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FINAL SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING AND QUALITY ASSURANCE
PROJECT PLAN) LOADING PLANT 1 INCLUDING SITES 9 AND 19 REMEDIAL
INVESTIGATION NWS YORKTOWN VA

07/01/2014
CH2M HILL

SAP Worksheet #1—Title and Approval Page

Final

**Sampling and Analysis Plan
(Field Sampling Plan and Quality Assurance Project Plan)
Loading Plant No. 1
(including Site 9 and Site 19)
Remedial Investigation**

**Naval Weapons Station Yorktown
Yorktown, Virginia**

Contract Task Order WE35

July 2014

Prepared for:

**Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic**

Under the

**NAVFAC CLEAN 8012 Program
Contract N62470-11-D-8012**

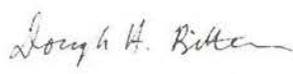
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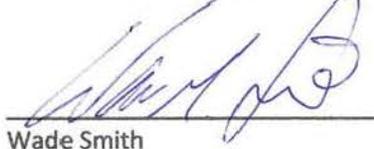
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Executive Summary

This site-specific Sampling and Analysis Plan (SAP) is being submitted to provide a systematic data collection and analysis structure for the Former Loading Plant No. 1 Remedial Investigation (RI) at Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia, which includes Site 9 (Explosives-contaminated Wastewater Discharge Area) and Site 19 (Conveyor Belt Soils at Building 10). In accordance with the Guidance for Uniform Federal Policy (UFP) for Quality Assurance Project Plans (QAPP) (USEPA, 2005), this Department of the Navy (Navy)-specific SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serves as a guideline for the field work and data quality. The field standard operating procedures (SOPs) are located in **Appendix A** of this SAP.

The Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic Division, is conducting this RI under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). CERCLA work is being conducted with the United States Environmental Protection Agency (USEPA) Region 3 as the lead regulatory agency. The Virginia Department of Environmental Quality (VDEQ) is the state regulatory agency. Together, these three agencies form the stakeholder agencies for this project.

This document will help ensure that environmental data collected and compiled are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is for the analytical laboratories that are currently contracted to provide analytical services for this investigation. The analytical services for this investigation will be provided by Chemtech as the primary laboratory. ALS-Rochester has been subcontracted by Chemtech for the analysis of perchlorate and hexavalent chromium. Geostructures has been subcontracted by Chemtech for grain size analysis. Data validation (DV) services will be provided by CH2M HILL.

The purpose of this RI is to determine whether site-related contamination associated with historical activities warrants additional CERCLA action at WPNSTA Yorktown Former Loading Plant No. 1. Although some data have been collected within the Former Loading Plant No. 1 boundary (at Sites 9 and 19 and the surrounding area), this investigation will address portions of the Former Loading Plant No. 1 site that have not been previously investigated and will fill gaps in the current dataset to help determine the nature and extent of potentially affected groundwater, soil, surface water, and sediment. It will also determine whether contamination poses a potential unacceptable human health or ecological risk, and, if so, which receptors are potentially at risk.

The recent demolition of all site buildings at Sites 9 and 19 has provided access to potentially affected areas that could not be sampled during previous site investigations. The building demolition included Building 10 and the Trinitrotoluene (TNT) Building (located upgradient of Sites 9 and 19) and three small material storage buildings (Powder Metal Storage, Bulk TNT Storage, and Nitrate Prep and Storage buildings) associated with Former Loading Plant No. 1. Activities in these buildings had the potential to be sources of contamination to all site media as a result of historical material storage and waste disposal practices, as well as the presence of floor drains in some of the former site buildings. Previous investigations addressed limited soil, sediment, surface water and groundwater areas at Sites 9 and 19. However, those site investigations did not include sampling of soil, surface water, or sediment in the vicinity of the former site buildings or in the concrete drainage channels adjacent to these buildings. Historical site investigations focused only on Site 9, located at the northwest corner of former Building 10, and the Site 19 TNT conveyor belt area. The Partnering Team has agreed that additional investigation will include potential site impacts resulting from historical operations at Former Loading Plant No. 1. For this reason, groundwater, soil, surface water and sediment will be sampled in the vicinity of Former Loading Plant No. 1 to gain a more complete understanding of potential site impacts. Additionally, groundwater seeps and/or pore water samples may be collected at Former Loading Plant No. 1, if groundwater results indicate that these media may be affected by site contamination. As investigation activities are being performed within the Former Loading Plant No. 1 site boundary in areas that have not been previously investigated, site media will be investigated for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) including polycyclic

aromatic hydrocarbons (PAHs), 1,4-dioxane, metals, cyanide, explosives, and perchlorate. Historical site activities at the Former Loading Plant No. 1 site included the use of VOCs and SVOCs, while previous investigation efforts have identified the presence of metals, cyanide, and explosives in site groundwater. Site groundwater and surface water samples will also be analyzed for dissolved metals and free cyanide. Additional samples may be collected and analyzed for hexavalent chromium during a second mobilization, if the total metals results indicate that chromium may be of concern.

The following is a summary of the data that will be collected to evaluate potential contamination associated with Former Loading Plant No. 1 and to further evaluate groundwater contamination identified during previous investigations to determine whether additional CERCLA action is warranted:

- New groundwater monitoring wells will be installed at Former Loading Plant No. 1. The new wells will be installed within the Cornwallis Cave aquifer or within the Yorktown-Eastover aquifer. Samples from the new monitoring wells and existing groundwater wells will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, total and dissolved metals, total and free cyanide, explosives, and perchlorate.
- Co-located surface and subsurface soil samples will be collected at Former Loading Plant No. 1 and sampled for VOCs, SVOCs including PAHs, 1,4-dioxane, total metals, total cyanide, explosives, and perchlorate.
- Additional soil samples will be collected in the vicinity of the former TNT Conveyor Belt to confirm that residual TNT concentrations in this area are below site cleanup goals. These samples will be collected at depths ranging from 0 to 36 inches below ground surface (bgs) based on historical sampling results. These soil samples collected in the TNT Conveyor Belt area will be analyzed for 2,4,6-TNT only.
- Additional soil samples will be collected in the vicinity of the former TNT Conveyor Belt to confirm that 2 feet of fill are present above the aluminum-impacted soil placed at the base of the trench during the 1998 RA. These samples will be collected at depths ranging from 12 to 24 inches bgs. These samples collected in the TNT Conveyor Belt area will be analyzed for aluminum and pH.
- Co-located surface water and sediment samples will be collected at Former Loading Plant No. 1 and sampled for VOCs, SVOCs including PAHs, 1,4-dioxane, total metals, total cyanide, explosives, and perchlorate. Surface water will also be analyzed for dissolved metals and free cyanide.
- A groundwater seep survey will be performed at Former Loading Plant No. 1. Following the seep survey and groundwater sampling effort, the need for groundwater seep and/or pore water sampling (up to 10 samples total) will be evaluated. The need to collect groundwater seep and/or pore water samples for select analytes will be based on groundwater sampling results, groundwater flow directions, and contaminant extent. The timeframe available for seep sampling varies seasonally. Seep sampling may only be possible during the late winter and early spring. As the groundwater seep sampling is contingent upon the identification of seeps and the site analytical results, this sampling will not be performed until early 2015, if determined to be necessary.
- If total metals results indicate that chromium may be of concern at the site, additional samples may be collected and analyzed for hexavalent chromium in a subsequent mobilization.

Data will be compared to human health and ecological risk-based screening values. Constituents of potential concern (COPCs) will be identified where analytes are detected that exceed their respective risk-based screening values. Additionally, for ecological receptors, if no screening values are available for comparison purposes, detected analytes will be retained for further consideration as COPCs. Groundwater data will also be compared to maximum contaminant levels (MCLs). Quantitative human health risk assessments (HHRAs) and ecological risk assessments (ERAs) will be performed for all COPCs. Concentrations of contaminants determined to pose potential risks based on the quantitative risk assessments will be compared to background concentrations (if applicable) to determine if they are consistent with background conditions. Following this step, any constituents of concern (COCs) will be identified. Further action at Former Loading Plant No. 1 will be considered based on risk-based COCs and MCL exceedances.

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Acronyms and Abbreviations

| | |
|--------|---|
| °C | degree Celsius |
| µg/kg | microgram per kilogram |
| µg/L | microgram per liter |
| µm | micrometer |
| µmol/g | micromole per gram |
| %D | percent difference; percent drift |
| %RSD | percent relative standard deviation |
| AES | atomic emission spectrometry |
| AM | Activity Manager |
| AQM | Activity Quality Manager |
| ASAP | as soon as possible |
| AVS | acid-volatile sulfide |
| AWQC | Ambient Water Quality Criteria |
| BD | bottom depth |
| BFB | bromofluorobenzene |
| bgs | below ground surface |
| CA | corrective action |
| CCV | continuing calibration verification |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CLEAN | Comprehensive Long-term Environmental Action—Navy |
| COC | constituent of concern |
| COD | coefficient of determination |
| COPC | constituent of potential concern |
| COR | Contracting Officer's Representative |
| CSM | conceptual site model |
| CV | calibration verification |
| CVAA | cold vapor atomic absorption |
| DFTPP | decafluorotriphenylphosphine |
| DI | deionized |
| DL | detection limit |
| DNB | dinitrobenzene |
| DNT | dinitrotoluene |
| DO | dissolved oxygen |
| DoD | Department of Defense |
| DPT | direct-push technology |
| DQI | data quality indicator |
| DV | data validation |
| ELAP | Environmental Laboratory Accreditation Program |
| ERA | ecological risk assessment |
| ESV | ecological screening value |
| FTL | Field Team Leader |
| g | gram |
| GC/MS | gas chromatography/mass spectrometry |

| | |
|------------------|--|
| H&S | health and safety |
| HCl | hydrochloric acid |
| HDPE | high-density polyethylene |
| HHRA | human health risk assessment |
| HMW | high molecular weight |
| HMX | Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine |
| HNO ₃ | nitric acid |
| HPLC/ESI/MS | high-performance liquid chromatography/electrospray ionization/mass spectrometry |
| HSO | Health and Safety Officer |
| HSP | Health and Safety Plan |
| IC | ion chromatography |
| ICAL | initial calibration |
| ICP | inductively coupled plasma |
| ICV | initial calibration verification |
| ID | identification |
| IDW | investigation-derived waste |
| IS | internal standard |
| L | liter |
| LCL | Lower Control Limit |
| LCS | laboratory control sample |
| LMW | low molecular weight |
| LOD | limit of detection |
| LOQ | limit of quantitation |
| MCL | maximum contaminant level |
| MDL | method detection limit |
| mg | milligram |
| mg/kg | milligram per kilogram |
| mg/L | milligram per liter |
| mL | milliliter |
| mm | millimeter |
| MPC | Measurement Performance Criteria |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| MTBE | methyl-tert-butyl ether |
| N/A | not applicable |
| NaOH | sodium hydroxide |
| NAVFAC | Naval Facilities Engineering Command |
| Navy | Department of the Navy |
| NB | nitrobenzene |
| NC | no criterion |
| NFA | no further action |
| NPDES | National Pollutant Discharge Elimination System |
| NT | nitrotoluene |
| ORP | oxidation-reduction potential |
| OVA | organic vapor analyzer |
| oz | ounce |
| PAH | polycyclic aromatic hydrocarbon |

