-93.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488-93.

F. Group Symbol

The appropriate group symbol from ASTM D 2488-93 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488-93, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group. Grain size is estimated in accordance with ASTM D 2488-93 (Table 2).

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on Table 3.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586-84). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in Tables 4 and 5.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586-84. The split-barrel sampler should measure 2-inch or 3-inch O.D., and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is “A” rod (1-5/8-inch O.D.). A stiffer rod, such as an “N” rod (2-5/8-inch O.D.), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log, CH2M HILL Form D1586, and a completed example

ASTM D 2488-90: Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).

V. Key Checks and Preventive Maintenance

Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later. Check that sample numbers and intervals are properly specified. Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP Decontamination of Drilling Rigs and Equipment.

CH2M HILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT ____________ LOCATION ____________

ELEVATION ____________ DRILLING CONTRACTOR ____________

DRILLING METHOD AND EQUIPMENT ____________

WATER LEVELS ____________ START ____________ FINISH ____________ LOGGER ____________

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

Figure 1
SOIL BORING LOG, FORM D1586

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
DEN 22371.G5	BL-3	1 OF 3

SOIL BORING LOG

PROJECT Howard Ave Landslide LOCATION Howard & 24th Ave, Centennial, CO
ELEVATION 5136 Feet DRILLING CONTRACTOR Kendall Explorations, Ashcan, Colorado
DRILLING METHOD AND EQUIPMENT 4"-inch H.S. Augers, Mobil B-61 rotary drill rig
WATER LEVELS 3.2 Feet, 8/5/89 START August 4, 1989 FINISH August 8, 1989 LOGGER J.A. Michner

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: NUMBER AND TYPE	SAMPLE: RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	2.5				Surface material consist of 4 inches AC underlain by 6 inches of 3/4 inch minus base rock	Start Drilling @ 3:00
	4.0	1-S	1.5	2-3-4 (7)	POORLY-GRADED SAND WITH SILT, (SP-SM), fine, light brown, wet, loose	Driller notes water at 4 feet
5	5.0 / 6.5	2-S	0.9	WOH/12"-1	ORGANIC SILT, (OL), very dark, gray to black, wet, very soft; strong H_2S odor, many fine roots up to about 1/4 inch	Driller notes very soft drilling 4ft. dark grey, wet silty cuttings.
	8.0 / 10.0	3-ST	1.3	—	ORGANIC SILT, similar to 2-S, except includes fewer roots (by volume)	
10	11.5	4-S	1.3	2-2-2 (4)	SILT, (ML), very dark gray to black, wet, soft	water level @ 3.2 feet on 8/5/89 @ 0730 Driller notes rough drilling action and chatter @ 13 ft
15	15.0 / 15.5	5-S	0.5	60/6"	SILTY GRAVEL, (GM), rounded gravel up to about 1 inch maximum observed size, wet, very dense	
20	20.0 / 21.0	6-S	1.0	12-50/6"	LEAN CLAY WITH SAND, (CL), medium to light green, moist, very stiff	Driller notes smoother, firm drilling @ 19 ft some angular rock chips @ bot tip of 6-S, poss boulders or rock Driller notes very hard, slow grinding, smooth drilling action from 21 to 23 ft, possibly bedrock
	23.0 / 23.1	7-S	0	50/1"	NO RECOVERY	
					END SOIL BORING @ 23.1 FEET SEE ROCK CORE LOG FOR CONTINUATION OF BL-3	

Figure 2
EXAMPLE OF COMPLETED LOG FORM

REV 11 89 FORM D1586

Designation: D 2488 – 93

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. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by 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 *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.

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

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

3. Terminology

3.1 *Definitions:*

3.1.1 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.

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

3.1.1.3 *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.

3.1.1.4 *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.

3.1.1.5 *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.

3.1.1.6 *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.

3.1.1.7 *sand*—particles of rock that will pass a No.

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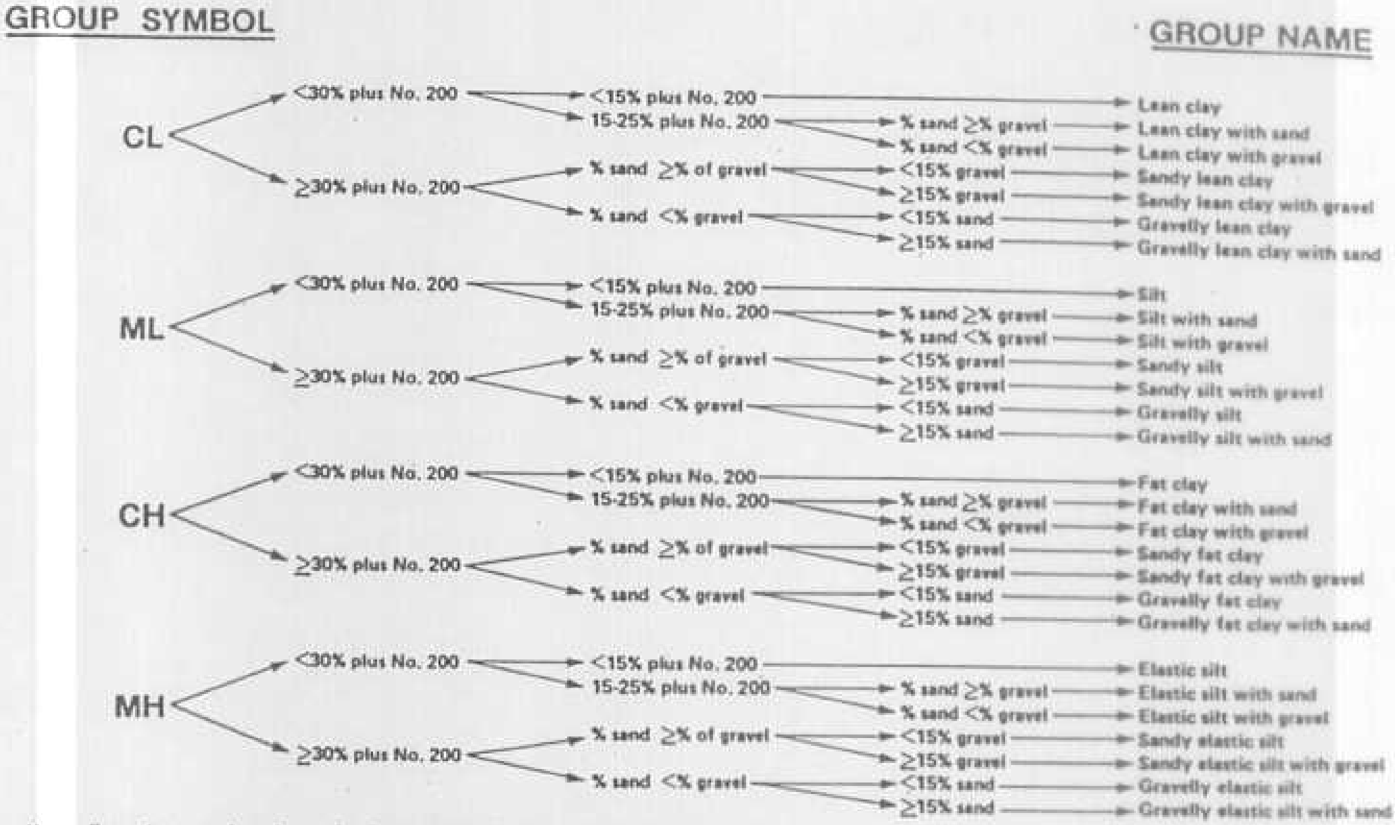
[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Sept. 15, 1993. Published November 1993. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 90.

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



NOTE—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)

(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.

3.1.1.8 *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).

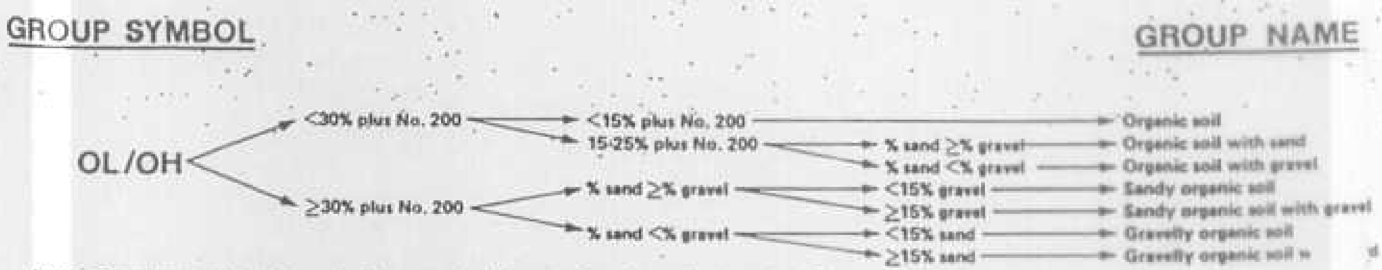
4. Summary of Practice

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, Figs. 1a and 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.

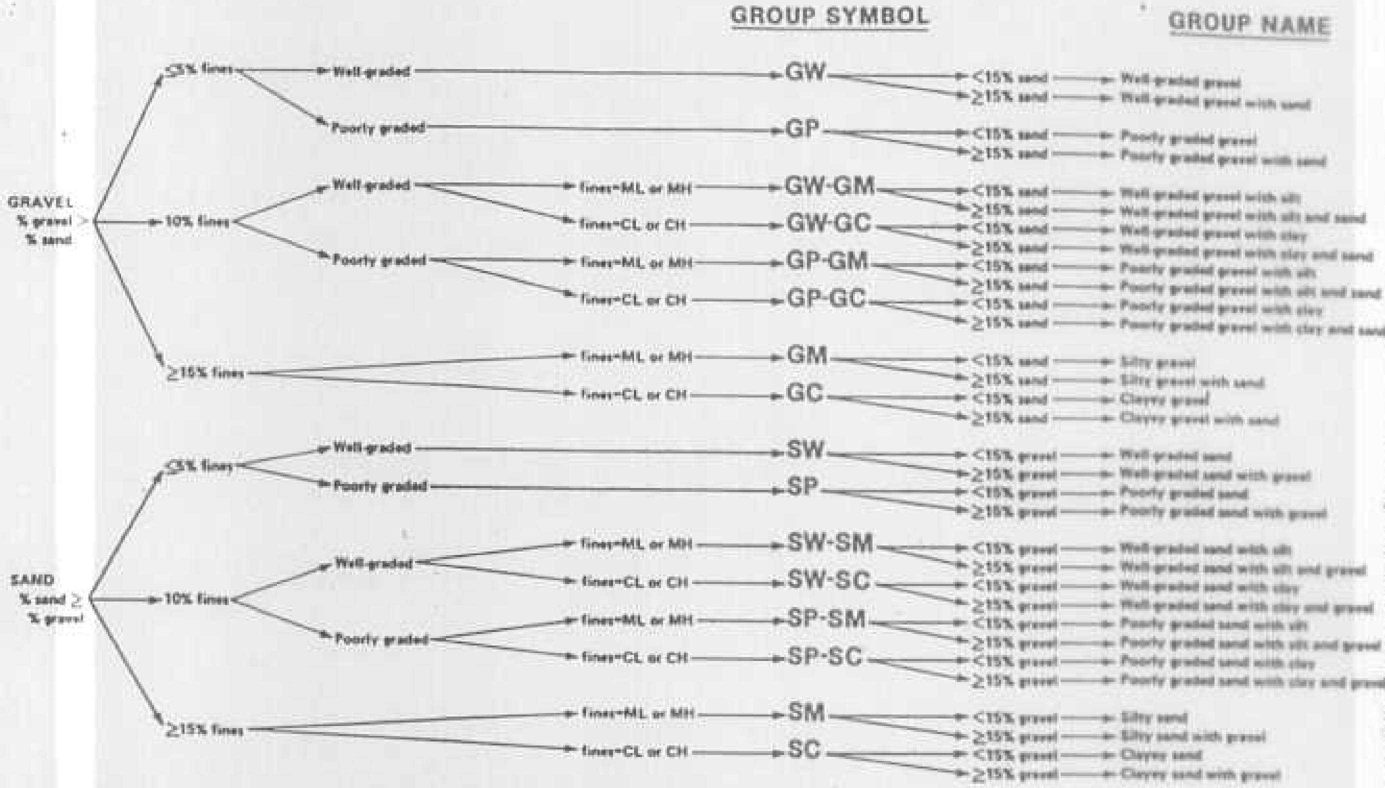
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

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



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

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



NOTE—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)

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.