| | |
|----------------|---|
| PAL | project action limit |
| PC | Project Chemist |
| PETN | pentaerythrite tetranitrate |
| PID | photoionization detector |
| PIL | project indicator level |
| PM | Project Manager |
| POC | point of contact |
| PPE | personal protective equipment |
| ppm | part per million |
| PQO | project quality objective |
| PVC | polyvinyl chloride |
| QA | quality assurance |
| QAO | Quality Assurance Officer |
| QAPP | Quality Assurance Project Plans |
| QC | quality control |
| QL | quantitation limit |
| QSM | Quality Systems Manual |
| r | correlation coefficient |
| r ² | coefficient of determination |
| RA | removal action |
| RDX | Hexahydro-1,3,5-trinitro-1,3,5-triazine |
| RF | response factor |
| RI | Remedial Investigation |
| RL | reporting limit |
| ROD | Record of Decision |
| RPD | relative percent difference |
| RPM | Remedial Project Manager |
| RRT | relative retention time |
| RSD | relative standard deviation |
| RSL | Regional Screening Level |
| RT | retention time |
| SAP | Sampling and Analysis Plan |
| SEM | simultaneously extracted metals |
| SIM | selected ion monitoring |
| SOP | standard operating procedure |
| SPCC | system performance check compound |
| SSC | Site Safety Coordinator |
| SSL | soil screening level |
| STC | Senior Technical Consultant |
| SVOC | semivolatile organic compound |
| TAL | Target Analyte List |
| TBD | to be determined |
| TCE | trichloroethene |
| TCL | Target Compound List |
| TD | top depth |
| Tetryl | trinitrophenylnitramine |
| TNB | trinitrobenzene |
| TNT | trinitrotoluene |

| | |
|--------|---|
| TOC | total organic carbon |
| UCL | Upper Control Limit |
| UFP | Uniform Federal Policy |
| USEPA | United States Environmental Protection Agency |
| UTL | Upper Tolerance Limit |
| UV | ultraviolet |
| UV-VIS | ultraviolet visible spectrum |
| VDEQ | Virginia Department of Environmental Quality |
| VOA | volatile organic analyte |
| VOC | volatile organic compound |
| WPNSTA | Naval Weapons Station |

SAP Worksheet #2—Sampling and Analysis Plan Identifying Information

[\(UFP-QAPP Manual Section 2.2.4\)](#)

Site Name/Number: Former Loading Plant No. 1 (including Site 9—Plant 1 Explosives-contaminated Wastewater Discharge Area and Site 19—Conveyor Belt Soils at Building 10)

Operable Unit: Not applicable

Contractor Name: CH2M HILL

Contract Number: N62470-11-D-8012

Contract Title: Comprehensive Long-term Environmental Action—Navy (CLEAN) 8012

Work Assignment Number (optional): N62470-11-D-8012, Contract Task Order WE35

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the:
 - Uniform Federal Policy (UFP) for Quality Assurance Project Plans (QAPP) (USEPA, 2005)
 - United States Environmental Protection Agency (USEPA) Guidance for QAPP, EPA QA/G-5 (USEPA, 2002)
2. Identify regulatory program:
 - Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
3. This SAP is a project-specific SAP.
4. List organizational partners (stakeholders) and identify the connection with lead organization:
 - Lead Organization:** Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic Division
 - Land Owner:** Department of Defense (DoD)
 - Lead Regulatory Agency:** USEPA Region 3
 - State Regulatory Agency:** Virginia Department of Environmental Quality (VDEQ)
5. If any required SAP elements and required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion as follows:

All SAP elements required for this project are described herein. Therefore, the crosswalk table is not necessary for this project.

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SAP Worksheet #3—Distribution List

[\(UFP-QAPP Manual Section 2.3.1\)](#)

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SAP Worksheet #4—Project Personnel Sign-off Sheet

[\(UFP-QAPP Manual Section 2.3.2\)](#)

The responsibility of implementing the SAP will vary depending on the role of the people and their organization. It is anticipated that the lead PM from each organization will be responsible for the overall SAP implementation. However, technical support staff, support contractors, and additional stakeholders may have input to the SAP and are also listed as potential signers, if applicable. The sign-off table is broken into two areas; those who will be responsible for the complete SAP implementation, and the supporting staff, contractors, or stakeholders who may sign the SAP. Personnel will indicate which sections of the SAP they reviewed.

The Naval Weapons Station (WPNSTA) Yorktown, Virginia, Partnering Team has an established system of receiving and reviewing documents. This document review system is also extended to individual agency technical support. Distribution of draft, draft final, and final versions of reports is made to the respective PM of each agency (NAVFAC, USEPA Region 3, and VDEQ). The deliverables are provided in two formats: a hard copy, as well as access to an electronic portable document format (commonly referred to as a “PDF”) version of the document. Prior to document distribution, each agency provides CH2M HILL with the number of copies they require. This is done to make sure that enough copies are provided so that the agencies can provide copies of the deliverable to any technical support staff. Comments are then returned to CH2M HILL by the PM of each agency in either letter or e-mail format. The agencies may also provide any comments received by their technical support staff. Review periods for each version of the document vary by report, but are expected to follow a schedule of: draft - 60 days, draft final - 14 days, and final - 14 days. However, the Department of the Navy (Navy), USEPA Region 3, and VDEQ expedite reviews whenever possible. The deadlines for reviews and comments are tracked by the Partnering Team using a document tracking tool maintained by CH2M HILL. This tracking sheet is provided to the Partnering Team following each update at Tier 1 partnering meetings. All comments received are uploaded to the Yorktown Administrative Record.

The following is a list of people who are responsible for ensuring overall implementation of the SAP:

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| Anita Dodson | CH2M HILL Navy CLEAN Program Chemist | (757) 671-6218 | | | |
| Laura Cook | Senior Technical Consultant (STC) | (757) 671-6214 | | | |

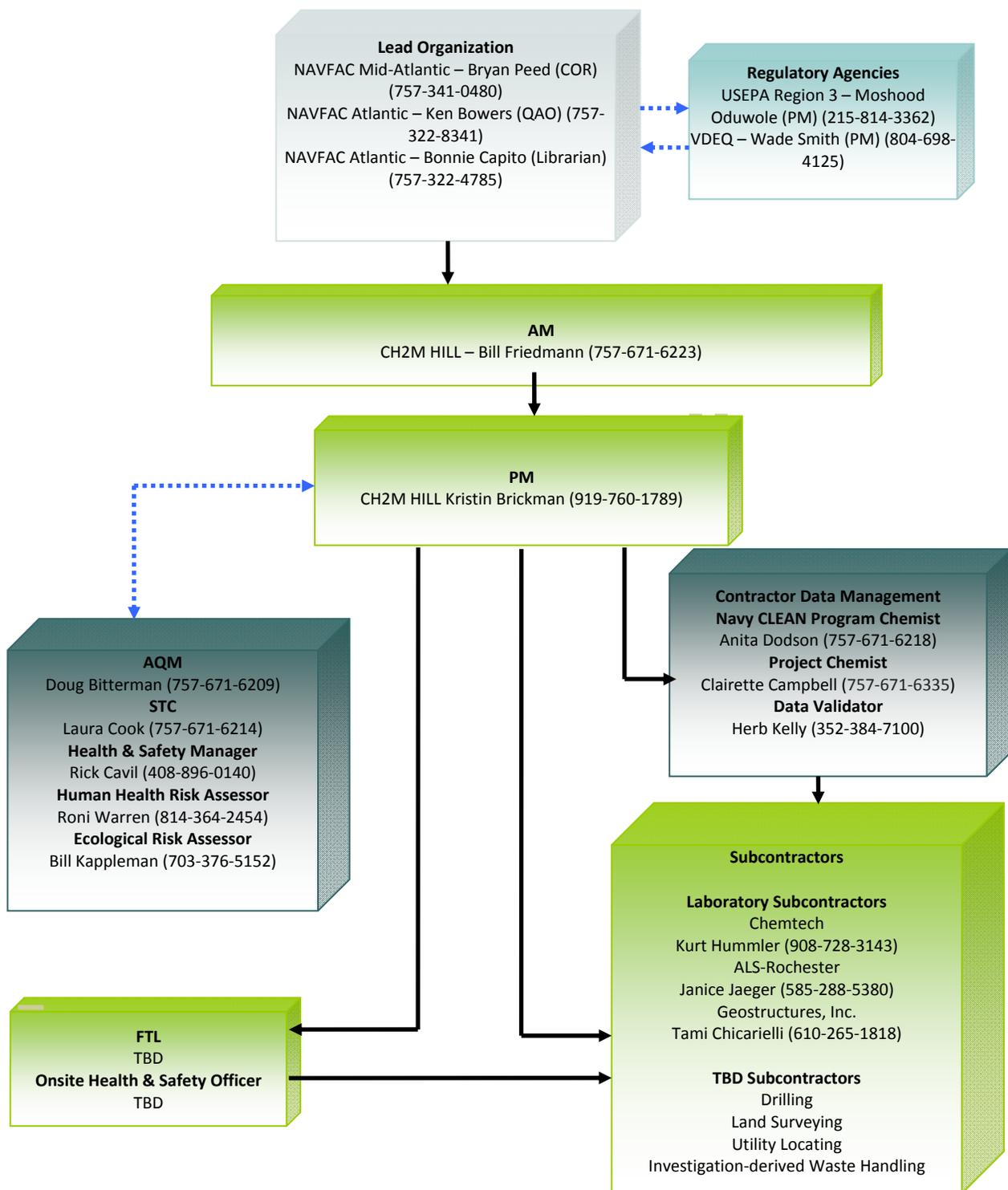
The following is a list of people who may provide input and therefore review portions or all of the SAP:

| Name | Organization/Title/Role | Telephone Number | Signature/e-mail receipt | SAP Section Reviewed | Date SAP Read |
|--------------------|--------------------------------------|------------------|--------------------------|----------------------|---------------|
| Clairette Campbell | CH2M HILL PC | (757) 671-6335 | | | |
| Roni Warren | CH2M HILL Human Health Risk Assessor | (814) 364-2454 | | | |
| William Kappleman | CH2M HILL Ecological Risk Assessor | (703) 376-5152 | | | |
| TBD | CH2M HILL FTL | TBD | | | |

SAP Worksheet #4—Project Personnel Sign-off Sheet (continued)

| Name | Organization/Title/Role | Telephone Number | Signature/e-mail receipt | SAP Section Reviewed | Date SAP Read |
|------------------|--------------------------|------------------|--------------------------|----------------------|---------------|
| Herb Kelly | CH2M HILL Data Validator | (352) 384-7100 | | | |
| Kurt Hummler | Chemtech PM | (908) 728-3143 | | | |
| Janice Jaeger | ALS-Rochester PM | (585) 288-5380 | | | |
| Tami Chicarielli | Geostructures PM | (610) 265-1818 | | | |

SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

[\(UFP-QAPP Manual Section 2.4.2\)](#)

The communication pathways for the SAP are as follows:

| Communication Drivers | Responsible Affiliation | Name | Phone Number and/or e-mail | Procedure |
|---|------------------------------|-----------------|----------------------------|---|
| Communication with NAVFAC (lead agency) | Navy COR for WPNSTA Yorktown | Bryan Peed | 757-341-0480 | Primary point of contact (POC) for Navy; communicates directly with VDEQ and USEPA as needed. Can delegate communication to other internal or external POCs. |
| Communication with VDEQ | VDEQ RPM | Wade Smith | 804-698-4125 | Primary POC for VDEQ; communicates directly with the Navy and USEPA as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings. |
| Communication with USEPA | USEPA RPM | Moshood Oduwole | 215-814-3362 | Primary POC for USEPA; communicates directly with the Navy and VDEQ as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings. |
| Navy Quality Assurance (QA)/Quality Control (QC) input | Navy Chemist | Ken Bowers | 757-322-8341 | Provides review comments to Navy contractor on Pre-draft SAP via Naval Installation Restoration Information Solution submittal. Provides overall Navy guidance via direct communication with Navy contractor chemist, as warranted. |
| Communication to/from Navy contractor (for example, submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations, etc.) | CH2M HILL AQM | Doug Bitterman | 757-671-6209 | Provides program-level quality review of the UFP-SAP. |
| Technical project implementation and data interpretation | CH2M HILL STC | Laura Cook | 757-671-6214 | Team members will contact the STC regarding questions and issues related to sampling and data interpretation, as needed. Responses will be communicated to the PM by e-mail or phone. |