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 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.

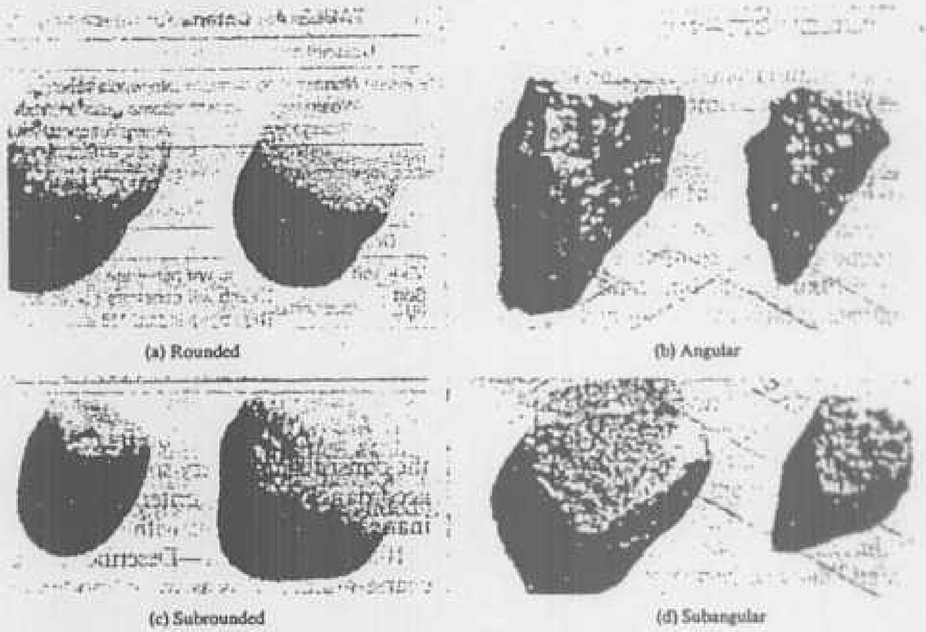


FIG. 3 Typical Angularity of Bulky Grains

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

9.2 The sample shall be carefully identified as to origin.

NOTE 6—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 (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ 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 7—If random isolated particles are encountered that 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.

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. 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.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

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

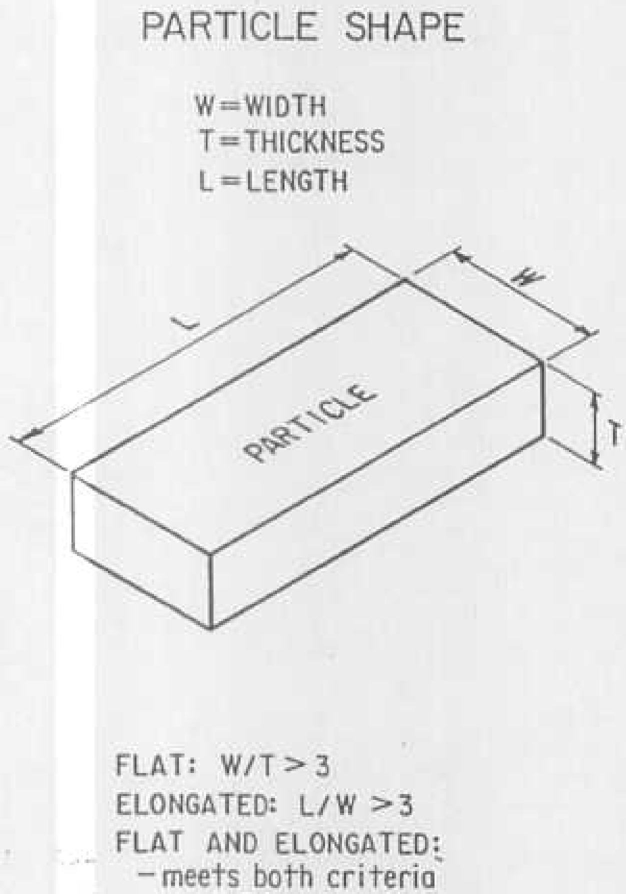


FIG. 4 Criteria for Particle Shape

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

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.

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 Consistency

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

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.

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.

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

10.14 A local or commercial name or a geologic interpre-

TABLE 6 Criteria for Describing Cementation

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 Structure

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

tation 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 8—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 9—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 10—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

TABLE 8 Criteria for Describing Dry Strength

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

TABLE 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

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.

14.7 *Identification of Inorganic Fine-Grained Soils:*

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

14.7.1 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 11—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.

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 12—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 Figs. 1a and 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 Figs. 1a and 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.

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

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 13—*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 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—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 %

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.

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.

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

[illegible]

[illegible]

X6. RATIONALE

Changes in this version from the previous version, D 2488 – 90, include the addition of X5 on Abbreviated Soil Classification Symbols.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

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

Standard Operating Procedure
Direct-Push Soil Sample Collection

STANDARD OPERATING PROCEDURE

Direct-Push Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Sampling rods
- Sampling tubes and acetate liners (if desired)
- Pre-cleaned sample containers and stainless-steel sampling implements
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sample from the tube.
4. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement.
5. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP *Decontamination of Personnel and Equipment*.
6. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the borehole made during sampling activities has been properly backfilled.

Standard Operating Procedure
General Guidance for Performing Cone Penetrometer Testing

STANDARD OPERATING PROCEDURE

General Guidance for Performing Cone Penetrometer Testing

I. Purpose and Scope

The purpose of this guideline is to describe cone penetrometer testing (CPT) and installing piezometers using CPT equipment. These procedures are general guidelines only and are in no way intended to replace the specifications in the operator's subcontract. Methods for installing piezometers using conventional methods are described in SOPs *Installation of Single-Cased Piezometers and Monitoring Wells* and *Installation of Double-Cased Piezometers and Monitoring Wells.*

II. Equipment and Materials

Cone penetrometer testing

- Cone penetrometer testing rig
- Associated rods, probes, and decontamination materials

Piezometer Riser/Screen

- Polyvinyl chloride (PVC), Schedule 40 or 80, minimum 3/4-inch ID, flush-threaded riser
- PVC, Schedule 40 or 80, minimum 3/4-inch ID, flush-threaded, factory slotted screen
- Filter fabric
- Stainless steel wire

Bottom Cap

- PVC, threaded to match the piezometer screen

Piezometer Cap

- Above-grade completion: PVC, threaded or push-on type, vented
- Flush-mount completion: PVC, locking, leak-proof seal

Bentonite

- Pure, additive-free granulated bentonite

Protective Casing

- Above-grade completion: 4-inch minimum ID steel pipe with locking cover, diameter at least 2 inches greater than the piezometer riser, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate

- Flush-mount completion: Morrison 6-inch or 9-inch 519 manhole cover, or equivalent; rubber seal to prevent leakage; locking cover inside of road box

Piezometer Development

- Double surge block with solid bottom, top open, separated by 2 feet of slotted pipe
- Development pump and associated equipment
- Containers (e.g., 55-gallon drums) for water produced from the piezometer.

III. Procedures and Guidelines

A. Cone Penetrometer Testing

The cone penetrometer testing system consists of 1.75-inch diameter probes that are pushed directly into the ground using a hydraulic ram mounted on a heavy truck. Electronic sensors mounted on the leading end of the probe (the penetrometer) are used to collect a variety of data. Data are both observed on a computer display and recorded for later analysis.

Two types of data will be collected: lithologic and hydrogeologic:

- Lithologic data will be collected by measuring the end-bearing resistance on the conical tip and the soil friction along the sides of the penetrometer. The end-bearing resistance and the ratio of the friction to the resistance indicate the grain size of the material being penetrated.
- Pore-water pressure also will be monitored. The pore-water pressure can be converted to an estimated of hydraulic head and the dissipation of the pore-water pressure can be used to estimate the hydraulic conductivity.

All downhole rods and probes will be decontaminated with the automated process provided with the CPT rig. Decontamination fluids generated during drilling activities will be contained according to the procedures detailed in the work plan.

B. Piezometer Installation

Piezometers will be constructed inside most of the holes provided by the CPT, once the hole has been advanced to the desired depth. Holes for most of the piezometers will be created by advancing a hollow rod with a disposable tip to the desired depth. At some locations, CPT will be performed to a specified depth at the top of the Upper Patapsco Unit and the hollow rods will be used to set the Upper Patapsco piezometer in the hole after the CPT rods are removed. At some of these locations, the piezometer will be set in the CPT hole but only as deep as the Talbot. For these locations, the hole will be grouted up to a depth approximately 10 feet below the intended depth of the Talbot piezometer and the piezometer will be set with the hollow rods.

The standard CPT approach may have difficulty penetrating the coarse, gravelly material that makes up much of the slag fill. Where difficulties are encountered penetrating the slag with the CPT, the CPT operator has both hydraulic and pneumatic hammers that can be used to pre-punch holes through the slag to facilitate penetrating the material with the CPT.

Before the piezometer is inserted into the hollow rods, the screen will be wrapped in filter fabric to prevent fine-grained material from entering the screen. The fabric will be tied off around the PVC riser above the screen with stainless-steel wire and 6 to 12 inches of the filter fabric will be extended above and beyond the wire. This extended filter fabric will be filled with granular bentonite and the filter fabric then will be tied off again above the bentonite.

After the disposable tip is punched out and the hollow rods are being withdrawn, the formation material will collapse around the screen. Once the hollow rods are withdrawn, the bentonite will hydrate, forming a seal above the screen. Several such seals will be placed at intervals up the PVC riser to ensure an adequate bentonite seal.

Lengths of screen typically will be 5 feet. Ten-foot lengths will be used at the water table and 2-foot lengths may be used in the deeper part of the slag fill to prevent screen zones from overlapping with those at the water table in the upper part of the slag fill.

For piezometers that will be completed above grade, a locking steel protective casing set in a concrete pad will be installed. The pad will slope to drain away water. Guard posts may be installed in high-traffic areas for additional protection. For piezometers with flush-mount completions, Morrison 6-inch or 9-inch 519 manhole road box and cover, or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad will be installed as a concrete collar surrounding the road box and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Each piezometer will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent piezometer number.

C. Piezometer Development

Piezometer development will be accomplished using a combination of surging throughout the screen and pumping until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include two surge blocks separated by approximately 2 feet of coarsely slotted pipe. The lower surge block will be solid; the upper surge block will be open and attached to riser pipe leading to the ground surface. Water will be pumped continuously from the surge block screened interval throughout the surging process. The pumping will be accomplished by airlift induction methods or using a small-diameter pump or bailer.

Development will begin by surging the screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone.

Following surging, the piezometer will be pumped to remove the fine materials that have been drawn into the piezometer or well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes.

Development equipment will be decontaminated before initial use and after the development of each piezometer. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Water generated during development will be contained and managed as detailed in the work plan.