SAP Worksheet #6—Communication Pathways (continued)

| Communication Drivers | Responsible Affiliation | Name | Phone Number and/or e-mail | Procedure |
|--|---|------------------|----------------------------|--|
| Communication regarding overall project status and implementation and primary POC with Navy COR, USEPA, and VDEQ | CH2M HILL WPNSTA Yorktown AM | Bill Friedmann | 757-671-6223 | Primary POC for stakeholder agency managers; can delegate agency communication to other contract staff, as appropriated. All information and materials about the project will be forwarded to the Partnering Team by the AM. The AM oversees all WPNSTA Yorktown projects and will receive project status reports from the PM. If field changes occur during investigation activities, the AM will work with the Navy COR to communicate the field changes to the Partnering Team via e-mail and/or phone within 24 hours. All data will be communicated to the Partnering Team via e-mail and meetings. |
| Communicates with AM and AQM. Manages all project phases | CH2M HILL PM | Kristin Brickman | 919-760-1789 | Issues are to be reported to the Navy COR immediately and followed up in writing within 2 business days. Primary modes of communication are phone, e-mail, letter, document submittal; timing dependent on nature of communication and predefined schedules, as applicable and as requested by stakeholder agencies; communicates directly with Navy COR as needed. Issues relayed to the Navy COR will be followed up in writing within 2 business days. |
| Health and Safety (H&S) expectations and procedures | CH2M HILL Health and Safety Officer (HSO) | Rick Cavil | 408-896-0140 | Review of Health and Safety Plan (HSP). Direct communication (via e-mail, telephone, hard copy, or in person, will be notified within 24 hours of incident) to/from Navy contractor project staff to ensure implementation of appropriate H&S procedures. |
| Implementation of sampling activities; SAP changes in the field; field corrective actions (CAs); daily field progress reports. | CH2M HILL FTL | TBD | TBD | Documentation of deviations from SAP in field logbooks and rationale for deviations, made within 24 hours of deviation; assistance in material procurement and delivery; injection oversight and implementation; deviations made only with approval from contractor PM and/or environmental manager. See Worksheet #32 Assessment Findings and CA Responses and Worksheet #32-1 CA Form. The FTL will immediately notify the PM of any field issues that would negatively affect the ability to meet project data quality objectives, or would negatively affect project schedule. The AM or PM may notify the Navy COR of any field data quality issues. FTL will e-mail or fax daily field progress reports to contractor PMs weekly; telephone communication with PMs on as-needed basis. |
| Ensure staff H&S in the field | CH2M HILL Site Safety Coordinator (SSC) | TBD | TBD | Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff. |

SAP Worksheet #6—Communication Pathways (continued)

| Communication Drivers | Responsible Affiliation | Name | Phone Number and/or e-mail | Procedure |
|--|--|---|--|--|
| Data tracking from collection through upload to database. Management of analytical lab and DV subcontractors. Analytical CAs/release of analytical data. | CH2M HILL PC | Clairette Campbell | 757-671-6335 | Tracks data from sample collection through upload to the database, making sure SAP requirements are met by laboratory and field staff. Will act as main POC for laboratory PM. The CH2M HILL AM and PM are informed within 24 hours of issues and will pass on communications to Navy and regulators as required. Analytical laboratory CAs will be identified by, or brought to the attention of, the PC as soon as they are discovered. Facilitates resolution on a same-day basis after consulting with the PM and AQM and the Navy chemist (if changes in the SAP are warranted) to be sure SAP requirements are met by the laboratory. Communicates with laboratories by phone, followed up with e-mail to document decisions and actions. If analytical laboratory issues affect data schedule or usability by rendering a significant amount of rejectable or unusable data such that the completeness goal cannot be obtained, the PC will notify the PM and Program Chemist. The Navy COR and Navy Quality Assurance Officer (QAO) will also be notified. |
| Reporting Laboratory Data Quality Issues | Laboratory PM | Kurt Hummer/ Chemtech Janice Jaeger/ ALS-Rochester Tami Chicarielli/ Geostructures | 908-728-3150 585-288-5380 610-265-1818 | All QA/QC issues with project field samples will be reported by the laboratory to the PC within 1 business day. The second-tier subcontracted laboratory will report all data quality issues to the primary subcontracted laboratory PM as soon as the QA/QC issue is identified. |
| Field and Analytical CAs | CH2M HILL Program Chemist CH2M HILL FTL | Anita Dodson TBD | 757-671-6290 757-671-6218 | The need for CA for field and analytical issues will be determined by the FTL and or Contractor Chemist. |
| Stop Work Order | CH2M HILL AM FTL SSC Field Team Members | Bill Friedmann TBD TBD TBD | 757-671-6223 TBD TBD TBD | Any field member can immediately stop work if an unsafe condition that is immediately threatening to human health is observed. The field staff, FTL, or SSC should notify the CH2M HILL PM and AM immediately, along with the Navy COR. Ultimately, the FTL, PM, and AM can stop work for a period of time. NAVFAC Mid-Atlantic can stop work at any time. |

SAP Worksheet #6—Communication Pathways (continued)

| Communication Drivers | Responsible Affiliation | Name | Phone Number and/or e-mail | Procedure |
|---------------------------------|--|--|--|--|
| Reporting data quality issues | DV | Herb Kelly | 352-384-7100 | The Data Validator reviews and qualifies analytical data as necessary. The data, along with a validation narrative, are returned to the PC within 14 calendar days. |
| DV CAs | CH2M HILL Data Validator, Program Chemist, and PC | Herb Kelly Anita Dodson Clairette Campbell | 352-384-7100 757-671-6218 757-671-6335 | The need for CA for DV issues will be determined by the CH2M HILL Data Validator, Program Chemist, and PC, as necessary. These staff members will make sure that QAPP requirements are met by the analytical results. The PC will notify the PM of any needed DV CAs. The PM will have 48 hours to respond to the request for the DV CA. DV CAs will be coordinated by the PC in coordination with the CH2M HILL Data Validator and Program Chemist. |
| Technical Support and Reporting | CH2M HILL Human Health Risk Assessment (HHRA) Lead, CH2M HILL Ecological Risk Assessment (ERA) Lead | Roni Warren Bill Kappleman | 814-364-2454 703-376-5152 | Risk assessment leads will oversee the preparation of the HHRA and ERA. |

SAP Worksheet #7—Personnel Responsibilities Table

[\(UFP-QAPP Manual Section 2.4.3\)](#)

| Title/Role | Organizational Affiliation | Responsibilities |
|--|----------------------------|--|
| Bryan Peed/NAVFAC COR | NAVFAC Mid-Atlantic | Coordinates all environmental activities at WPNSTA Yorktown |
| Moshood Oduwole/USEPA RPM | USEPA Region 3 | Manages all aspects of the project to confirm federal regulations and requirements are met |
| Wade Smith/VDEQ RPM | VDEQ | Manages all aspects of the project to confirm state regulations and requirements are met |
| Bonnie Capito/Librarian | NAVFAC Atlantic | Responsible for document tracking and filing |
| Bill Friedmann/AM | CH2M HILL | Responsible for support to Navy to implement CERCLA Environmental Restoration Program ERP at WPNSTA Yorktown |
| Kristin Brickman/PM | CH2M HILL | Day-to-day project management to implement SAP. Directs and oversees staff; health, safety, and environment. Contractor POC for decision making. Conducts data usability assessment. |
| Douglas Bitterman/AQM | CH2M HILL | Provides activity-level quality review and guidance |
| Laura Cook/STC | CH2M HILL | Provides senior technical oversight |
| William Kappleman/Ecological Risk Assessor | CH2M HILL | Responsible for ERA to determine any impacts to ecological receptors |
| Roni Warren/Human Health Risk Assessor | CH2M HILL | Responsible for HHRA to determine any impacts to human receptors |
| Anita Dodson/Program Chemist | CH2M HILL | Provides program-level review of the UFP-SAP and program-level support throughout the project duration |
| Clairette Campbell/PC | CH2M HILL | Performs oversight of laboratory and data validators, and evaluates usability of data. Manages sample tracking. |
| TBD/FTL | CH2M HILL | Supervises field sampling and coordinates all field activities |
| Herb Kelly/Data Validator | CH2M HILL | Responsible for the analytical data review and validation |
| Rick Cavil/HSO | CH2M HILL | Oversees H&S for CLEAN Program |
| Kurt Hummler/Laboratory PM | Chemtech | Responsible for Chemtech analytical services |
| Janice Jaeger/Laboratory PM | ALS-Rochester | Responsible for ALS-Rochester analytical services |
| Tami Chicarielli/Laboratory PM | Geostructures | Responsible for Geostructures analytical services |

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SAP Worksheet #8—Special Personnel Training Requirements Table

[\(UFP-QAPP Manual Section 2.4.4\)](#)

| Project Function | Specialized Training By Title or Description of Course | Training Provider | Training Date | Personnel/Groups Receiving Training | Personnel Titles/ Organizational Affiliation | Location of Training Records/Certificates |
|---------------------|---|------------------------------|-----------------|-------------------------------------|---|---|
| All site activities | Recognize, Retreat, and Respond (known as "3R") Training for explosives | Munitions Response Personnel | Personnel files | FTL, field team members, and SSC | FTL, SSC, and field team members from CH2M HILL | CH2M HILL, NAVFAC, regulatory agency, or subcontractor Human Resources Department |

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SAP Worksheet #9a—Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

| Project Name: Remedial Investigation (RI) at WPNSTA Yorktown Former Loading Plant No. 1 Projected Date(s) of Sampling: April 2010 (tentative) PM: Renee Hunt | | | | Site Name: Former Loading Plant No. 1 Site Location: WPNSTA Yorktown, Virginia | |
|---|-----------------------------------|-------------|----------------|---|--|
| Date of Sessions: April 24, 2009 Scoping Session Purpose: To review previous investigation data and develop preliminary sample location strategy for the site in preparation for stakeholder agency scoping session. | | | | | |
| Name | Title | Affiliation | Phone # | E-mail Address | Project Role |
| Bill Friedmann | AM | CH2M HILL | (757) 671-6223 | william.friedmann@ch2m.com | Overseeing project delivery, technical support |
| Brett Doerr | STC | CH2M HILL | (757) 671-6219 | brett.doerr@ch2m.com | Senior technical support |
| Laura Cook | AQM and STC | CH2M HILL | (757) 671-6214 | laura.cook@ch2m.com | Senior technical and quality support |
| William Kappleman | Senior Ecological Risk Assessor | CH2M HILL | (703) 376-5152 | william.kappleman@ch2m.com | Senior technical support |
| Roni Warren | Senior Human Health Risk Assessor | CH2M HILL | (814) 364-2454 | roni.warren@ch2m.com | Senior technical support |
| Renee Hunt | PM | CH2M HILL | (414) 847-0349 | renee.hunt@ch2m.com | UFP-SAP production, project support |
| Catherine Schripsema | Project Engineer | CH2M HILL | (312) 873-9749 | catherine.schripsema@ch2m.com | UFP-SAP production, project support |

Comments/Decisions:

At the time of this initial scoping session, the team was planning to evaluate groundwater at Former Loading Plant No. 1 (including Sites 9 and 19). The meeting was completed to review the previous investigations conducted at Sites 9 and 19 to determine current data objectives and future needs for investigation. Based on this data review, the team determined that additional groundwater data would be needed to determine if site impacts may pose an unacceptable risk to human health or the environment, whether remedial actions are warranted and, if there is no unacceptable risk, to complete site closure. Tentative sample locations were identified based on existing analytical results, potential site risks, and transport mechanisms for each site (surface water bodies and flow, groundwater direction, and site terrain).

Action Items:

- The team agreed to load all groundwater analytical data electronically and compare data to background and updated screening values to assist in identifying appropriate analytical parameters for investigation.

Resolution: Groundwater data were loaded electronically and compared to background and updated screening values. Explosives, total and free cyanide, perchlorate, and total/dissolved metals were identified as warranting further investigation in site groundwater.
- The team agreed to have proposed monitoring well locations and existing well conditions field-verified.

Resolution: Site reconnaissance performed at Site 9 confirmed that the proposed well locations are accessible by an all-terrain rig and that all existing monitoring wells appear to be in good condition.

SAP Worksheet #9a—Project Scoping Session Participants Sheet (continued)

3. It was requested that Site 19 historical data be reviewed regarding the placement as backfill of aluminum-contaminated soil from the nearby Building 527 removal action (RA) and the potential for aluminum to leach from soil to groundwater. Resolution: Site 19 historical data were reviewed to evaluate the potential for aluminum to leach from soil to groundwater, and the capability of the existing site wells to monitor the potential aluminum contamination associated with Building 527.

Aluminum concentrations in the two samples collected from the soil removal area near Building 527 were 90,600 milligrams per kilogram (mg/kg) and 59,300 mg/kg, which exceed the Risk-based Regional Screening Level (RSL) for aluminum of 55,000 mg/kg. The remaining Site 19 aluminum concentrations in soil ranged from 7,480 to 28,200 mg/kg. These data were collected during the 1995 site sampling event. Aluminum concentrations were compared to the maximum Station background concentration of 19,200 mg/kg and the site-specific background concentration of 8,380 mg/kg during the 1995 data evaluation. Because soil pH levels are greater than 5.5 at the site, this suggests aluminum leaching is unlikely at the site.

MW9GW01 and MW19GW05 are located immediately downgradient of the former aluminum-contaminated soil area. Because elevated aluminum concentrations were not observed in the downgradient wells, it appears that aluminum was not affecting site groundwater at the former soil removal location. Additionally, existing wells at Site 19 surrounding the former conveyor belt area will adequately monitor potential groundwater impacts from the aluminum-contaminated fill. Although aluminum concentrations in soil exceeded soil screening levels (SSLs) at two sample locations, the existing monitoring wells at Site 19 are considered sufficient to monitor the potential aluminum contamination associated with Building 527.

Consensus Decisions:

None.

SAP Worksheet #9b—Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

| Project Name: RI at WPNSTA Yorktown Former Loading Plant No. 1 Projected Date(s) of Sampling: April 2010 (tentative) PM: Renee Hunt | | | Site Name: Former Loading Plant No. 1 Site Location: WPNSTA Yorktown, Virginia | | |
|---|------------------|---------------------|---|--|--|
| Date of Sessions: June 25, 2009 Scoping Session Purpose: To review previous investigation data and present the proposed sampling approach for Former Loading Plant No. 1 to the Partnering Team. | | | | | |
| Name | Title | Affiliation | Phone # | E-mail Address | Project Role |
| Bill Friedmann | AM | CH2M HILL | (757) 671-6223 | William.Friedmann@ch2m.com | Overseeing project delivery, technical support |
| Renee Hunt | PM | CH2M HILL | (414) 847-0349 | Renee.Hunt@ch2m.com | UFP-SAP production, project support |
| Adam Forshey | Project Engineer | CH2M HILL | (757) 671-6267 | Adam.Forshey@ch2m.com | Coordination of field investigation and reporting effort |
| Wade Smith | RPM | VDEQ | (804) 698-4125 | wade.smith@deq.virginia.gov | Lead representative of VDEQ, responsible for review of documents and making sure that appropriate regulations are applied |
| Rob Thomson | RPM | USEPA | (215) 814-3357 | Thomson.Bob@epamail.epa.gov | Lead representative of USEPA, responsible for review of documents and making sure that appropriate regulations are applied |
| Tom Kowalski | RPM | NAVFAC Mid-Atlantic | (757) 444-3826 | Tom.Kowalski@navy.mil | Representative of lead agency responsible for overseeing execution of projects |

Comments/Decisions:

During the June 2009 Tier I partnering meeting, the Partnering Team members discussed the historical site information and the resolution of the action items from the previous scoping session, as summarized in **Worksheet #9a**. The Partnering Team concurred with the rationale for proposed groundwater sample locations following resolution of the following action items:

Action Items:

- Determine the status of Building 10. Is Plant 1 still in operation? If possible, inspect the flooring for anti-spark coating.
 Resolution: The existence of Building 10 at Site 9 was verified through field reconnaissance. The flooring of this building was inspected, with no significant cracks or deterioration observed in the concrete flooring. No evidence of anti-spark coating was observed.
- Perform additional site reconnaissance regarding the discharge location from Building 10 to Site 9. Possibly move the GW06 well location based on reconnaissance information.

SAP Worksheet #9b—Project Scoping Session Participants Sheet (continued)

Resolution: The path of the Site 9 discharge area was verified through field reconnaissance. The discharge location from Building 10 could not be identified in the field because of the heavy vegetation growth in the area.

Proposed monitoring well location 9GW05 was moved to the north of its previous location to make sure that this well will be installed downstream of the historical discharge location. An additional attempt will be made to identify the discharge location at Site 9 following the vegetation clearing to be conducted before the new monitoring well installation.

3. Verify the rationale for not analyzing perchlorate at Site 19.

Resolution: Site 19 was not included in the Yorktown Perchlorate White Paper for perchlorate monitoring. However, because of the historical site activities and because Site 19 groundwater has not previously been analyzed for perchlorate, analysis of the Site 19 groundwater for perchlorate is proposed as part of the RI.

4. Follow up on high metals concentrations historically observed in GW04 at Site 19. Why are concentrations so high? Is another downgradient well needed to collect additional information?

Resolution: Historically elevated metals concentrations in 19GW04 were investigated. Although total metals concentrations in 19GW04 exceeded metals screening criteria, dissolved metals concentrations in this well were not elevated. High turbidity measurements were also historically recorded in this well; therefore, the elevated total metals concentrations may be associated with the turbidity. Additionally, this well is not located topographically downgradient of Site 19; therefore, metals impacts from Site 19 would not be expected at this location. The direction of groundwater flow in this area is uncertain because of the limited number of monitoring wells in this portion of the site. 19GW04 will be resampled during the RI to evaluate whether elevated metals concentrations are present within this well, and a co-located deep well is proposed adjacent to the existing 19GW04 to evaluate potential metals impacts within the Yorktown-Eastover aquifer. Installation of an additional downgradient well is not needed at this time.

Consensus Decisions:

None.

SAP Worksheet #9c—Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

| Project Name: RI at WPNSTA Yorktown Former Loading Plant No. 1 Projected Date(s) of Sampling: June 2012 (tentative) PM: Renee Hunt | | | | Site Name: Former Loading Plant No. 1 Site Location: WPNSTA Yorktown, Virginia | |
|--|------------------|---------------------|----------------|---|---|
| Date of Sessions: December 14, 2010 Scoping Session Purpose: To discuss the modified sampling approaches for Former Loading Plant No. 1 as requested by the USEPA | | | | | |
| Name | Title | Affiliation | Phone # | E-mail Address | Project Role |
| Bill Friedmann | AM | CH2M HILL | (757) 671-6223 | William.Friedmann@ch2m.com | Overseeing project delivery, technical support |
| Renee Hunt | PM | CH2M HILL | (414) 847-0349 | Renee.Hunt@ch2m.com | UFP-SAP production, project support |
| Adam Forshey | Project Engineer | CH2M HILL | (757) 671-6267 | Adam.Forshey@ch2m.com | Coordination of field investigation and reporting effort |
| Wade Smith | RPM | VDEQ | (804) 698-4125 | wade.smith@deq.virginia.gov | Lead representative of VDEQ, responsible for review of documents and making sure that appropriate regulations are applied |
| Rob Thomson | RPM | USEPA | (215) 814-3357 | Thomson.Bob@epamail.epa.gov | USEPA support, responsible for review of documents and making sure that appropriate regulations are applied |
| Tom Kowalski | RPM | NAVFAC Mid-Atlantic | (757) 444-3826 | Tom.Kowalski@navy.mil | Representative of lead agency responsible for overseeing execution of projects |

Comments/Decisions:

Prior to this meeting, it was verified that the buildings present at Former Loading Plant No. 1 were to be demolished. The team decided to add sampling of other media because removal of remaining buildings at the sites would allow for the sampling of potential source areas. Consequently, the USEPA requested the following modified sampling plan to address potential soil and groundwater impacts in the vicinity of the former site buildings:

- Additional soil and groundwater samples will be added in the vicinity of former Building 10 and the three former material storage buildings (Powder Metal Storage, Bulk Trinitrotoluene (TNT) Storage, Nitrate Prep and Storage) located in the southwestern portion of Site 19. Historical site activities at the former Plant 1 included the use of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs), and previous investigations have identified the presence of metals, cyanide, and explosives in site groundwater.
- Sampling will occur following the demolition of the Former Loading Plant No. 1 site buildings. Previous site investigations did not include sampling of soil, surface water, or sediment in the vicinity of the former site buildings or in the concrete drainage channels adjacent to these buildings. Historical site investigations

SAP Worksheet #9c—Project Scoping Session Participants Sheet (continued)

focused only on Site 9 and Site 19. The Partnering Team has agreed that the Site 9 and Site 19 site boundaries will be expanded to investigate potential site impacts resulting from historical operations at the Former Loading Plant No. 1.

- After the building demolition activities were performed, the need for additional groundwater monitoring wells in the vicinity of the recent building demolition areas that have not been previously investigated was identified. A total of eight new groundwater monitoring wells will be installed at the Former Loading Plant No. 1. Two of these wells will be located near the Site 9 drainageway, three wells will be located along the western edge of the Building 10 footprint, one well will be located along the former conveyor belt connecting former Building 10 to the former Nitrate Prep and Storage Building, and the remaining two new wells will be located immediately west of the former Bulk TNT Storage and the Nitrate Prep and Storage buildings.
- Six surface soil and six subsurface soil samples will be collected along the western edge of the Building 10 footprint. The surface and subsurface samples will be co-located with three of the new monitoring wells.
- Groundwater at the Former Loading Plant No. 1 will be analyzed for VOCs, total and dissolved metals, total and free cyanide, SVOCs, explosives, and perchlorate. USEPA requested this analytical suite, which is more robust than previously requested, because groundwater wells are being installed in areas that have not been previously investigated and the last round of groundwater sampling at Sites 9 and 19 was performed in 1995.
- Soil at the Former Loading Plant No. 1 will be analyzed for VOCs, total metals, total cyanide, SVOCs, explosives, and perchlorate. USEPA requested this analytical suite, which is more robust than previously requested, because soil samples are located in the vicinity of the recent building demolition areas that have not been previously investigated. Historical site documentation indicates that organic solvents were used at this site.
- Four surface soil and four subsurface soil samples will be collected at the Former Loading Plant No. 1. Soil samples will be collected along the former Nitrate Conveyor Belt connecting former Building 10 to the former Nitrate Prep and Storage Building and within the footprints of the Powder Metal Storage, Bulk TNT Storage, and Nitrate Prep and Storage buildings. The surface and subsurface samples collected beneath the former conveyor belt will be co-located with one of the new monitoring wells.