IV. Attachments

Schematic diagram of piezometer construction

Standard Operating Procedure
Piezometer Completion Diagram

	PROJECT NUMBER	PIEZOMETER NUMBER SHEET 1 OF 1
CH2MHILL	PIEZOMETER COMPLETION DIAGRAM	

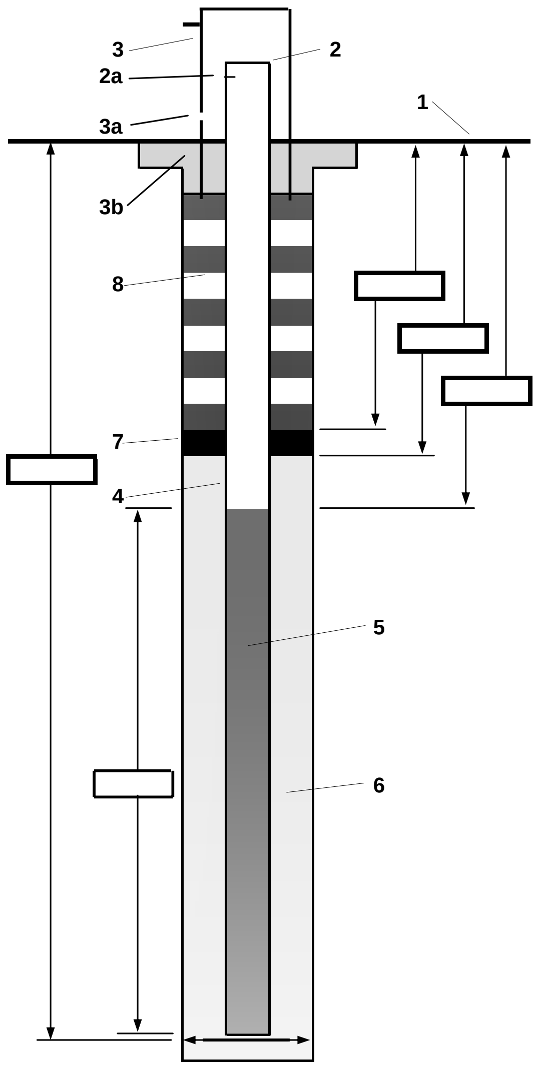
PIEZOMETER COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation ______

2- Top of casing elevation ______

a) vent hole? ______

3- Protection cover type ______

a) weep hole? ______

b) concrete pad dimensions ______

4- Diameter/type of well casing ______

5- Type/slot size of screen ______

6- Type screen filter ______

a) Quantity used ______

7- Type of seal ______

a) Interval sealed ______

8- Types of seal

a) Intervals sealed ______

Development method ______

Development time ______

Estimated purge volume ______

Comments ______

Standard Operating Procedure
Close Support Laboratory Method for
Analysis of Chlorinated Volatiles in Soil

STANDARD OPERATING PROCEDURE

Close Support Laboratory Method for Analysis of Chlorinated Volatiles in Soil

I. Scope and Application

This method is proposed for field screening of soil and solid samples for chlorinated volatile hydrocarbons. It is presented as a means to rapidly characterize contamination in soil samples.

Application of this method is limited to screening analysis of soil for the target constituents listed in the field sampling plan. The chromatographic record produced in the analyses allows the site investigation team to examine the relative degree of soil contamination associated with other nontargeted compounds in the sample extracts. Positive identification and quantification of specific constituents will be supported by analyses of duplicate and other composited samples at a remote CLP laboratory employing EPA approved testing protocols.

Preliminary method validation data indicates analysis recoveries of upwards of 80 percent.

The method detection limits (MDL) for the target constituents are estimated to be 10 ug/kg. These estimates are the result of previous method development work.

II. Summary of Method

The methods presented here are loosely based on EPA Method 3550, sonification extraction, found in the EPA SW846, *Test Methods for Evaluating Solid Waste*, 3rd ed., November 1986. In brief, pentane is used in conjunction with sonification to effect extraction of the target constituents from the sample matrix. The extract is subsequently analyzed on a capillary gas chromatograph using an electron capture detector (ECD).

III. Interferences

Samples containing compounds that co-elute with the target constituents may cause a positive bias in the results.

The presence of compounds that closely match the retention times of the target constituents may result in false identifications.

The MDLs for the target constituents may be suppressed by baseline noise associated with samples having high levels of background organics or other interferences.

The response factors for uncalibrated peaks that are significantly different than those of the target constituents may produce errors in the estimation of the total target constituent contamination.

IV. Safety

The target constituents are either identified as or suspected of being carcinogens. All samples are assumed to be hazardous. All stock and working calibration standards, as well as all samples, shall be handled with the utmost care using good laboratory techniques in order to avoid harmful exposure.

Lab analysts shall wear lab coats, safety glasses, and surgical gloves at all times when preparing and handling standards and field and lab samples.

Standards and samples shall be prepared in a fume hood.

Pentane (C_5H_{12}) is regulated by NIOSH. The suggested permissible exposure level (PEL) is 120 ppm with a ceiling level of 610 ppm. Exposure pathways are oral, dermal, and airway. Effects of short term exposure are drowsiness and irritation of eyes and nose, large doses may cause unconsciousness. Prolonged overexposure may cause irritation of the skin. The odor threshold of n-pentane is reported as 2.2 ppm. Pentane is highly flammable and is incompatible with strong oxidizing agents.

Sample extracts and standards prepared in flammable solvents shall be stored in a cooler (outside the laboratory).

All of the target compounds are reported in the NIOSH manual as having "good warning properties." Any situation which leads to or causes noticeable odors or produces any physical symptoms in the workers shall be investigated immediately followed by appropriate corrective action.

The ultrasonic sonicator used for sample extraction emits a high frequency sound. When in use, the sonicator horn shall be inside the sound chamber with the door closed.

Safety equipment including a fire extinguisher, first aid kit, eye wash, and chemical spill cleanup kit shall be available for use at all times.

Lab wastes shall be separated and properly disposed. The wastes include: used sample aliquots initial wash water, chemical wastes generated in the analysis, and disposables used in the preparation of the samples. These wastes shall be collected and deposited in a drum clearly marked as "CSL Lab Wastes Only--Hazardous." Water used for final rinsing of glassware will be considered nonhazardous and will be released into a 50 gallon drum. These wastes will then be disposed of in accordance with the appropriate and relevant disposal method.

V. Apparatus and Materials

Soil sampling equipment as described in the Quality Assurance Project Plan.

Volatiles sample vials (i.e., 40 ml capacity with septum screw caps).

Balance--Sartorius top loading electronic with 1,500 gram capacity with 0.01 gram sensitivity.

Glassware--class A volumetric pipets and flasks, beakers, vials, pasteur pipets, and miscellaneous glassware as necessary for preparation and handling of samples and standards.

Labware--necessary for preparation and handling of samples and standards.

Syringes--Hamilton glass type as required for injection of sample extracts and standards, preparation of dilutions, and spiking of samples.

Sonifier--Heat Systems Ultrasonic Sonicator with variable control up to 375 watt output and watercooled cup horn.

Gas chromatograph (GC)--Hewlett-Packard Model 5890A; temperature programming, electronic integration, report annotation, automatic sampler, 30-meter megabore capillary column (DB-1, 1.50 micron film thickness), and ECD.

VI. Chemicals, Reagents, and Gases

Pentane–spectro grade, 99.9 percent.

Sodium sulfate–reagent grade, anhydrous powder form.

Stock standards–prepare or purchase stand materials at approximately 1,000 mg/L in methanol.

Working standards–prepared from stock standards by precise dilution in pentane.

Nitrogen–carrier gas, prepuried grade.

VII. Calibration

External calibration–four-level calibration at approximately 10.0, 1.0, 0.1, and 0.01 µg/ml for the target constituents in pentane.

Working calibration–working calibration shall be performed with the analysis of each working day’s lot of samples or with each lot of 20 samples, whichever is more frequent. Working calibration shall be verified by use of a mid-range standard mix. If the response factors and retention times vary by more than ± 15 percent or ± 0.10 minutes from the initial calibration, then recalibration shall be performed on freshly prepared working standards.

VIII. Sample Preparation and Extraction

Place a labeled vial on the top loading balance and record its tare weight. Add an aliquot of soil, approximately 5 grams to the vial and accurately record the soil sample weight to the nearest 0.01 grams.

Sample treatment: If the sample is wet or a highly consolidated material (i.e, clay), then add about 2 grams of sodium sulfate and mix using a glass rod.

In a labeled VOA vial, volumetrically pipet 5.0 ml of pentane (Section 6.8) and record the volume added.

With the VOA vial cap tightly in place, sonicate at an output setting of 30 percent for approximately 5 minutes. The resulting sonicated sample should be dispersed throughout the pentane solvent and have a grain-like appearance. If not, then add an additional 1 gram of sodium sulfate and resonify. Repetitions of this process may be needed to properly extract some samples.

After sonication, let the VOA vial stand until the solids have settled. Using a pasteur pipet, transfer a suitable aliquot of the pentane solvent (extract) from the vial into a labeled GC auto-sampler vial and cap immediately with septum crimp seals. Refrigerate the sample extracts until analyzed.

IX. Analysis

Perform GC analysis on the extract.

If the analysis indicates that the results are more than 50 percent above the calibration range, dilute the sample extract such that concentrations fall within the calibration range.

Check the retention values for each of the target constituents against the expected (calibration) value. Flag those results where the retention time does not fall within ± 0.05 minutes of the expected value. Reject those results where the retention time does not fall with ± 0.10 minutes of the expected value.

Use the retention time marker as an indicator of the reliability of each sample injection and GC run. The retention time marker should fall within the same windows as the target constituents and should be within ± 15 percent area counts of its initial calibration value. If these criteria are not met, re-evaluate the data using relative retention times. Reruns should occur to resolve data suspicions.

X. Calculations

Quantification of the target compounds is based on the integrated areas of samples in comparison to the integrated areas of the calibration standards for each analyst. The integrator reports the concentrations in ug/ml in the extracts. Calculation of the concentration for each target constituent in the original sample on an as received basis is as follows:

conc. in ug/kg = ((A x Vt x DF)/Ws) x 1000

where:

A = amount of target constituent found in the extract in ug/ml

Vt = volume of solvent added to the VOA vial, 5.0 ml (Section 8.1)

DF	=	dilution factor, if required (Section 10.2)
1,000	=	dimensional correction factor
Ws	=	weight of the sample added to the VOA vial in grams (Section 8.1)

XI. Quality Assurance

Quality assurance measures shall include as a minimum:

- Daily mid-range calibration checks performed prior to the analysis of each day's lot of samples or with each lot of 20 samples, whichever is more frequent.
- Analysis of field blank samples at a frequency of 1 in 20 samples analyzed or 1/day, whichever is more frequent.
- Analysis of laboratory blank samples at the same frequency. Should the results of the laboratory blanks show contamination, the cause of the contamination should be investigated and corrective action taken.
- Analysis of field duplicate samples at a frequency of 1 in 20 samples or 1/day, whichever is more frequent.
- Analysis of a mid-range matrix spike samples and a matrix spike duplicate at a frequency of 1 in 20 samples analyzed or 1/day, whichever is more frequent.
- Use of the retention time marker during the analysis of all samples and standards.

Standard Operating Procedure
Low-Flow Groundwater Sampling
from Monitoring Wells

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This procedure presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature (e.g., Horiba® U-22 or similar)
- Water-level indicator
- In-line disposable 0.45µ filters (QED® FF8100 or equivalent)
- Adjustable-rate, positive-displacement pump, submersible, or peristaltic pump
- Generator
- Disposable polyethylene tubing
- Plastic sheeting
- Well-construction information
- Calibrated bucket or other container and watch with second indicator to determine flow rate
- Sample containers
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. For the well to be sampled, information is obtained on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.

2. Instruments are calibrated according to manufacturer's instructions.

3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Water level measurements are collected in accordance with SOP *Water Level Measurements*. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well installation log.

7. Attach and secure the polyethylene tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake at least 2 feet above the bottom of the well to avoid mobilization of any sediment present in the bottom. Preferably, the pump should be in the middle of the screen.

8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.

9. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5 to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP or Eh, turbidity, and temperature of water are measured and recorded in the field logbook.

10. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.5 feet). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1 to 0.2 liters per minute) to avoid affecting well drawdown.

11. During purging, the field parameters are measured frequently (every 3 to 5 minutes) until the parameters have stabilized. Field parameters are considered stabilized when measurements meet the following criteria:

    - pH: within 0.1 pH units
    - Specific conductance: within 3 percent
    - Dissolved oxygen: within 10 percent

- Turbidity: within 10 percent or as low as practicable given sampling conditions
- ORP: within 10 mV

B. Sample Collection

Once purging has been completed, the well is ready to be sampled. The elapsed time between completion of purging and collection of the groundwater sample from the well should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Each bottle typically will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the logbook:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; whether the sample is filtered or not; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Samples may be field filtered before transfer to the sample bottle. Filtration must occur in the field immediately upon collection. Inorganics, including metals, are to be collected and preserved in the filtered form as well as the unfiltered form. The recommended method is through the use of a disposable in-line filtration module (0.45-micron filter) using the pressure provided by the pumping device for its operation.
4. Samples for analysis for volatile organic compounds should be collected first, if such samples are required.

5. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.

6. The bottle is capped, then labeled clearly and carefully following the procedures in SOP *Packaging and Shipping Procedures*.

7. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.

2. It may not be possible to prevent drawdown in the well if the water-bearing unit has sufficiently low permeability. If the water level was in the screen to start with, do not worry about it because there is no stagnant water in the riser above the screen to begin with.

   If the water level in the well is in the riser above the screen at the beginning of purging, then be sure you pump out sufficient volume from the well to remove the volume of water in the riser above the screen. For a 2-inch diameter well, each foot of riser contains 0.163 gallons; for a 4-inch riser, each foot of riser contains 0.653 gallons; for a 6-inch riser, each foot of riser contains 1.47 gallons.

   Alternatively, the water in the riser above the screen can be removed by lowering the pump into the well until the pump intake is just below the water level, starting the pump, running it at a low rate, and slowly lowering the pump as the water level in the riser declines. This approach can be terminated when the water level reaches the top of the screen, at which time the stagnant water in the riser has been removed. This may not be a practical approach for dedicated sampling equipment. As with typical low-flow sampling, the flow rate should be kept as low as practicable.

3. There may be circumstances where a positive-displacement or submersible pump cannot be used. An example is at isolated, hard-to-reach locations where the required power supply cannot be brought. In this case, a peristaltic pump may be used. Samples can be collected by the procedures described above for all but those for VOC analysis. The water to be placed in the vials for VOC analysis should not be run through the peristaltic pump but instead should be collected by the following:

   - Stop the pump when it is time to collect the VOC sample.

- Disconnect the tubing upstream from the pump (a connector must be installed in the line to do this).
- Pinching the tubing to keep the water in the tubing, remove the tubing from the well. Be sure that the tubing does not contact other than clean surfaces.
- Place the end of the tubing that was in the well into each VOC vial and fill the vial by removing the finger from the other end of the tube.
- Once the vials are filled, return the tubing to the well and collect any other samples required.

4. Nondedicated sampling equipment is removed from the well, cleaned, and decontaminated in accordance with SOP *Decontamination of Personnel and Equipment*. Disposable polyethylene tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5 to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
    - Inspect sampling pump regularly and replace as warranted
    - Inspect quick-connects regularly and replace as warranted
    - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it’s effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

Standard Operating Procedure
Groundwater Sampling from Monitoring Wells

STANDARD OPERATING PROCEDURE

Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This procedure presents general guidelines for the collection of groundwater samples from monitoring wells. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Probe box with inlet/outlet ports for purged groundwater and watertight ports for each probe
- pH meter: Orion Model SA250 or equivalent
- Temperature/conductivity meter: YSI Model 33 or equivalent
- Dissolved oxygen meter: YSI Model 57 or equivalent
- In-line disposable 0.45µ filters: QED FF8100 or equivalent
- Bailer, teflon or stainless steel
- Peristaltic pump, bladder pump, or submersible sampling pump with tubing, support cables, and power supply (may not be required if well yield is low)

III. Procedures and Guidelines

A. Setup and Purging

1. For the well to be sampled, information is obtained on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.
2. A pump will be used for well purging if the well yield is adequate; otherwise, a bailer may be used.
3. Instruments are calibrated according to manufacturer's instructions.
4. The well number, site, date, and condition are recorded in the field logbook.
5. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed.

6. Water level measurements are collected in accordance with SOP Water Level Measurements, and the total depth of the well is measured.

7. The volume in gallons of water in the well casing or sections of telescoping well casing is calculated as follows:

   $0.052 (\pi r^2h) = 0.163 (r^2h)$ = gallons

   where: $\pi = 3.14$

   r = Radius of the well pipe in inches
   h = height of water in well in feet

   The volume of water in typical well casings may be calculated as follows:

   2-inch diameter well:
   0.163 gal/ft x ___ (linear feet of water) = gallons

   4-inch diameter well:
   0.653 gal/ft x ___ (linear feet of water) = gallons

   6-inch diameter well:
   1.469 gal/ft x ___ (linear feet of water) = gallons

   The initial field parameters of pH, specific conductance, and temperature of water are measured and recorded in the field logbook. The measurement probes are inserted into the probe box. The purged groundwater is directed throughout the box, allowing measurements to be collected before the water contacts the atmosphere.

8. Sampling equipment is cleaned and decontaminated prior to sampling in accordance with SOP Decontamination of Personnel and Equipment.

9. If a bailer is being used, it is removed from either its protective covering or the well casing and attached to a cord compatible with constituents and long enough to reach the bottom of the well. If a sampling pump is being used, the air line, discharge line, and support cable or rope are attached to the pump. The support line should bear the weight of the pump. If the well is purged using dedicated tubing, it is lowered into the well to the top of the screened zone.

10. The sampling device is lowered to the well interval from which the sample is to be collected. The pump intake will be placed above the top of the screen, where possible. If a bailer is being used, it is allowed to fill with a minimum of surface disturbance to prevent sample water aeration. When the bailer is raised, the bailer cord must not touch the ground.

During purging, the field parameters are measured at least once for each well volume. In productive wells, the well purging end point is determined using the field measurements. In nonproductive wells, the well is repeatedly bailed dry to obtain a minimum of three well volumes, then allowed to recover before sampling.

12. Three to five well volumes are purged (more may be purged if parameters do not stabilize). Purging is stopped when field parameters have stabilized over two consecutive well volumes. Field parameters are considered stabilized when pH measurements agree within 0.5 units, temperature measurements agree within 1°C, and specific conductance and dissolved oxygen measurements agree within 10 percent.

B. Sample Collection

Once purging has been completed, the well is ready to be sampled. The elapsed time between completion of purging and collection of the groundwater sample from the well should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Each bottle typically will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs. Samples may be field filtered before transfer to the sample bottle. Filtration must occur in the field immediately upon collection. Inorganics, including metals, are to be collected and preserved in the filtered form as well as

the unfiltered form. The recommended method is through the use of a disposable in-line filtration module (0.45 micron filter) using the pressure provided by the pumping device for its operation. When a bailer is used, filtration may be driven by a peristaltic pump.

3. VOC samples from wells purged using dedicated tubing and a sampling pump will be collected using a bailer
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.
5. The bottle is capped, then labeled clearly and carefully.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. If the sampler is dedicated, it is returned to the well and the well is capped and locked. Nondedicated samplers are cleaned and decontaminated in accordance with SOP Decontamination of Personnel and Equipment.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:

- Inspect sampling pump regularly and replace as warranted
- Bring supplies for replacing the bladder if using a positive-displacement bladder pump
- Inspect tubing regularly and replace as warranted
- Inspect air/sample line quick-connects regularly and replace as warranted
- Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Standard Operating Procedure
Direct-Push Groundwater Sample Collection

STANDARD OPERATING PROCEDURE

Direct-Push Groundwater Sample Collection

I. Purpose

To provide a general guideline for the collection of groundwater samples using direct-push (e.g., Geoprobe®)sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) groundwater sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Direct-push (e.g., Geoprobe®) sampling rods and slotted lead rod
- Polyethylene sampling tubing and stainless steel foot valve
- Pre-cleaned sample containers
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate slotted lead rod and other non-dedicated downhole equipment in accordance to SOP Decontamination of Personnel and Equipment.
2. Drive slotted steel lead rod to the desired sampling depth using the truck-mounted hydraulic percussion hammer.
3. Insert the stainless steel foot valve into the end of the polyethylene sampling tubing and insert tubing through the rods.
4. Fill all sample containers, beginning with the containers for VOC analysis.
5. Remove polyethylene sampling tubing from the rods. Remove the foot valve and discard polyethylene tubing.
6. Decontaminate all non-dedicated downhole equipment (lead rod, foot valve, etc.) in accordance to SOP Decontamination of Personnel and Equipment.
7. Backfill bore hole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the borehole made during sampling activities has been properly backfilled.

Standard Operating Procedure
Sediment Sampling

STANDARD OPERATING PROCEDURE

Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples during field operations.

II. Scope

The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Operators manual , if available, should be consulted for specific details

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device)
- Stainless steel spoon or spatula for media transfer
- Measuring tape
- Log book
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.)
- Materials for classifying soils, particularly the percentage of fines
- Sample jars, including jars for Total Organic Carbon and pH, as appropriate

IV. Procedures and Guidelines

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas.
2. Make a sketch of the sample area showing important nearby river features and permanent structures that can be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc).
3. Transfer sample into appropriate sample jars with a stainless steel spoon or utensil. The sampler's fingers should never touch the sediment since gloves may introduce organic interferences into the sample. Classify the soil type of

the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.

4. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.

5. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.

6. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.

7. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.

8. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

None.

VI. Key Checks and Items

- Start downstream, work upstream.
- Log exact locations using permanent features.
- Beware of hidden hazards.

Standard Operating Procedure
Surface Water Sampling

STANDARD OPERATING PROCEDURE

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting surface water samples. Materials, equipment, and procedures may vary; refer to the Field Sampling Plan and operators manuals for specific details.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the Field Sampling Plan should be consulted for project-specific details.

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. Procedures and Guidelines

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP Decontamination of Personnel and Equipment. Methods for surface water sample collection are described below.

A. Manual Sampling

Surface water samples are collected manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly. Specific types of weighted bottle samplers include dissolved oxygen, Kemmerer, or Van Dorn, and are acceptable in most instances.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.

2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle.

3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.

4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.

5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

Standard Operating Procedure
Field Measurement of pH, Specific Conductance,
Turbidity, Dissolved Oxygen, ORP, and Temperature
Using the Horiba® U-22 with Flow-through Cell

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using the Horiba® U-22 with Flow-through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using the Horiba® U-22 for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of groundwater samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Horiba® U-22 Water Quality Checker with flow-though cell
- Distilled water in squirt bottle
- Horiba® U-22 Auto-Calibration Standard Solution

III. Procedures and Guidelines

A. Parameters and Specifications

Parameter	Range of measurement	Accuracy
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 °C	+/- 1.0 °C
ORP	-1999 to +1999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using Horiba® Standard Solution. Calibration procedure:

1. Fill the calibration beaker to about 2/3 with the pH 4 standard solution.
2. Fit the probe into the beaker. All the parameter sensors will now be immersed in the standard solution except the D.O. sensor; the D.O. calibration is done using atmospheric air.
3. Turn power on.
4. Press CAL key to put the unit in the calibration mode.
5. Press the ENT key to start automatic calibration. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one by one: pH, COND, TURB, and DO. When the calibration is complete, the readout will briefly show END. The instrument is now calibrated.
6. If the unit is calibrated properly, pH will read 4.0 +/- 3%, conductivity will read 4.49 +/- 3%, and turbidity will read 0 +/- 3%

C. Sample Measurement

As water passes through the flow-through Cell, press MEAS to obtain reading; record in the field notebook.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

Standard Operating Procedure
VOC Sampling-Water

STANDARD OPERATING PROCEDURE

VOC Sampling--Water

I. Purpose

To provide general guidelines for sampling aqueous volatile organic compounds.