Action Items:

None.

Consensus Decisions:

The Partnering Team concurred on the above sample locations and analyses.

SAP Worksheet #9d—Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

| Project Name: RI at WPNSTA Yorktown Former Loading Plant No. 1 | | | Site Name: Former Loading Plant No. 1 | | |
|---|------------------|---------------------|--|--|--|
| Projected Date(s) of Sampling: June 2012 (tentative) | | | Site Location: WPNSTA Yorktown, Virginia | | |
| PM: Renee Hunt | | | | | |
| Date of Sessions: April 7, 2011 | | | | | |
| Scoping Session Purpose: To discuss the modified sampling approach for Former Loading Plant No. 1 as requested by the USEPA | | | | | |
| Name | Title | Affiliation | Phone # | E-mail Address | Project Role |
| Bill Friedmann | AM | CH2M HILL | (757) 671-6223 | William.Friedmann@ch2m.com | Overseeing project delivery, technical support |
| Adam Forshey | Project Engineer | CH2M HILL | (757) 671-6267 | Adam.Forshey@ch2m.com | Coordinating field investigation and reporting effort |
| Wade Smith | RPM | VDEQ | (804) 698-4125 | wade.smith@deq.virginia.gov | Lead representative of VDEQ, responsible for review of documents and making sure that appropriate regulations are applied |
| Moshood Oduwole | RPM | USEPA | (215) 814-3362 | odumole.moshood@epamail.epa.gov | Lead representative of USEPA, responsible for review of documents and making sure that appropriate regulations are applied |
| Tom Kowalski | RPM | NAVFAC Mid-Atlantic | (757) 444-3826 | Tom.Kowalski@navy.mil | Representative of lead agency responsible for overseeing execution of projects |

Comments/Decisions:

Additional information was provided to the project team regarding the presence of waste material observed on the ground surface at Site 9. The presence of surface waste within the Site 9 wastewater drainage area was addressed in a 1994 RA. Following this RA, soil confirmation samples at Site 9 were collected, resulting in a recommended no further action (NFA) determination to avoid destroying habitat and creating erosion problems to retrieve remaining observed waste. The team agreed that the waste observed at Site 9 would not be addressed in this RI effort, as detailed in the Record of Decision (ROD). Bill Friedmann discussed that the sample data were acceptable and they documented the risk management decision in the ROD. The team determined that there was no significant evidence of the waste being a potential source of site contaminants. Additionally, there are previous sediment samples all through the drainage area adjacent to the waste and the amount of sampling data was adequate to justify that no release occurred.

SAP Worksheet #9d—Project Scoping Session Participants Sheet (continued)

Additionally, it was discussed that the groundwater results at Former Loading Plant No. 1 will be used to make a decision on if or where we should collect additional sediment, seep, and pore water samples within the portions of the Plant 1 site not included within the historical Site 9 boundary. The sampling approach and sample locations were reviewed for all sites. The team agreed to collect surface water/sediment/groundwater seeps and/or pore water as needed, based on the results of the groundwater sampling effort.

Action Items:

None

Consensus Decisions:

The team agreed that the waste observed at Site 9 would not be addressed in this RI effort, as detailed in the ROD. The team determined that there was no significant evidence of the waste being a potential source of site contaminants. The team agreed to collect surface water/sediment/groundwater seeps and/or pore water in the portions of the Plant 1 site not included in the previous ROD, as needed, based on the results of the groundwater sampling effort.

SAP Worksheet #9e—Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

| Project Name: RI at WPNSTA Yorktown Former Loading Plant No. 1 Projected Date(s) of Sampling: October 2013 (tentative) PM: Kristin Brickman | | | | Site Name: Former Loading Plant No. 1 Site Location: WPNSTA Yorktown, Virginia | |
|--|------------------|---------------------|----------------|--|--|
| Date of Sessions: August 14, 2012 Scoping Session Purpose: To discuss the modified sampling approach for Former Loading Plant No. 1 as requested by the USEPA | | | | | |
| Name | Title | Affiliation | Phone # | E-mail Address | Project Role |
| Bill Friedmann | AM | CH2M HILL | (757) 671-6223 | William.Friedmann@ch2m.com | Overseeing project delivery, technical support |
| Adam Forshey | Project Engineer | CH2M HILL | (757) 671-6267 | Adam.Forshey@ch2m.com | Coordination of field investigation and reporting effort |
| Wade Smith | RPM | VDEQ | (804) 698-4125 | wade.smith@deq.virginia.gov | Lead representative of VDEQ, responsible for review of documents and making sure that appropriate regulations are applied |
| Moshood Oduwole | RPM | USEPA | (215) 814-3362 | oduwole.moshood@epamail.epa.gov | Lead representative of USEPA, responsible for review of documents and making sure that appropriate regulations are applied |
| Jim Gravette | RPM | NAVFAC Mid-Atlantic | (757) 341-0477 | James.Gravette@navy.mil | Representative of lead agency responsible for overseeing execution of projects |

Comments/Decisions:

At the time of this meeting all structures related to Former Loading Plant No. 1 had been removed and the site had been graded. The schedule of the Former Loading Plant No. 1 UFP-SAP was discussed with the team. The goals of the modified investigation approach for Former Loading Plant No. 1 were discussed by the team and determined to be: evaluate current site groundwater conditions with new and existing groundwater monitoring wells; address soil, groundwater, sediment and surface water in the portions of the site that were not included in previous investigations; and confirm residual TNT concentrations associated with the former TNT Conveyor Belt. The site sampling approach includes the analysis of VOCs, SVOCs including polycyclic aromatic hydrocarbons (PAHs), metals and cyanide, explosives, and perchlorate, because historical site activities at the Former Loading Plant No. 1 included the use of VOCs and SVOCs and previous investigation efforts have identified the presence of metals, cyanide, and explosives in site groundwater.

The modified approach included the following:

- Because demolition of the Former Loading Plant No. 1 buildings has been completed, the study area boundary was expanded to encompass former buildings used to support Former Loading Plant No. 1 activities. Additional sample locations were added in the vicinity of former Building 10 and four material storage buildings (Powder Metal Storage, Bulk TNT Storage, Nitrate Prep and Storage, and the TNT Building).
- Because demolition of the Former Loading Plant No. 1 buildings has been completed, the study area boundary was expanded to encompass former buildings used to support Former Loading Plant No. 1 activities. Additional sample locations were added in the vicinity of former Building 10 and four material storage buildings (Powder Metal Storage, Bulk TNT Storage, Nitrate Prep and Storage, and the TNT Building).

SAP Worksheet #9e—Project Scoping Session Participants Sheet (continued)

- The team agreed to install a total of nine new groundwater monitoring wells at the Former Loading Plant No. 1. Seven of these wells will be screened in the Cornwallis Cave aquifer, with one well located near Site 9; three wells located near former Building 10; and three wells located near the Powder Metal Storage, Bulk TNT Storage, and Nitrate Prep and Storage buildings. Two wells will be screened within the Yorktown-Eastover aquifer and will be placed in the vicinity of existing wells 19GW04 and 19GW06.
- Groundwater at the Former Loading Plant No. 1 will be analyzed for VOCs, SVOCs including PAHs, total and dissolved metals, total and free cyanide, explosives, and perchlorate.
- A total of 49 surface and 49 subsurface soil samples will be co-located at the Former Loading Plant No. 1. Twenty-nine surface and subsurface soil samples will be collected within the former Building 10 footprint. Surface soil samples will be collected at a depth of 0 to 6 inches below ground surface (bgs), and subsurface soil samples will be collected at a depth of 6 to 24 inches bgs. Fourteen surface and subsurface soil samples will be collected within the former material storage building footprints. Six surface and subsurface soil samples will be collected within the former Nitrate Conveyor Belt footprint. Samples within the building footprints will focus on the material loading areas.
- The 49 co-located surface and subsurface soil samples at the Former Loading Plant No. 1 will be analyzed for VOCs, SVOCs including PAHs, total metals, total cyanide, explosives, and perchlorate.
- Six additional soil sampling locations were agreed to by the team in the vicinity of the former TNT Conveyor Belt to confirm residual TNT concentrations in this area. Two of these samples will be collected near Building 98 at a depth of 0 to 24 inches bgs. Four of these samples will be collected beneath the former Nitrate Conveyor Belt at a depth of 24 to 36 inches bgs. These six additional soil sampling locations will be analyzed for 2,4,6-TNT only.
- A total of 17 surface water and 17 sediment samples will be co-located at the Former Loading Plant No. 1. Twelve of these samples will be located within the former Building 10 drainage channels, three of these samples will be collected within the TNT Building drainage channel, and two of these samples will be collected from the Bulk TNT Storage drainage channel. The team agreed that the surface water and sediment samples would no longer be contingent on the results of the groundwater sampling, but would be collected from the drainage channels during the first sampling mobilization, because these portions of the site were not sampled during historical site investigation activities and require additional characterization.
- Surface water at the Former Loading Plant No. 1 will be analyzed for VOCs, SVOCs including PAHs, total and dissolved metals, total and free cyanide, explosives, and perchlorate. Sediment will be analyzed for VOCs, SVOCs including PAHs, total metals, total cyanide, explosives, and perchlorate. Surface water/sediment sampling will not be performed within the downstream portions of Site 9, shown on **Figure 2**, which has already received an NFA determination in the ROD. Several of the proposed sediment/surface water samples are within the upstream portions of Site 9 to evaluate contaminant concentrations at the transition between the concrete-lined channels and the natural drainage channel.

SAP Worksheet #9e—Project Scoping Session Participants Sheet (continued)

- Groundwater seep pore water samples may be collected based on the results of the groundwater sampling effort.

Action Items:

None

Consensus Decisions:

The Partnering Team concurred on the above sample locations and analyses.

SAP Worksheet #9f—Project Scoping Session Participants Sheet

[\(UFP-QAPP Manual Section 2.5.1\)](#)

| Project Name: RI at WPNSTA Yorktown Former Loading Plant No. 1 Projected Date(s) of Sampling: August 2014 (tentative) PM: Kristin Brickman | | | Site Name: Former Loading Plant No. 1 Site Location: WPNSTA Yorktown, Virginia | | |
|--|---------------------------------|---------------------|---|--|--|
| Date of Sessions: March 5, 2014 Scoping Session Purpose: To discuss the USEPA comments on the UFP-SAP for Former Loading Plant No. 1 | | | | | |
| Name | Title | Affiliation | Phone # | E-mail Address | Project Role |
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Comments/Decisions:

During this meeting, the outstanding USEPA comments on the SAP were discussed and other questions from the Partnering Team were addressed regarding the investigation approach. The western boundary of the investigation area was questioned, and Bill Friedmann indicated that the boundary is currently defined by the extent of the previous sampling activities. Jim Gravette indicated that the Former Loading Plant No. 1 boundary

SAP Worksheet #9f—Project Scoping Session Participants Sheet (continued)

does not extend into Lee Pond, as Lee Pond is a separate site that has already been closed under the CERCLA program.