II. Scope

Standard techniques for collecting representative samples are summarized. Site specific details are discussed in the FSP.

III. Equipment and Materials

- Sample vials, clean latex or surgical gloves, pH meter
- Hydrochloric acid (HCl) for preservation
- pH meter or pH indicating paper
- Surgical or latex gloves

IV. PROCEDURES AND GUIDELINES

1. Sample VOCs before sampling other analyte groups.
2. When sampling for VOCs, especially residential wells, evaluate the area around the sampling point for possible sources of air contamination by VOCs. Products that may give off VOCs and possibly contaminate a sample include perfumes and cosmetics, skin applied pharmaceuticals, automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) and household paint products (paint strippers, thinners, turpentine, etc.).
3. To check the amount of hydrochloric acid (HCl) that needs to be added at each location, fill a test vial (40 ml) with the water to be sampled, add one drop of hydrochloric acid (HCl), gently mix, and check the pH. Repeat this cycle (if necessary) until you reach a pH of 2, counting the number of drops of HCl required. DISCARD THE TEST VIAL and add an equal number of drops of HCl to each of the sample vials. proceed to sample.
4. Keep the caps off the sample vials for as short a time as possible.
5. Wear clean latex or surgical gloves.
6. Fill the sample vial immediately, allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. DO NOT RINSE THE SAMPLE VIALS BEFORE FILLING.
7. Fill the sample vial with a minimum of turbulence, until the water forms a positive meniscus at the brim.
8. Replace the cap by gently stetting it on the water meniscus. Tighten firmly, but DO NOT OVERTIGHTEN.

9. Invert the vial and tap it lightly. If you see air bubbles in the sample, do not add more sample. Use another vial to collect another sample. Repeat if necessary until you obtain a proper sample.

V. ATTACHMENTS

None.

VI. KEY CHECKS AND ITEMS

- Check for possible sources of contamination.
- Check pH.
- Fill slowly, with as little turbulence as possible.
- Check for air bubbles.

Standard Operating Procedure
Field Rinse Blank Preparation

STANDARD OPERATING PROCEDURE

Field Rinse Blank Preparation

I. Purpose

To prepare a blank to determine adequacy of decon procedures and whether any cross-contamination is occurring during sampling.

II. Scope

The general protocols for preparing the rinse blank are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II grade water)
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP Decontamination of Personnel and Equipment.

B. To collect the sample for volatiles analysis, pour blank water over one piece of equipment and into 40-ml vials until there is a positive meniscus and seal vials. Note the sample number and associated piece of equipment in the field notebook.

For non-volatiles, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. Document and ship samples in accordance with the procedures for other samples.

D. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II grade water.

Standard Operating Procedure
Homogenization of Soil and Sediment Samples

STANDARD OPERATING PROCEDURE

Homogenization of Soil and Sediment Samples

I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for TCL VOCs or field GC screening; samples for these analyses should NOT be homogenized.

III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, and stainless steel pans.

IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for semivolatiles, pesticides, PCBs, metals, cyanide, or field XRF screening should be homogenized in the field. After a sample is taken, a stainless steel spatula should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

Samples for VOCs should be taken immediately upon opening the spoon and should not be homogenized.

Prior to homogenizing the soil or sediment sample, any rocks, twigs, leaves, or other debris should be removed from the sample. The sample should be placed in a decontaminated stainless steel pan and thoroughly mixed using a stainless steel spoon. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

All stainless steel spoons, spatulas, and pans must be decontaminated following procedures specified in SOP Decontamination of Personnel and Equipment prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

Standard Operating Procedure
Packaging and Shipping Procedures

Packaging and Shipping Procedures

I. Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with about 3 inches of vermiculite.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.

G. Fill remaining spaces with vermiculite.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

I. Separate copies of forms. Seal proper copies (traffic reports, packing lists) along with a return address label within a large zip-lock bag and tape to inside lid of cooler.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. **Do not** cover custody seals.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

II. Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. First, a special airbill including a Shipper's Certification for Restricted Articles is required. Second, “Flammable Liquid N.O.S.” or “Flammable Solid N.O.S.” (as appropriate) labels must be placed on at least two sides of the cooler. Third, sample containers are packaged in metal cans with lids before being placed in the cooler, as indicated below:

- Place approximately ½ inch of vermiculite in the bottom of the can.
- Position the sample jar in the zip-loc bag so that the sample tags can be read through the plastic bag.
- Place the jar in the can and fill the remaining volume with vermiculite.
- Close the can and secure the lid with metal clips.
- Write the traffic report number on the lid.
- Place “This Side Up” and “Flammable Liquid N.O.S.” or “Flammable Solid N.O.S.” (as appropriate) labels on the can.
- Place the cans in the cooler.
- For medium concentration samples, ship samples with ice or “blue ice” inside the coolers. (Double bag ice in zip-lock plastic bags.)

III. Special Instructions for Shipping Medium and High Concentration Samples by Federal Express

A. Label cooler as hazardous shipment:

- Write shipper's address on outside of cooler. If address is stenciled on, just write “shipper” above it.
- Write or affix sticker saying “This Side Up” on two adjacent sides.
- Write or affix sticker saying “ORM-E” with box around it on two adjacent sides. Below ORM-E, write NA#9188.
- Label cooler with “Hazardous Substance, N.O.S.” and “liquid” or “solid,” as applicable.

B. Complete the special shipping bill for restricted articles.

- Under Proper Shipping Name, write “Hazardous Substance, N.O.S.” and “liquid” or “solid,” as applicable.
- Under Class, write “ORM-E.
- ”Under Identification No., write NA No. 9188.

C. For high concentration samples, ship samples with "blue ice" only inside coolers.

Standard Operating Procedure
Chain-of-Custody

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sample Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

V Procedures

The term “chain-of-custody” refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

V.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s);
- CTO Number;
- Project Sample Number;
- Sample location or sampling station number;

- Date and time of sample collection and/or measurement;
- Field observations;
- Equipment used to collect samples and measurements; and,
- Calibration data for equipment used.

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - Contract Task Order (CTO) Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identify of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

V.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

V.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographs will be stored in the project files. It is good practice to identify sample locations in photographs by including an easily read sign with the appropriate sample/location number.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.

V.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below.

- Enter header information (CTO number, samplers, and project name).

- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).

- Sign, date, and enter the time under “Relinquished by” entry.

- Have the person receiving the sample sign the “Received by” entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).

- If a carrier is used, enter the airbill number under “Remarks,” in the bottom right corner;

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample shipping package. Retain the copy with field records.

- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.

- Place the seal across the shipping container opening so that it would be broken if the container were to be opened.

- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

VI Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VII Attachments

Sample Label
Chain of Custody Form
Custody Seal

VIII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

Attachment A

Example Sample Label

QAL

Quality Analytical Laboratories, Inc.
2567 Fairlane Drive
Montgomery, Alabama 36116
PH. (334)271-2440

Client ______

Sample No. ______

Location ______

Analysis ______

Preservative HCL

Date ______ By ______

CEIMIC CORPORATION

10 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900

SITE NAME	DATE
ANALYSIS	TIME
	PRESERVATIVE

SAMPLE TYPE

☐ Grab ☐ Composite ☐ Other ______

COLLECTED BY:

Attachment B

Example Chain-of-Custody Record

CH2M HILL

APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project # ☐☐☐☐☐☐☐☐.☐☐.☐☐

Purchase Order #

Project Name

Company Name CH2M HILL Office

Project Manager & Phone #
Mr. [ ]
Ms. [ ]
Dr. [ ]

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

Sampling Date	Sampling Time	Type: COMP	Type: GRAB	Matrix: WATER	Matrix: SOIL	Matrix: AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	LAB TEST CODES / ANALYSES REQUESTED										REMARKS	LAB 1 ID	LAB 2 ID

SHADED AREA – FOR LAB USE ONLY

Lab 1 #
Lab 2 #
Quote #
Kit Request #
Project #
No. of Samples
Page of
Login
LIMS Ver

Sampled By & Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS BUS Fed-Ex Hand Other ____	Shipping #
Work Authorized By (Please sign and print name)	Remarks		

QC Level: 1 2 3 Other: ____

COC Rec	ICE
Ana Req	TEMP
Cust Seal	Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

REV 3/94 FORM 340

Attachment C

Example Custody Seal

CH2M HILL

CUSTODY SEAL

Date ______________________ ______________________

Signature ______________________ ______________________

Standard Operating Procedure
Decontamination of Drilling Rigs and Equipment

STANDARD OPERATING PROCEDURE

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Alconox® or Liquinox®
- Buckets
- Brushes
- Distilled organic-free water
- Methanol, pesticide grade
- ASTM–Type II grade water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, and between boreholes. This will include, but is not limited to, rods, split-spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

   Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

   a. Rinse with tap water
   b. Rinse with de-ionized water
   c. Solvent rinse with methanol
   d. Rinse with de-ionized water

2. Probes

   Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, OVM equipment, the probe will be wiped with clean paper-towels or cloth wetted with methanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

The effectiveness of field cleaning procedures will be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis. Anytime a sampling event occurs, at least one such quality control sample shall be collected. The total number of equipment blanks will be at least 5 percent of the number of samples collected during large-scale field sampling efforts.

At least one piece of field equipment shall be selected for this procedure each time equipment is washed. An attempt should be made to select different pieces of equipment for this procedure.

Standard Operating Procedure
Decontamination of Personnel and Equipment

Standard Operating Procedure

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water)
- Distilled water
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) trisodium phosphate ("TSP") and water solution
- Concentrated (V/V) pesticide grade methanol (DO NOT USE ACETONE)
- 10% (V/V) nitric acid (HNO_3) and water solution (only ultrapure grade HNO_3 is to be used)
- Large plastic pails or tubs for TSP and water, scrub brushes, squirt bottles for TSP, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Phthalate-free gloves
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in TSP solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with TSP solution, remove, and discard into DOT approved 55-gallon drum.
2. Wash outer gloves in TSP solution, rinse, remove, and discard into DOT approved 55-gallon drum.
3. Remove disposable coveralls ("Tyveks") and discard into approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep hoses from touching the ground
3. Turn off pump after sampling. Remove pump from well and place pump in decontamination tube, making sure that tubing does not touch the ground
4. Turn pump back on and pump 1 gallon of TSP solution through the sampling pump.
5. Rinse with 1 gallon of 10% methanol solution pumped through the pump. (DO NOT USE ACETONE).
6. Rinse with 10% HNO_3 solution pumped through the pump, when sampling for inorganics (carbon steel split spoons will be rinsed with a 1% solution).
7. Rinse with 1 gallon of tap water.
8. Rinse with 1 gallon of deionized water.
9. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.
10. Collect all rinsate and dispose of in a DOT approved 55-gallon drum.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Prior to entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with TSP solution.
5. Rinse with potable water.
6. Rinse with 10% HNO_3 solution when sampling for inorganics (carbon steel split spoons will be rinsed with a 1% solution).
7. Rinse with distilled or potable water and methanol solution (DO NOT USE ACETONE).
8. Air dry.
9. Rinse with deionized water.
10. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
11. Collect all rinsate and dispose of in a DOT approved 55-gallon drum.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with TSP solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT approved 55-gallon drum.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with TSP solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.

2. Dispose of all used paper towels in a DOT approved 55-gallon drum.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Navy

2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of TSP, methanol, nitric acid, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

Standard Operating Procedure
Disposal and Waste Fluid Solids

STANDARD OPERATING PROCEDURE

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or Baker® Tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or rolloffs or Baker® Tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are potentially hazardous affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. The drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. The analysis will be used to determine if drilling wastes are covered by land disposal restrictions.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to Baker® Tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the fenced drum storage area by the drilling services subcontractor.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. Prior to disposal to the sanitary sewer system, contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

Check that representative samples of the containerized materials are obtained.

Standard Operating Procedure
Civil Surveying

STANDARD OPERATING PROCEDURE

Civil Surveying

I. Surveying: General

Modified third order survey procedures will be used for all surveying.

II. Records

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person talking field notes will be identified in the log. Information on weather (wind speed/wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Notes should also include instrument field I.D. number and environmental settings. Graphite pencils or waterproof ballpoint pens should be used. Erasing is not acceptable; use a single-strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work. (Field notebooks will be available on site.)

III. Traverse Survey

Horizontal angular measurements shall be made with a 20-second or better theodolite or transit. When using a 20-second instrument the horizontal angles shall be turned 4 times, (2 each direct and inverted) with the mean of the fourth angle being within 5 seconds of the mean of the second angle. When using a 10 second or better instrument the angles shall be doubled, (once each direct and inverted) with the mean of the second angle within 5 seconds of the first angle. Minimum length of any traverse courses shall be 300 feet.

Distance measurements shall be made with a calibrated steel tape corrected for temperature and tension or a calibrated electronic distance meter (EDM). When using a EDM the parts per million (PPM), curvature and refraction corrections shall be made. Vertical angle measurements used for distance slope corrections shall be recorded to the nearest 20 seconds of arc deviation from the horizontal plane.

Horizontal traverse stations shall be established and referenced for future use. All stations shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The station shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, or iron rod and cap.

Vertical Survey

When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent bench mark. If practical, level circuits should close on a known bench mark other than the starting bench mark. The following criteria shall be met in conducting the survey:

- Instruments shall be pegged weekly or after any time it is dropped or severely jolted.
- Foresight and backsight distances shall be reasonably balanced and shall not be greater than 250 feet in length.
- No side shot shall be used as a beginning or ending point in another level loop.
- Rod readings shall be made to 0.01 foot and estimated to 0.005 feet.
- Elevations shall be adjusted and recorded to 0.01 foot.

Temporary bench marks (TBMs) shall be established and referenced for future use. All TBMs shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The TBMs shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, etc. or spikes set in the base of trees (not power poles), or tops of anchor bolts for transmission line towers, etc. (Horizontal traverse stations will not be considered as a TBM, but may be used as a permanent turning point.)

Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step One—Coordinate closures will be computed using unadjusted bearings and unadjusted field distances.
- Step Two—Coordinate positions will be adjusted (if the traverse closes within the specified limits) using the compass rule.
- Step Three—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.
- Step Four—The direction and length of the unadjusted error of closure, the ratio of error, and the method of adjustment shall be printed with the final adjusted coordinates.

Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for the circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the

closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustments.

Monitoring Well Surveys

Monitoring well locations will be surveyed only after the installation of the well casing, (with its tamper-proof locking cover), which is set in concrete. The horizontal plane survey accuracy is ±1 foot and is measured to any point on the well casing cover. The vertical plane survey must be accurate to ±0.01 foot. The following two elevations will be measured:

- Top of the outer protective casing (on the lip next to the lock hasp, not the cap).
- Ground surface (on the north side of the well).

If no notch or mark exists, the point at which the elevation was measured on the inner casing, shall be described so that water level measurements may be taken from the same location. Wells will not be opened because of health and safety concerns.

Grid Surveys

Selected soil boring locations may be located by the survey crew after the soil borings are complete. The selected borings will be staked in the field by the field team leader. The stake will be marked with the boring number for reference. The horizontal plane survey accuracy is ± 1 foot and is measured to any point on the ground surface immediately adjacent to the stake.

Exhibit A
STANDARDS FOR MODIFIED THIRD-ORDER PLANE SURVEYS

<u>Traverse</u>

Max Number of bearing courses between azimuth checks	30
Astronomical bearings: standard error of results	6"
Azimuth closure at azimuth checkpoint not to exceed	20" $\sqrt{N}$
Standard error of the mean for length measurements	1 in 50,000
Position closure per loop in feet before azimuth adjustment	1:10,000

<u>Leveling</u>

Levels error of closure per loop in feet	0.05 $\sqrt{M}$

N = the number of stations for carrying bearing
M = the distance in miles

Appendix C
MEC Support

Procedures for Communicating Potentially Live Munitions and Explosives of Concern (MEC) to Navy

The following are procedures designed to effectively communicate the finding of potentially live munitions and explosives of concern (MEC) that could be encountered during investigative, avoidance and / or remedial work at St. Juliens Creek Annex (SJCA). Communicating in a fast, accurate, and calm manner is critical in keeping the situation under control. During all intrusive investigations, a qualified MEC Technician with expertise and knowledge in dealing with MEC will be present. Only the MEC Technician will determine whether an item is considered live or inert. If the MEC Technician can not make a determination regarding the found item or if the item is determined to be live, the following steps should be taken:

1. Stop all work. Under no circumstances should work continue near the item (Norfolk Naval Shipyard [NNSY] security typically does not permit any work to occur at a site even if it is some distance away from the item).
2. Contact the NNSY Security dispatcher at (757) 396-5111. If the field team lead reports to the NNSY he / she should discuss the situation with the MEC Technician prior to making the call. It is imperative to communicate whether the situation is an emergency, that activities have stopped, and that people will not have access to the area.
3. Immediately following notification to NNSY Security, a phone call should be placed to the CH2M HILL activity manager/project manager. The CH2M HILL activity manager/project manager will be responsible for contacting the NAVFAC Mid-Atlantic project manager Ms. Agnes Sullivan @ 444-4120.
4. If the project is a construction project that includes the NNSY Resident Office In Charge Of Construction (ROICC), contact the ROICC office at (757) 396-5121.
5. From the moment that NNSY security arrives, they are in charge and there are no exceptions.
6. Naval Ordnance Safety & Security Activity (NOSSA) will be notified by in accordance with Navy policy.

The MEC Technician will review and as necessary, discuss this procedure with CH2M HILL, the Navy, and other contractors working on the site

To:	Commanding Officer Naval Ordnance Safety and Security Activity ATTN: Code N5 101 Strauss Ave., BLDG D327 Indian Head, MD 20640-5555	**Date:**	October 4, 2004
From:	Robert Schirmer, P.E.		
Subject:	Explosive Safety Submission Waiver Request for Anomaly Avoidance and MEC-Related Scrap Clearance at IRP Site 2, Site 4, Site 19, and Site 21, St. Juliens Creek Annex, Chesapeake, Virginia (Figure 1)		

Transmitted herein are four explosive safety submission (ESS) waiver requests prepared for the four sites referenced above. The waiver requests were developed in accordance with NOSSAINST 8020.15 to seek approval from the NOSSA for an exemption of requiring an ESS for the proposed anomaly avoidance at three sites and MEC-related scrap clearance at one site. An outline of the proposed site activities is presented below. A more complete description of the technical and field approach will be provided in a work plan to be submitted following receipt of NOSSA's comments on these ESS waivers.

Anomaly Avoidance Objective and Approach

The primary objective of the anomaly avoidance is to direct subsurface soil collection and drilling operations away from areas which indicate magnetic anomalies. This operation will take place at Sites 2, 19, and 21 (Figure 2). Historical information and recent in-field findings suggest that MEC-related scrap may be encountered only Site 2. Additional site background details are provided in the waiver request forms.

The general field approach consists of the following at Sites 2, 19, and 21:

1. Conduct anomaly avoidance using Schonstedt magnetometer to detect any metallic anomalies on or near ground surface (in locations where needed)
2. Continued clearance using the Schonstedt until no anomalies are encountered at which point subsurface soil sampling or groundwater monitoring well drilling may proceed

MEC-Related Scrap Clearance Objective and Approach

The MEC-related scrap clearance objective is to find and remove any MEC-related scrap which may have been disposed of or discarded during past site operations. This operation will take place at Site 4 (Figure 2). Historical information and previous in-field findings did not encounter any MEC-related scrap at Site 4, however, due to the general operations of St. Juliens Creek Annex, it is possible that MEC-related scrap may be encountered at this site. Additional site background details are provided in the waiver request forms.

The general field approach consists of the following at Sites 4:

1. Conduct anomaly sweep of the site using Schonstedt magnetometer to detect any metallic anomalies on or near ground surface (in locations where needed)
2. Investigate subsurface anomalies using hand tool or similar equipment
3. Remove any MEC-related scrap

Disposal of all MEC-related scrap will be by performed by a qualified UXO contractor or the active-duty military EOD units. After the removal of MEC-related scrap, the area will be surveyed again to confirm all suspected anomalies have been investigated and cleared. If additional anomalies are found, they will be investigated in the same manner as before.

If MEC is encountered that poses a risk to people, equipment, or property during either anomaly avoidance or MEC-related scrap clearance activities, all operations will be stopped and an ESS submitted and approved prior to continuance of the activities.

Operational Risk/Hazard Assessment

An operational risk/hazard assessment has been performed for the above-listed tasks for each of the four sites, following procedures described in the OPNAVINST 3500.39A. Based on the historical information and findings at each site, the operational risk for each of the tasks is expected to be negligible. A copy of the hazard assessment is also included as attachments. Because of the expected negligible risk, a waiver of the ESS requirement for each site is therefore requested.

Enclosures - Waiver Request Forms
Operational Risk/Hazard Assessment
Figures 1 & 2

EXPLOSIVES SAFETY SUBMISSION
WAIVER REQUEST

Date:	04-Oct-04
Supporting EOD unit or UXO contractor: (if Applicable)	EOD Mobile Unit 2 DET Norfolk and USA Environmental
Site name: (activity, city, state)	IRP Site 2 (Waste Disposal Area B), St. Juliens Creek Annex, Chesapeake, Virginia
POC name:	Mr. Robert Schirmer (NAVFAC - Mid Atlantic
POC phone/fax/e-mail:	(757) 322-4751 (757) 322-4805 robert.g.schirmer@navy.mil

Site history: (describe past site use; discuss why munitions are or are not likely to be encountered

Site 2 is a former waste disposal area located at the corner of St. Juliens Drive and Cradock Street, in the southwestern portion of the facility (Figure 2) . The waste disposal area began operating in 1921. Initially, refuse was burned onsite and was used to fill an adjacent swampy area. Mixed municipal wastes, organics, inorganics, solvents, and waste ordnance may have been disposed at Site 2. The total volume of waste prior to burning is reported to have been approximately 35,185 cubic yards, and it is estimated that half of this waste was disposed of prior to 1942. In 1942, an incinerator was installed and replaced the open-burning practices. The waste disposal area was closed sometime after 1947 (A.T. Kearney, 1989).

During the 1989 RCRA Facility Assessment (RFA), stained soil associated with leaking heavy equipment stored onsite, ash, and ABM were observed on the ground surface at Site 2. An RFI was recommended at Site 2 owing to the high potential for release to soil, which is attributable to the waste disposal area being unlined and the moderate to high potential for release to surface water via runoff and groundwater discharge because of proximity to St. Juliens Creek. Additionally, soil sampling for inorganics was recommended in the areas of ABM to determine if hazardous constituents were associated with the material.