The proposed sampling beneath the former TNT conveyor belt trench was discussed. The site configuration during conveyor belt operations was discussed, including how the conveyor belt operated, historical information regarding TNT from the belt impacting the soils beneath, and how the RA was performed to removed TNT concentrations exceeding the clean-up level to the extent possible. The proposed sampling approach to assess TNT concentrations potentially remaining in place at the ends of the conveyor belt trench was discussed. Two co-located surface and subsurface soil samples near Former Building 98 will be collected at depths of 0 to 6 inches and 6 to 24 inches bgs to assess residual TNT concentrations left in place near Building 98. Additionally six soil samples will be collected and analyzed for 2,4,6-TNT at a depth of 24 to 36 inches bgs at the eastern and western ends of the trench to confirm that soil exceeding the TNT clean-up level of 15,000 micrograms per kilogram ($\mu\text{g}/\text{kg}$) was removed from the site during the 1998 RA.

The aluminum-impacted soils that were placed within the base of the excavation and then covered with fill during the 1998 RA were discussed. It was noted that aluminum concentration in the soil exceeded human health screening values and ecological screening values (ESVs). The proposed sampling approach to confirm that 2 feet of fill are present above the aluminum-impacted soil was discussed. Soil samples will be collected at six locations along the length of the former conveyor belt trench. Samples will be collected at depths of 12 to 18 inches and 18 to 24 inches at these locations and analyzed for aluminum and pH.

Donna Caldwell asked if the existing monitoring wells would be redeveloped, and Bill Friedmann confirmed that they would be.

John McCloskey requested that the Site 9 and Site 19 areas that are closed under a ROD be added to a site figure. Peter Knight questioned whether contamination has migrated to the portion of Site 9 drainage way closed by the ROD, to which Jim Gravette indicated that an official request would have to come from USEPA if resampling of site media closed by a ROD is being requested.

Action Items:

The Site 9 and Site 19 areas that have been closed under a ROD will be added to a site figure. NAVFAC will submit a second response-to-comments document to USEPA to document the results of the team's discussion.

Consensus Decisions:

The Partnering Team concurred on the sampling approach for the TNT conveyor belt trench.

SAP Worksheet #10—Conceptual Site Model

[\(UFP-QAPP Manual Section 2.5.2\)](#)

WPNSTA Yorktown History and Location

WPNSTA Yorktown is a 10,624-acre installation located on the Virginia Peninsula in York and James City counties, Virginia (**Figure 1**). WPNSTA Yorktown is bounded to the northwest by Cheatham Annex, to the northeast by the York River and the Colonial National Historic Parkway, to the southwest by Route 143 and Interstate 64, and to the southeast by Route 238 and the town of Lackey.

Originally named the United States Mine Depot, WPNSTA Yorktown was established in 1918 to support the laying of mines in the North Sea during World War I. For 20 years after World War I, the depot continued to receive, reclaim, store, and issue mines, depth charges, and related materials. During World War II, the facility was expanded to include three TNT loading plants and new torpedo overhaul facilities. A research and development laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the facility, which included the design and development of depth charges and advanced underwater weapons. On August 7, 1959, the depot was renamed the United States WPNSTA. Today, the primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

Former Loading Plant No. 1 Description and History

Former Loading Plant No. 1 is located south of Lee Road, approximately 300 feet east of Lee Pond (**Figure 2**). The general overland flow direction is downhill toward the west-northwest. The drainage around the site buildings was generally diverted to drainage trenches that eventually discharge to Lee Pond. Portions of the site containing the former building footprints and works area are clear of vegetation, but wooded areas are present within the northwestern portion of the site.

The Former Loading Plant No. 1 provided mine loading activities from the late 1930s through the 1990s. The Former Loading Plant No. 1 included the Mine Loading Building (Building 10), TNT Building (Building 11), three small material storage buildings connected to Building 10 via conveyor belts (Powder Metal Storage [Building 527], Bulk TNT Storage [Buildings 98] and Nitrate Prep and Storage [Building 528]), the TNT Conveyor Belt (Site 19), the Nitrate Conveyor Belt, and the Wastewater Discharge Area (Site 9) (**Figure 2**). The operations at Former Loading Plant No. 1 included mine loading activities performed in former Building 10, with materials for these operations being stored in smaller adjacent buildings. Buildings 98, 527, and 528 were connected to Building 10 by conveyor belts. Raw materials and the loaded mines were delivered to the site buildings by rail car and by truck. Operations at Former Loading Plant No. 1 included the use of VOCs and SVOCs during the mine preparation process, and explosives and metals were used when loading the mines. Documented historical waste disposal practices included wastewater discharge to the drainage channels throughout the Former Loading Plant No. 1 area. There is also potential for waste dumping to have occurred near the building doorways, loading docks, and through floor drains, because this type of waste disposal was frequently practiced at WPNSTA Yorktown. No written documentation of spills and releases at the Former Loading Plant No. 1 is available, but based on historical waste disposal practices, releases may have occurred at this site. Wastewater discharge to Lee Pond and contamination associated with the former TNT Conveyor Belt between Building 10 and Buildings 98 and 527 were evaluated as part of the Sites 9 and 19 investigations and actions as described below. The remaining wastewater discharges and possible waste dumping pathways have not been investigated.

Site 9 and Site 19 are the portions of the Former Loading Plant No. 1 that have been previously investigated (**Figure 2**). Site 9 is defined as the Plant 1 Explosives-contaminated Wastewater Discharge Area, and Site 19 is defined as the Conveyor Belt Soils at Building 10.

SAP Worksheet #10—Conceptual Site Model (continued)

Site 9 was identified in the Federal Facilities Agreement as the drainage that extends to Lee Pond from the north end of Building 10. The primary discharges to Site 9 are from the two 600-foot concrete channels that bound the eastern and western sides of Building 10 and then converge at the north end of former Building 10 and overland flow. Wastewater discharge from the west side of former Building 10 was conveyed to Lee Pond under a National Pollutant Discharge Elimination System (NPDES) permit. From the late 1930s to 1974, Site 9 was used as a drainageway for Building 10 explosives-contaminated wastewater and possibly organic solvents. A carbon adsorption tower was installed in 1974 to treat the wastewater prior to discharge in accordance with an NPDES permit. In 1986, the effluent from the tower was diverted to the sanitary sewer and ultimately to a wastewater treatment facility operated by the Hampton Roads Sanitation District. Solid wastes, including weapons casings and railroad ties, were discarded along the portion of the drainageway to the east of Bollman Road. Additionally, to the west of Bollman Road, several drums were discarded along the drainageway.

The Initial Assessment Study (C.C. Johnson & Associates, Inc., and CH2M HILL, 1984) for WPNSTA Yorktown was performed in 1984 and identified the types and quantities of wastes disposed of at Site 9. These materials included trichloroethene (TCE), TNT, Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), and Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) and solvents such as TCE that have been discharged from Plant 1 with the explosives-contaminated wastewater. It was estimated that wastewater containing 100 parts per million (ppm) each of TNT and RDX and 30 ppm of HMX were discharged to Site 9 for approximately 40 years.

Investigation activities identified TNT as the primary constituent in soil, with concentrations as high as 2,100,000 µg/kg. 2,4,6-TNT was also identified as the primary contaminant in groundwater and surface water (Lee Pond and the site drainageway), with concentrations as high as 2,300 micrograms per liter (µg/L) and 370 µg/L, respectively (Baker, 1997).

A soil RA was conducted in September 1994 to remove surface and subsurface debris at Site 9 associated with unexploded ordnance and railroad ties (locations shown on **Figure 2**). Confirmatory soil samples were collected and analyzed for VOCs, SVOCs, inorganic constituents, pesticides, polychlorinated biphenyls, and explosives. The excavated area was backfilled with on-base borrow topsoil and was re-graded (IT Corporation, 1995).

In March 1998, a ROD was signed for Site 9 indicating that NFA was required for site soil, surface water, and sediment, because potential human health risks were considered acceptable or manageable for these media. Although contaminant concentrations in Site 9 soil and sediment posed a risk to ecological receptors, the Navy, USEPA, and VDEQ agreed that remediation would result in greater ecological harm than leaving the drainage undisturbed with the concentrations remaining in soil and sediment (Navy, 1998). However, characterization of groundwater impacts in the vicinity of Site 9 was not complete at the time of the 1998 ROD.

Site 19 encompasses the area directly below and adjacent to the former conveyor belt that extended from the former Building 98 (Bulk TNT Storage) to former Building 10. The former TNT Conveyor Belt was used to transport TNT from Building 98 to Building 10 for explosives loading during Plant 1 munitions processing. Prior to 1970, an undocumented number of TNT spills occurred along the conveyor belt, affecting the underlying soils. Past operational practices included routinely spraying the conveyor walls and floors with water to control the potential buildup of TNT dust. This water then dripped onto the ground beneath the conveyor belt (Navy, 1998). The area has not been used for any other land use since operations ceased in the 1970s (Baker, 1997). The site buildings were decontaminated and demolished in 2011 and 2012.

Soil removal activities were conducted at the site in 1973 and 1974 to remove contaminated soil from beneath the TNT Conveyor Belt. The exact location and quantity of soil removed was not documented. Soil sampling results following the soil removal indicated that explosives impacts remained, with TNT and RDX detected at concentrations as high as 17,730,000 and 37,000 µg/kg, respectively (C.C. Johnson & Associates, Inc. and CH2M HILL, 1984).

SAP Worksheet #10—Conceptual Site Model (continued)

Investigation activities identified TNT as the primary constituent in Site 19 soil, with concentrations as high as 863,000 µg/kg near the conveyor belt area (Baker, 1997). Low levels of TNT (5.1 µg/L) were detected in site groundwater. Aluminum-contaminated soils were also identified in the vicinity of Building 527, with concentrations as high as 90,600 mg/kg.

In March 1998, a ROD was signed to address soil impacts at Site 19. The proposed remedy for Site 19 included removing the conveyor belt, excavating site soil beneath the belt, excavating aluminum-contaminated soil near Building 527, and backfilling the area beneath the conveyor belt with clean fill and the aluminum-contaminated soil from Building 527 (Navy, 1998).

The proposed remedy was implemented in April 1998. Following removal of the conveyor belt, approximately 1,000 cubic yards of explosives-contaminated soil were removed from a trench area approximately 450 feet long and 15 feet wide. Soil was excavated to a depth of approximately 2 feet. The excavated soil was disposed of at the Site 22 biocell for additional treatment. Approximately 60 cubic yards of soil containing elevated aluminum concentrations (elevated relative to base background and regulatory screening criteria, but historical documents do not specify the specific regulatory criteria) were excavated from the area around Building 527 and placed in the conveyor belt trench at a depth of approximately 2 feet, covered with clean fill, and the site was revegetated (OHM, 2000). Available confirmation sample data do not clearly indicate whether or not all soil with 2,4,6-TNT concentrations exceeding the established remedial goal has been removed. The available historical data indicate that elevated 2,4,6-TNT concentrations were detected along the excavation floor near the end of the excavation; however, the historical data do not reflect at which end of the excavation the elevated concentrations were observed. The historical data also infer that the elevated concentrations on the excavation floor may have been removed through additional excavation activities. The pH of Site 19 soil samples collected during previous RI activities ranged from 5.6 to 7.1, which does not exceed the pH-based ESV (pH less than 5.5). Subsurface soil sampling is needed to confirm that 2,4,6-TNT concentrations along the former excavation floor are below the established remedial goal of 15,000 µg/kg. Additionally, surface and subsurface soil samples are needed near the sidewall of the excavated area to evaluate the residual TNT concentrations that were left in place at the time of the RA because of the presence of Building 98.