During the Relative Risk Ranking (RRR) data collection study in 1996, two surface soil and two groundwater samples were collected at Site 2 and analyzed for VOCs, SVOCs, pesticides/PCBs, inorganics, and nitramines. The soil samples were found to contain pesticides/PCBs and inorganics. The groundwater samples contained 2,4,6-trinitrotoluene, 1,3,5-trinitrobenzene, acetone, and several inorganics (CH2M HILL, 1996).

The RI field investigation activities conducted in 2001 included geophysical investigations, monitoring well installations, water-level monitoring, waste delineation, and the collection and analysis of surface and subsurface soil samples, groundwater samples, sediment samples, and surface water samples. Based on the results of the waste delineation trenching, historical aerial photograph reviews, and SJCA IR Partnering Team discussions, it was determined that Site 2 had not been operated as a cut-and-fill landfill. Therefore, Site 2 was reclassified as a waste disposal area. In addition, the Site 2 boundary was adjusted to reflect the extent of waste.

Based on the results of the Site 2 RI and data gaps identified, an Expanded RI was conducted from December 2003 through January 2004 and included shallow monitoring well installation and sampling to further define the nature and extent of groundwater contamination, stormwater and surface water sampling to assess the source of VOC contamination in inlet surface water, and sediment sampling. A qualified UXO subcontractor was on site during the entire intrusive investigation.

Intrusive activities to be conducted in the fall of 2004 include the advancement of up to 20 direct push technology (DPT) points, installation of up to five monitoring wells, and collection of three sediment samples. The DPT uses a 2-inch diameter rod which will be advanced to a maximum depth of 20 feet below ground surface (bgs). Groundwater is no more than five feet bgs. The five monitoring wells will require the use of 10-inch outside diameter augers which will be advanced to a maximum depth of 20 feet bgs.

Munitions encountered or believed to be present; (quantity, type/ nomeclature, and condition)

Only MEC-related scrap has been encountered at the site. A total of four inert items have been encountered during previous investigations at Site 2. They include: one protective cap and projectile fuze, one MK II 40mm cartridge casing, and two 5-inch projectile cartridge casings.

Prepared By: Mark Kelly, CH2M HILL, Inc., MEC Safety Coordinator
Date: 04-Oct-04

Site Name: IRP Site 2 (Waste Disposal Area B), St. Juliens Creek Annex, Chesapeake, Virginia

The following tasks will be performed during the expanded remedial investigation of Site 2.

Task 1: Intrusive activities to be conducted in the fall of 2004 include the advancement of up to 20 direct push technology (DPT) points, installation of up to five monitoring wells, and collection of three sediment samples. The DPT uses a 2-inch diameter rod which will be advanced to a maximum depth of 20 feet below ground surface (bgs). Groundwater is no more than five feet bgs. The five monitoring wells will require the use of 10-inch outside diameter augers which will be advanced to a maximum depth of 20 feet bgs.

MGFD: Unexpended primer from 5-inch projectile cartridge casing

Hazard Category	Hazard	Mishap Probability				Mishap Probability
I - May cause death	Category	A	B	C	D	A - Likely
II - May cause severe injury	I	1	1	2	3	B - Probably in time
III - May cause minor injury	II	1	2	3	4	C - May occur in time
IV - Minimal threat	III	2	3	4	5	D - Unlikely to occur
	IV	3	4	5	5	

RAC Definitions
1 - Critical
2 - Serious
3 - Moderate
4 - Minor
5 - Negligible

RAC = 5 based on analysis

EXPLOSIVES SAFETY SUBMISSION
WAIVER REQUEST

Date:	04-Oct-04
Supporting EOD unit or UXO contractor: (if Applicable)	EOD Mobile Unit 2 DET Norfolk and USA Environmental
Site name: (activity, city, state)	IRP Site 4 (Landfill D), St. Juliens Creek Annex, Chesapeake, Virginia
POC name:	Mr. Robert Schirmer (NAVFAC - Mid Atlantic
POC phone/fax/e-mail:	(757) 322-4751 (757) 322-4805 robert.g.schirmer@navy.mil

Site history: (describe past site use; discuss why munitions are or are not likely to be encountered

The Site 4 landfill covers an estimated 10 acres. The site is located on dredge fill material which reportedly originated from Blows Creek and the Southern Branch of the Elizabeth River. In earlier documents, Site 4 was referred to as Dump D or SWMU 6 and included SWMU 7 and AOC L.

The first indication of activity at Site 4 is a trench identified on a historical aerial photograph from 1961. The trench was approximately 1,000 ft long and paralleled Blows Creek about 500 ft north of it. The original trench and others were filled with trash, wet garbage, and soil from subsequent trenches. It is not known how many trenches were eventually dug, but based on a review of historical aerial photographs, there appears to have been only two trenches.

An Initial Assessment Study (IAS) indicated that around 1970, sanitary landfill operations began at Site 4 in the marshes of Blows Creek. Primarily trash and wet garbage were disposed of. Sanitary landfill operations continued until 1976, at which time trash and garbage were hauled to an off-site facility, and inert material was then disposed of at the landfill. The RFA indicates that refuse was disposed of at Site 4 between 1970 and 1981. The wastes managed were primarily trash, wet garbage, construction material, and outdated civil defense stores. Wastes disposed of at Site 4 were estimated at 1.5 million ft3.

The results of sampling conducted to date at Site 4 have not indicated the presence of hazardous materials. Although trenching and landfilling may have continued after 1976 (implementation of RCRA), it is believed that only municipal wastes and inert material were disposed of. In addition, no sampling to date has indicated the presence of hazardous waste. Based on a comparative analysis conducted as part of a Feasibility Study (CH2M HILL, 2004), a soil cover and removal of contaminated sediment in the upland drainage ditch has been selected as the recommended remedial alternative for Site 4. A Proposed Remedial Action Plan (PRAP), Record Of Decision (ROD), and Remedial Design (RD) will be submitted in FY 2004. The RD will be implemented in FY 2005.

Intrusive activities, scheduled for spring of 2005, associated with the placement of the soil cover will include the consolidation of surface waste from the edges of the landfill to allow appropriate construction of the landfill cover.

Munitions encountered or believed to be present; (quantity, type/ nomeclature, and condition)

No MEC or MEC-related scrap have been encountered during any of the previous investigations at Site 4. It has been reported that only municipal wastes have been disposed of at Site 4. However, due to the relatively high level of munitions-related activity at SJC Annex, basic MEC avoidance techniques will be included in the work plan. These techniques include visual surface sweeps and subsurface magnetometer checks prior to intrusive activies such as excavation.

Prepared By: Mark Kelly, CH2M HILL, Inc., MEC Safety Coordinator
Date: 04-Oct-04

Site Name: IRP Site 4 (Landfill D), St. Juliens Creek Annex, Chesapeake, Virginia

The following task will be conducted during the construction of the soil cover.

Task 1: Intrusive activities, scheduled for spring of 2005, associated with the placement of the soil cover will include the consolidation of surface waste from the edges of the landfill to allow appropriate construction of the

MGFD: N/A

Hazard Category	Hazard Category	Mishap Probability A	B	C	D	Mishap Probability
I - May cause death	I	1	1	2	3	A - Likely
II - May cause severe injury	II	1	2	3	4	B - Probably in time
III - May cause minor injury	III	2	3	4	5	C - May occur in time
IV - Minimal threat	IV	3	4	5	5	D - Unlikely to occur

RAC Definitions
1 - Critical
2 - Serious
3 - Moderate
4 - Minor
5 - Negligible

RAC = 5 based on analysis

EXPLOSIVES SAFETY SUBMISSION
WAIVER REQUEST

Date:	04-Oct-04
Supporting EOD unit or UXO contractor: (if Applicable)	EOD Mobile Unit 2 DET Norfolk and USA Environmental
Site name: (activity, city, state)	IRP Site 19 (Building 190), St. Juliens Creek Annex, Chesapeake, Virginia
POC name:	Mr. Robert Schirmer (NAVFAC - Mid Atlantic
POC phone/fax/e-mail:	(757) 322-4751 (757) 322-4805 robert.g.schirmer@navy.mil

Site history: (describe past site use; discuss why munitions are or are not likely to be encountered

Building 190 was located near Building M-5, south of the mouth of Blows Creek. The 1981 IAS identified Building 190 to have handled loose ordnance materials and used for loading explosives into ammunition. From the 1940s to the 1970s, Explosive D and Composition A-3 were used at Building 190.

The RFA reported that various ordnance items had been disposed of in the area between Building M-5 and Building 190 during past ordnance management activities (A. T. Kearney, 1989). Site 19 was referred to as AOC H during the RFA, and the area was noted to contain a variety of construction rubble and facility personnel reported no knowledge of residual contamination from ordnance management operations. The RFA recommended that a determination be made as to whether residual ordnance exists and the collection of soil samples to determine possible residual contamination.

During a Relative Risk Ranking (RRR) data collection study, surface soil and groundwater samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, inorganics, and nitramines. No nitramines were detected in the surface soil samples and no ordnance encountered during the investigation. (CH2M HILL, 1996).

A Site Investigation (SI) was conducted at Site 19 in August 2003 and included the collection of subsurface soil samples. No ordnance was encountered during this investigation and no explosive chemicals were detected in the soil samples. A qualified UXO subcontractor was on site during the entire intrusive investigation.

Intrusive activities to be conducted in the fall of 2004 include the advancement of up to five direct push technology (DPT) points and the collection of five shallow soil samples. The DPT uses a 2-inch diameter rod which will be advanced to a maximum depth of 3 feet bgs. The five shallow soil samples will be collected at a depth of 6 inches up to 2 feet bgs. These shallow soil samples will be collected with a hand auger or trowel.

Munitions encountered or believed to be present; (quantity, type/ nomeclature, and condition)

No MEC or MEC-related scrap have been encountered during any of the previous investigations at Site 19. However, due to the relatively high level of munitions-related activity at SJC Annex, basic MEC avoidance techniques will be included in the work plan. These techniques include visual surface sweeps and subsurface magnetometer checks prior to intrusive activies such as soil boring/sampling.

Prepared By: Mark Kelly, CH2M HILL, Inc., MEC Safety Coordinator
Date: 04-Oct-04

Site Name: IRP Site 19 (Building 190), St. Juliens Creek Annex, Chesapeake, Virginia

The following tasks will be performed during the expanded soil and groundwater investigation of Site 19.

Task 1: Intrusive activities to be conducted in the fall of 2004 include the advancement of up to five direct push technology (DPT) points and the collection of five shallow soil samples. The DPT uses a 2-inch diameter rod which will be advanced to a maximum depth of 3 feet bgs. The five shallow soil samples will be collected at a depth of 6 inches up to 2 feet bgs. These shallow soil samples will be collected with a hand auger or trowel.