All previous investigations and the RA were focused on the Building 10 former wastewater discharge area (Site 9) and the former TNT Conveyor Belt (Site 19), and areas immediately adjacent to these features. Historical site documentation indicates that organic solvents, explosives, and metals were used in the mine preparation and loading activities performed in the former buildings and structures. Following demolition of Buildings 10, Building 11, Building 527, Building 98, Building 528, and the Nitrate Conveyor Belt in 2011, the team agreed to evaluate whether environmental media in these areas could have been affected by site operations. The areas most likely directly affected would be building entrances where the material was moved, floor drains, and wastewater discharge areas. Compounds that may be present based on likely historical use at the site are VOCs, SVOCs including PAHs, metals, cyanide, explosives, and perchlorate. 1,4-dioxane is also a potentially site-related compound based on the historical use of the solvent TCE at Plant 1. Previous sampling events did not include 1,4-dioxane because it is an emerging contaminant. Associated analytical data needed to support the HHRAs and ERAs include total organic carbon (TOC) and pH in soil and sediment, grain size and acid-volatile sulfide (AVS)/simultaneously extracted metals (SEM) in sediment, hardness in surface water, and potentially hexavalent chromium in groundwater, soil, sediment and surface water.

SAP Worksheet #10—Conceptual Site Model (continued)

Geological and Hydrogeological Setting

WPNSTA Yorktown

WPNSTA Yorktown is situated within the Virginia Coastal Plain Physiographic Province, which is characterized by unconsolidated sediments several thousand feet in thickness (Meng and Harsh, 1988). Deposition and erosion associated with fluctuating sea levels resulted in terraces that decrease in topographic elevation in a stair-step pattern, as well as scarps, oriented north to south, delineating the eroded shoreline along the toe of each terrace.

Two terraces (Lackey Plain and Croaker Flat) are divided by one scarp (the Camp Peary Scarp) within the boundaries of WPNSTA Yorktown.

The surficial strata at Former Loading Plant No. 1 is characterized by medium to fine grained sands with varying amounts of silt and trace amounts of clay and gravel. The surficial strata is underlain by the Cornwallis Cave aquifer, in which groundwater is first encountered. The Cornwallis Cave aquifer is approximately 10 to 30 feet thick. Groundwater thickness ranges from 5 to 10 feet within the Cornwallis Cave aquifer. The Yorktown Confining Unit underlies the Cornwallis Cave aquifer and consists of silty clay and/or clayey silt and ranges in thickness from 15 to 25 feet. Underlying the Yorktown Confining Unit, the Yorktown-Eastover aquifer is consists of coarser grained fine sand deposits with varying amounts of silt, clay, and marine shell fragments. The Yorktown-Eastover aquifer is approximately 70 feet thickness at the site. The basal unit within the York County shallow aquifer system is the Eastover-Calvert Confining Unit, which consists of silt and clay. The top of the Eastover-Calvert Confining Unit is approximately 110 feet bgs at the site (USGS, 1997). Existing site monitoring wells are screened in either the Cornwallis Cave aquifer or the Yorktown-Eastover aquifer (Baker, 1997).

Groundwater within the Cornwallis Cave and Yorktown-Eastover aquifers is locally controlled by topography, with discharge to nearby Lee Pond. Groundwater has been encountered at depths of 10 to 29 feet bgs within the Cornwallis Cave aquifer, with flow to the west toward Lee Pond. Within the Yorktown-Eastover aquifer, groundwater has been encountered at approximately 39 to 51 feet bgs, with flow to the west. Deeper groundwater flow travels primarily toward the York River.

Surface water flow within these drainage ditches is primarily influenced by rainwater runoff; and these drainage ditches are dry throughout much of the year.

Potential Exposure and Receptor Pathways

A three-dimensional depiction of the Former Loading Plant No. 1 conceptual site model (CSM) is presented on **Figure 3**. Surface site features, groundwater flow characteristics, and potential receptors and exposure routes are presented on the CSM. The potential receptors considered in this CSM include current /future adult and adolescent trespassers, current/future maintenance workers/groundkeepers, future adult and child residents, future construction workers, future industrial workers, and terrestrial and aquatic ecological receptors. Potential exposure pathways for human receptors include ingestion of, dermal contact with, and inhalation of emissions from soil, groundwater, surface water, and sediment. Potential exposure pathways for ecological receptors include direct contact, root uptake (plants), and ingestion (both incidental ingestion of site media and exposure via food webs). The area that encompasses Former Loading Plant No. 1 is not currently in use. No future redevelopment or use of this area is currently planned.

SAP Worksheet #10—Conceptual Site Model (continued)

Data Gaps

The project quality objectives (PQOs) and environmental questions (**Worksheet #11**) consider those media, potential sources, and transport mechanisms, which include historical handling and disposal practices of materials (VOCs, SVOCs, explosives and metals) used at Former Loading Plant No. 1 in order to gain a complete understanding of the CSM. Anecdotal evidence indicates that chemical waste was discharged to the drainage channels throughout the Former Loading Plant No. 1. Historical disposal practices may also have included dumping waste on the ground surface or into drainage channels, or inadvertently discharging materials to the environment through floor drains, floor cracks, spills, and conveyor belt transport.

An investigation to address the following data gaps at Former Loading Plant No. 1 will be performed during the sampling effort outlined in this UFP-SAP:

- Groundwater – Groundwater contamination at the site was identified during previous site investigations. Existing site monitoring wells are associated with Site 9 or Site 19; however, the existing groundwater well network does not allow for adequate characterization of groundwater in all areas of Former Loading Plant No. 1. The nature and extent of groundwater contamination at the site cannot be determined with the existing well network; therefore, additional monitoring wells are proposed to fill data gaps within the current well network to evaluate groundwater contamination. To provide a better understanding of site geology within the deeper portions of the shallow aquifer system at Former Loading Plant No. 1, the borings for the Yorktown-Eastover aquifer may be extended to the top of the Eastover-Calvert Confining Unit. Following characterization of the deeper soil lithology, the borings will be partially abandoned to allow for construction of the Yorktown-Eastover aquifer wells in the shallow portion of the aquifer.
- Surface and subsurface soils – Soils throughout much of the Former Loading Plant No. 1 have not been previously investigated because the site buildings have only been recently demolished. Soil samples have been proposed in portions of the site that may have been affected by historical site operations, specifically in the vicinity of floor drains, loading areas, the Nitrate Conveyor Belt footprint, and former building subslab locations. Soil samples will be analyzed for VOCs, SVOCs and PAHs, 1,4-dioxane, metals, cyanide, explosives, and perchlorate, because these constituents are associated with historical site operations. No additional investigation will be performed within the Site 9 drainage area because the 1998 Site 9 ROD documented that NFA was required in this area for soil. A limited soil investigation will be performed within the Site 19 TNT Conveyor Belt footprint to confirm that 2 feet of fill are present above the aluminum-impacted soil and to confirm that residual 2,4,6-TNT concentrations along the excavation floor and western side wall are less than the established cleanup goal of 15,000 µg/kg. A CSM of the 1998 soil excavation at Site 19 is shown on **Figure 4**.
- Surface water and sediment – Surface water and sediment throughout much of Former Loading Plant No. 1 have not been previously investigated and may have been affected by historical site operations, specifically in the concrete-lined channels that were used for wastewater discharges during historical site operations. No additional investigation will be performed within the western portion of the Site 9 drainage area because the 1998 Site 9 ROD documented that NFA was required in this area for surface water or sediment.
- Pore water and groundwater seeps – Pore water and groundwater seeps at Former Loading Plant No. 1 have not been previously investigated but could have been affected by historical site activities. These media will only be investigated if analytical results from investigation of the site media described above indicate that pore water and groundwater seeps may be affected by site contaminants at concentrations of concern.

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SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

[\(UFP-QAPP Manual Section 2.6.1\)](#)

Problem Definition/Objective, Environmental Questions, and Project Quality Objectives

| Problem Definition/Objective | Environmental Question | General Investigation Approach | PQO |
|--|---|---|--|
| <p>Determine the nature and extent of site contaminants in groundwater, soil, surface water and sediment associated with Former Loading Plant No. 1 historical activities and evaluate potential impacts on site receptors</p> | <p>What are the nature and extent of site contaminants in groundwater associated with historical Former Loading Plant No. 1 activities?</p> | <p>Nine new groundwater monitoring wells will be installed in the vicinity of the Former Loading Plant No. 1 building footprints, with shallow wells installed within the Cornwallis Cave aquifer and deeper wells installed within the Yorktown-Eastover aquifer. The nine new monitoring wells will be installed downgradient of the former site buildings and will be distributed as follows: one shallow well downgradient of the former TNT Building, four shallow wells and one deep well downgradient of former Building 10, one shallow well downgradient of the former Nitrate Prep and Storage Building, one shallow well downgradient of the Bulk TNT Storage Building, and one deep well co-located with YS19-GW004 downgradient of Site 19.</p> <p>The 9 new monitoring wells and 12 existing monitoring wells will be sampled and analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, total and dissolved metals, total and free cyanide, explosives, and perchlorate (Figure 5). Site monitoring wells will be screened in either the upper portions of the surficial Cornwallis Cave aquifer, or the Yorktown-Eastover aquifer.</p> | <p>If the nature and extent of site contamination in groundwater has been reliably determined or can be reasonably estimated based on the results of the field investigation and laboratory analysis, the RI Report will be completed, risks will be assessed, and evaluation of a path forward for the sites will be completed.</p> <p>If the nature and extent has not been reliably determined or cannot be reasonably estimated based on the results of the field investigation and laboratory analysis, additional investigation activities will be proposed to accomplish this objective, to be implemented after team consensus is reached.</p> |
| | <p>What is the thickness and lithology of the Yorktown-Eastover aquifer at this site?</p> | <p>The borings of the two new Yorktown-Eastover aquifer wells may be extended to the top of the Eastover-Calvert Confining Unit to allow for further characterization of this aquifer. After reaching the top of the Eastover-Calvert Confining Unit, the borings will be partially abandoned to allow for construction of the Yorktown-Eastover aquifer wells in the shallow portion of the aquifer.</p> | <p>If the results of the RI indicate that the deeper portions of the Yorktown-Eastover aquifer may be impacted by site contamination, the deep boring data will be utilized to plan future investigation activities.</p> <p>If the results of the RI indicate that site contamination has not impacted the deeper portion of the Yorktown-Eastover aquifer, no further investigation of the deeper Yorktown-Eastover aquifer will be proposed.</p> |