MGFD: N/A

Hazard Category	Hazard Category	Mishap Probability				Mishap Probability
I - May cause death		A	B	C	D	A - Likely
II - May cause severe injury	I	1	1	2	3	B - Probably in time
III - May cause minor injury	II	1	2	3	4	C - May occur in time
IV - Minimal threat	III	2	3	4	5	D - Unlikely to occur
	IV	3	4	5	5	

RAC Definitions
1 - Critical
2 - Serious
3 - Moderate
4 - Minor
5 - Negligible

RAC = 5 based on analysis

EXPLOSIVES SAFETY SUBMISSION
WAIVER REQUEST

Date:	04-Oct-04	Supporting EOD unit or UXO contractor: (if Applicable)	EOD Mobile Unit 2 DET Norfolk and USA Environmental
Site name: (activity, city, state)	IRP Site 21 (Building 187), St. Juliens Creek Annex, Chesapeake, Virginia		
POC name:	Mr. Robert Schirmer (NAVFAC - Mid Atlantic	POC phone/fax/e-mail:	(757) 322-4751 (757) 322-4805 robert.g.schirmer@navy.mil
Site history: (describe past site use; discuss why munitions are or are not likely to be encountered	Building 187 was a locomotive shed used for locomotive maintenance. The IAS stated that the area around the locomotive shed was saturated with oil (NEESA, 1981). Currently, the building and surrounding areas are covered with concrete and asphalt. A review of historical documents and historic aerial photographs dating back to 1937 do not indicate any disposal of base generated waste or ordnance. During a Relative Risk Ranking (RRR) data collection study performed in 1996, surface soil and groundwater samples were collected and analyzed for VOCs, SVOCs, pesticides/PCBs, and inorganics. Soil and groundwater were not sampled for explosives, but no ordnance encountered during the investigation. (CH2M HILL, 1996). A Site Investigation (SI) was conducted at Site 21 in August 2003 and included the installation of seven groundwater monitoring wells collection of subsurface soil samples. No ordnance was encountered during this investigation and no explosive chemicals were detected in the soil samples. A qualified UXO subcontractor was on site during the entire intrusive investigation. **Intrusive activities to be conducted in the fall of 2004 includes the installation of up to five monitoring wells. The five monitoring wells will require the use of 10-inch outside diameter augers which will be advanced to a maximum depth of 20 feet bgs.**		
Munitions encountered or believed to be present; (quantity, type/ nomeclature, and condition)	No munitions have been encountered during any of the previous investigations at Site 21. However, due to the relatively high level of munitions-related activity at SJC Annex, basic MEC avoidance techniques will be included in the work plan. These techniques include visual surface sweeps and subsurface magnetometer checks prior to intrusive activies such as monitor well installation.		

Prepared By: Mark Kelly, CH2M HILL, Inc., MEC Safety Coordinator
Date: 04-Oct-04

Site Name: IRP Site 21 (Building 187), St. Juliens Creek Annex, Chesapeake, Virginia

The following tasks will be performed during the expanded groundwater investigation of Site 21.

Task 1: Intrusive activities to be conducted in the fall of 2004 includes the installation of up to five monitoring wells. The five monitoring wells will require the use of 10-inch outside diameter augers which will be advanced to a maximum depth of 20 feet bgs.

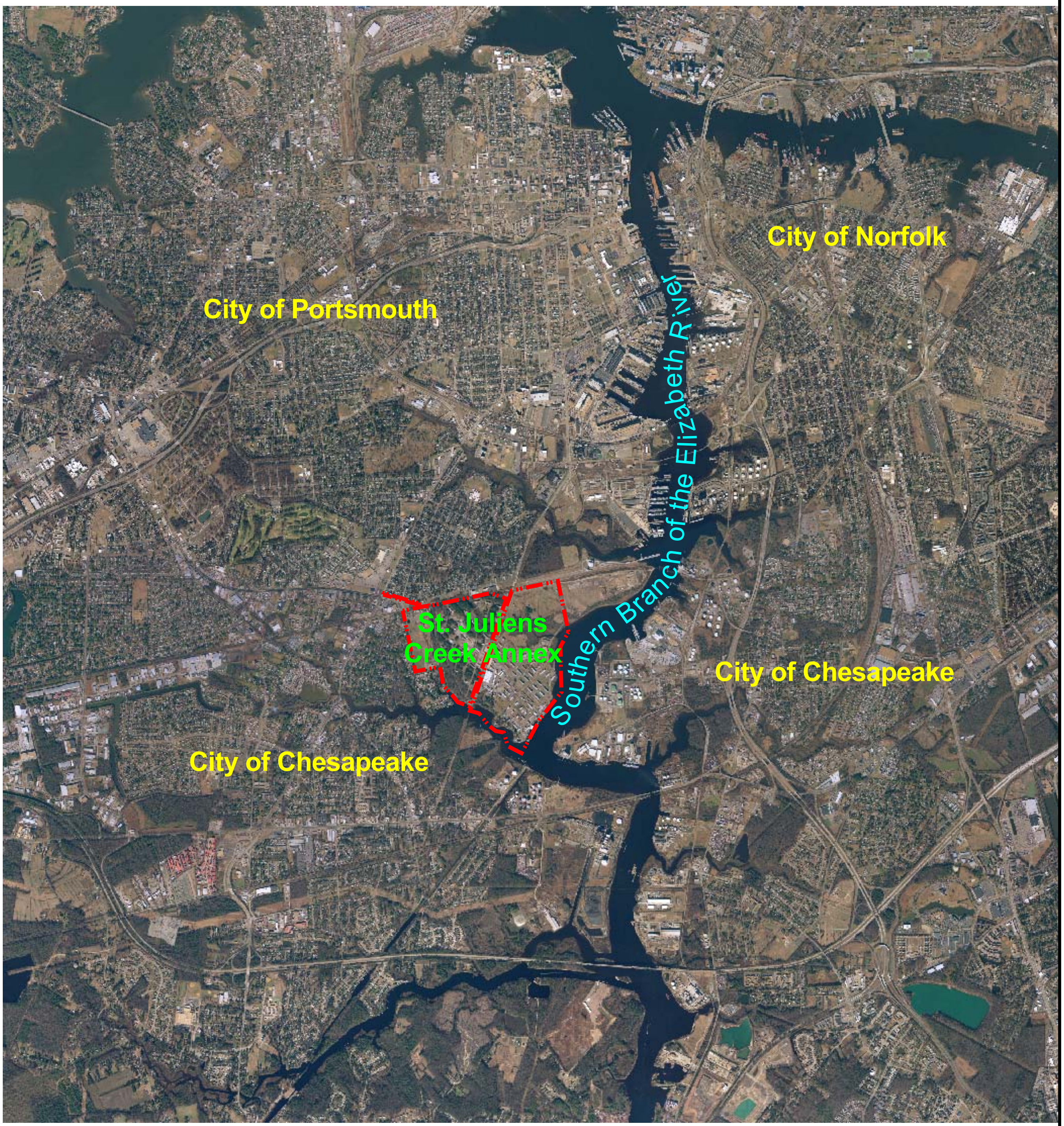
MGFD: N/A

Hazard Category	Hazard Category	Mishap Probability A	B	C	D	Mishap Probability
I - May cause death	I	1	1	2	3	A - Likely
II - May cause severe injury	II	1	2	3	4	B - Probably in time
III - May cause minor injury	III	2	3	4	5	C - May occur in time
IV - Minimal threat	IV	3	4	5	5	D - Unlikely to occur

RAC Definitions
1 - Critical
2 - Serious
3 - Moderate
4 - Minor
5 - Negligible

RAC = 5 based on analysis

File Path: c:\18gis\cd projects\ess waiver sites.apr



LEGEND

St. Juliens Creek Annex

N

0 2 4 6 Miles

Figure 1
Waiver For ESS Submittal
St. Juliens Creek Annex
Base Location Map
Chesapeake, Virginia

CH2MHILL

File Path: c:\18gis\cd projects\ess waiver sites.apr

LEGEND

ESS Waiver Sites

N

2000 0 2000 4000 Feet

Figure 2
Waiver For ESS Submittal
St. Juliens Creek Annex
Sites 2, 4, 19, & 21
Chesapeake, Virginia

CH2MHILL

DEPARTMENT OF THE NAVY
NAVAL ORDNANCE SAFETY & SECURITY ACTIVITY
FARRAGUT HALL BLDG D-323
23 STRAUSS AVENUE
INDIAN HEAD MD 20640-5555

8020
Ser N511/1637
14 Oct 04

From: Commanding Officer, Naval Ordnance Safety and Security Activity
To: Commander Officer, NAVFAC Mid-Atlantic

Subj: EXPLOSIVES SAFETY SUBMISSION (ESS) WAIVER REQUEST FOR IRP SITES 2, 4, 19, AND 21 AT ST. JULIEN'S CREEK ANNEX

Ref: (a) Mr. Robert Schirmer memo of 4 Oct 04 (w/encl)
(b) NOSSAINST 8020.15, Military Munitions Response Program Oversight dtd 8 Mar 04
(c) NAVSEA OP 5, Revision 7
(d) DoD 4160.21-M
(e) DoD 4160.21-M-1

1. As requested by reference (a), the Naval Ordnance Safety and Security Activity (NOSSA) reviewed the subject Explosives Safety Submission (ESS) waiver requests in accordance with references (b) and (c).

2. Based on the information presented in reference (a) and on the ESS criteria in Section 7 of reference (b), NOSSA waives the requirement for submission of an ESS at this time as follows:

a. Site 2, 19, and 21: Using anomaly avoidance techniques as defined in reference (b), select points where direct push technology (DPT) will be used to install monitoring wells and collect sediment samples.

b. Site 4: Collect and remove surface debris, including munitions-related debris that poses no explosives hazard. All munitions-related debris must be inspected, certified, and verified in accordance with reference (d) and demilitarized in accordance with reference (e).

3. At any time should you encounter live munitions during your proposed anomaly avoidance and munitions-related scrap clearance activities, you must stop both processes and submit an ESS.

4. The NOSSA point of contact for this ESS waiver is Mr. Douglas Murray. He can be contacted at DSN 354-4355.

Pamela G. Clements
PAMELA G. CLEMENTS
By direction

Copy to: (See next page)

Subj: EXPLOSIVES SAFETY SUBMISSION (ESS) WAIVER REQUEST FOR IRP SITES 2, 4, 19, AND 21 AT ST. JULIEN'S CREEK ANNEX

Copy to:
CNO (N411; N45C)
COMNAVFACENGCOM (EN)
NOSSA ESSOLANT (N712L)

Appendix D
Example Sediment Diffusion Sampler Specification

EON PRODUCTS, INC.

We Make It Easier For Y

Product Catalog

Groundwater | Sampling | Diffusion Sampling in Sedim

Home Page
Product Catalog
Groundwater
· Sampling
· Pumping
· Water Level
· Water Quality
· Hydrocarbon Removal
Soil Sampling
Direct Push Tools
Gas & Air
Metal Analysis
Field Supplies
Personal Safety
Service and Rentals
Rentals
Tech. Documents
Search EON Site
Company Profile
Contact Info.

Diffusion Sampling in Sediments

Sediment Diffusion Sampler

Patents 6,196,074 and 5,804,743

Sediment Diffusion Samplers are placed at the bottom of lakes, ponds, or streambeds, or in saturated embankments where Volatile Organic Compounds can migrate from groundwater to surface water.

The Equilibrator™ passive diffusion samplers are used for sediment application and can be buried directly in sediments or used with our protective canister screens.

Special sizes and configurations are available.

Sediment Diffusion Sampler Ordering Information			
GSD 200	Equilibrator PDB	1.5" x 18"	350 ml
GSD 190	Equilibrator PDB	1.5" x 12"	150 ml

Protective Canister Screen

When passive diffusion samplers are buried in stream beds or embankments they can be exposed to moving debris, sharp objects, soil pressures, or installation stress that may damage the membrane.

EON's Protective Canister Screens allow the free passage of water into the sampler while protecting the sampler from physical damage. Casings are made of 2-inch diameter slotted PVC with a pointed tip and screw-off top. Diffusion samplers are placed inside the canister and the entire assembly is installed.

Canisters will withstand a moderate amount of pushing during installation and retrieval, and they are reusable.

Protective Canister Screen Ordering Information		
GSD 410	Protective Canister Screen for PDB	2" x 12"
GSD 415	Protective Canister Screen for PDB	2" x 20"
FSF 275	Marking Flag, 30" stem	100 ct

EON Products, Inc. · Toll-Free: (800) 474-2490