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

| Problem Definition/Objective | Environmental Question | General Investigation Approach | PQO |
|------------------------------|--|---|--|
| | <p>What are the nature and extent of site contaminants in soil associated with historical Loading Plant No. 1 activities?</p> | <p>Surface (0-6 inches) and subsurface (6-24 inches) soil samples will be collected at 44 locations in the vicinity of the Former Loading Plant No. 1 building footprints. The soil sampling locations are located within the former building footprints, near former drain locations where applicable, and near the historical loading areas. The 44 soil sampling locations are distributed as follows: 4 locations at the former TNT Building, 4 locations at the former Nitrate Prep and Storage Building, 2 locations at the former Bulk TNT Storage Building, 4 locations at the former Powder Storage Building, 24 locations at former Building 10, and 6 samples at the former Nitrate Conveyor Belt.</p> <p>These soil samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, total metals, total cyanide, explosives, and perchlorate (Figure 6). Samples will also be analyzed for pH and TOC to evaluate the fate and transport of contaminants with regard to ecological receptors.</p> | <p>If the nature and extent of site contamination in soil has been determined or can be reasonably estimated based on the results of the field investigation and laboratory analysis, the RI Report will be completed, risks will be assessed, and evaluation of a path forward for the site will be completed.</p> <p>If the nature and extent has not been reliably determined or cannot be reasonably estimated based on the results of the field investigation and laboratory analysis, additional investigation activities will be proposed to accomplish this objective, to be implemented after team consensus is reached.</p> |
| | <p>What are the nature and extent of site contaminants in surface water associated with historical Loading Plant No. 1 activities?</p> | <p>If surface water is present within the site drainage ditches, surface water samples will be collected at 17 locations in the drainage ways in the vicinity of the Former Loading Plant No. 1 building footprints. The 17 surface water sampling locations are distributed as follows: 3 locations near the former TNT Building, 2 locations near the former Bulk TNT Storage Building, and 12 locations near former Building 10. The surface water sampling will be performed one to two days after a rain event to maximize the potential for surface water sampling.</p> <p>These samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, total and dissolved metals, total and free cyanide, explosives, and perchlorate (Figure 7). Samples will also be analyzed for hardness to evaluate the fate and transport of contaminants with regard to ecological receptors. Water quality parameters will also be field-measured, as will water depth and flow rate.</p> | <p>If the nature and extent of site contamination in surface water has been determined or can be reasonably estimated based on the results of the field investigation and laboratory analysis, the RI Report will be completed, risks will be assessed, and evaluation of a path forward for the site will be completed.</p> <p>If the nature and extent has not been reliably determined or cannot be reasonably estimated based on the results of the field investigation and laboratory analysis, additional investigation activities will be proposed to accomplish this objective, to be implemented after team consensus is reached.</p> |

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

| Problem Definition/Objective | Environmental Question | General Investigation Approach | PQO |
|---|---|--|--|
| | <p>What are the nature and extent of site contaminants in sediment associated with historical Loading Plant No. 1 activities?</p> | <p>Sediment samples will be collected at 17 locations in the drainage ways in the vicinity of the Former Loading Plant No. 1 building footprints. The 17 sediment sampling locations are co-located with the 17 surface water samples, and are distributed as follows: 3 locations near the former TNT Building, 2 locations near the former Bulk TNT Storage Building, and 12 locations near former Building 10.</p> <p>These samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, total metals, total cyanide, explosives, and perchlorate (Figure 7). Samples will also be analyzed for pH, TOC, AVS/SEM, and grain size to evaluate the fate and transport of contaminants with regard to ecological receptors.</p> | <p>If the nature and extent of site contamination in sediment has been determined or can be reasonably estimated based on the results of the field investigation and laboratory analysis, the RI Report will be completed, risks will be assessed, and evaluation of a path forward for the site will be completed.</p> <p>If the nature and extent has not been reliably determined or cannot be reasonably estimated based on the results of the field investigation and laboratory analysis, additional investigation activities will be proposed to accomplish this objective, to be implemented after team consensus is reached.</p> |
| | <p>Do contaminant levels in groundwater, soil, surface water or sediment pose unacceptable risks to current or future receptors?</p> | <p>An HHRA and an ERA will be performed during the RI for site groundwater, soil, surface water and sediment to assess risks to current and future receptors.</p> | <p>If contaminant levels pose an unacceptable risk to receptors, the RI Report will summarize the investigation findings and propose a path forward to address unacceptable risks.</p> <p>If contaminant levels do not pose an unacceptable risk to receptors, the RI Report will summarize the investigation findings and propose an NFA determination.</p> |
| <p>Confirm that at least 2 feet of backfill is located over the aluminum-impacted soil present in the base of the former TNT Conveyor Belt trench.</p> | <p>Is the 2 feet of backfill present in the former Conveyor Belt trench?</p> | <p>Six soil samples will be collected from 12 to 24 inches bgs within the former TNT Conveyor Belt excavation area. These samples will analyzed for aluminum and pH.</p> | <p>If 2 feet of backfill without elevated aluminum concentrations are confirmed within the TNT conveyor belt trench, this information will be presented in the RI Report and NFA will be planned regarding the aluminum-impacted soil at this site.</p> <p>If the backfill at the site contains elevated aluminum concentrations within 2 feet of the surface, additional samples may be collected to define the area of elevated aluminum concentrations. The results of this investigation will be presented in the RI Report and the path forward for this portion of the site will be determined with team consensus.</p> |
| <p>Confirm that 2,4,6-TNT concentrations in the former TNT Conveyor Belt trench and near former Building 98 are less than site-specific cleanup goals</p> | <p>Are 2,4,6-TNT concentrations in soil beneath the former conveyor belt trench and near former Building 98 less than the site-specific cleanup goal?</p> | <p>Four soil samples will be collected at a depth of 24 to 36 inches bgs beneath the former TNT Conveyor Belt. Two co-located surface and subsurface soil samples will be collected from two locations near Former Building 98 at depths of 0 to 6 inches and 6 to 24 inches bgs. These samples will be located in the vicinity of historical sample locations with results indicating that soil exceeding the 2,4,6-TNT site-specific cleanup level of 15,000 µg/kg was left in place at the time of the remedial action (Figure 8).</p> | <p>If it is confirmed that 2,4,6-TNT concentrations within the remedial area are less than the site-specific cleanup goal of 15,000 µg/kg, this information will be presented in the RI Report and a NFA determination will be recommended for the former conveyor belt trench.</p> <p>If it is confirmed that 2,4,6-TNT concentrations within the removal area are greater than the site-specific cleanup goal, additional data may be collected to define the extent of soil impacts in the vicinity of the former conveyor belt trench. Results of this investigation will be presented in the RI Report and the collected data will be used in the future to develop potential remedial alternatives for the site.</p> |

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

| Problem Definition/Objective | Environmental Question | General Investigation Approach | PQO |
|---|--|--|--|
| <p>If necessary (based on decision logic presented on Figure 9), determine whether groundwater seeps and pore water are affected by site contaminants at Sites 9 and 19</p> | <p>Are groundwater seeps present at Sites 9 and 19?</p> | <p>A groundwater seep survey will be performed during the RI activities to evaluate whether seeps are present at Sites 9 and 19 or in the vicinity of the nearby surface water bodies.</p> | <p>If groundwater seeps are present and groundwater results indicate that the groundwater seeps may be affected by site contaminants exceeding human health screening values or ESVs, the groundwater seeps will be sampled for the groundwater constituents of potential concern (COPCs) at that location (pore water will be sampled in the vicinity of previously identified seeps if seeps are absent at the time of sampling).</p> <p>If groundwater seeps are not present or if groundwater results do not indicate that existing seeps may be affected, this contaminant transport pathway will be considered incomplete and no further consideration will be given to groundwater seeps at Sites 9 and 19.</p> |
| | <p>Is groundwater contamination at Sites 9 and 19 migrating at levels that may affect groundwater seeps/pore water?</p> | <p>Groundwater sampling results will be evaluated to determine whether groundwater seeps or pore water may be potentially affected by site contaminants. A decision tree is shown on Figure 9. Potentially affected media will be sampled for constituents determined to be of concern, plus physical parameters.</p> | <p>Pore water and seeps sample data will be used to determine if there is a complete pathway for groundwater contamination to affect surface water and sediment. This will be determined by comparing groundwater concentrations, seeps/pore water concentrations, and concentrations in surface water and sediment. If it is determined that a complete pathway is present and contaminants at the site are shown through risk assessment to pose unacceptable risks, this fate and transport pathway will be considered during the development of alternatives in a feasibility study.</p> |
| | <p>Do contaminant levels in groundwater seeps and pore water pose an unacceptable risk to current or future receptors?</p> | <p>An HHRA and an ERA will be performed during the RI for these media to assess risks to current and future receptors.</p> | <p>If contaminant levels pose a risk to receptors, the RI Report will summarize the investigation findings and propose a path forward to address unacceptable risks.</p> <p>If contaminant levels do not pose a risk to receptors, the RI Report will summarize the investigation findings and propose an NFA determination for this portion of the site.</p> |
| <p>Determine whether hexavalent chromium is of concern to human and/or ecological receptors at Sites 9 and 19</p> | <p>Do total chromium levels in site media pose an unacceptable risk to current or future receptors?</p> | <p>Site media will be analyzed for total chromium during site sampling activities. If a review of total chromium data for groundwater or soil indicates that total chromium concentrations may be of concern to human or ecological receptors, the Partnering Team will determine whether to analyze select site media for hexavalent chromium during a second field mobilization.</p> | <p>If total chromium concentrations in any site medium potentially pose a risk to receptors, the Partnering Team may decide to resample select site media to be analyzed for hexavalent chromium.</p> <p>If total chromium concentrations do not pose a potentially unacceptable risk to receptors, site media will not be analyzed for hexavalent chromium.</p> |

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Who will use the data?

The data will be used by the Navy (and its contractors) and the regulatory agencies. Once published in the Administrative Record for the site, the data will be available to the public.

What are the Project Action Limits and Project Indicator Levels?

Project action limits (PALs) are media-specific standards and criteria chosen for evaluation to help provide a conservative assessment of site conditions and to identify COPCs that are to be considered for quantitative risk calculations. The following list presents a summary of the PALs for each medium. **Worksheets #15-1a through #15-4i** provide the PALs for each constituent in each medium. Unless otherwise noted, the screening values used will be the most currently published values available.

- There are instances where the laboratory's limit of detection (LOD) for a specific constituent will be greater than the corresponding PAL. Any detection of this constituent above the LOD will be considered an exceedance of the associated PAL. In cases where a constituent is not detected, it will be considered not present at the LOD. In efforts to reach lower limits, the laboratory will report concentrations between the limit of quantitation (LOQ) and detection limit (DL) as estimated; these results will have a J qualifier applied to them.
- Soil data, with the exception of the TNT Conveyor Belt samples, will be screened against the PALs, which are based on the following human health screening values and ESVs:
 - Human Health Screening Criteria for Soil – USEPA Residential RSLs. RSLs based on non-carcinogenic effects will be divided by 10 to account for exposure to more than one constituent that affects the same organ. RSLs based on carcinogenic endpoints will not be adjusted.
 - ESVs for Surface and Shallow Subsurface Soil (0 to 24 inches bgs) – ecological SSLs for plants/soil invertebrates and other values from the literature compiled for use at WPNSTA Yorktown (Appendix B, only soil data collected from the 0-6 inch depth interval will be screened against ESVs).
 - Soil data also will be screened against the SSLs to assist in evaluating whether soil concentrations may potentially leach to groundwater, resulting in groundwater levels above acceptable risk or the federal maximum contaminant levels (MCLs).
- The soil data from the TNT conveyor belt samples will be compared to the remedial goal developed during the previous RA of 15,000 µg/kg.
- The soil data collected from the TNT conveyor belt samples analyzed for aluminum will be compared to ecological and human health values for that compound.
- Sediment data will be screened against the PALs, which are based on the following human health screening values and ESVs:
 - Human Health Screening Criteria for Sediment – USEPA Residential Soil RSLs x 10. RSLs based on non-carcinogenic effects will be divided by 10 to account for exposure to more than one constituent that affects the same organ. RSLs based on carcinogenic endpoints will not be adjusted.
 - ESVs for Sediment – Values from the literature compiled for use at WPNSTA Yorktown (freshwater, Appendix B).

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

- Groundwater data will be screened against the PALs, which are based on the following human health screening values and ESVs:
 - Human Health Screening Criteria for Groundwater – USEPA Tap Water RSLs. RSLs based on non-carcinogenic effects will be divided by 10 to account for exposure to more than one constituent that affects the same organ. RSLs based on carcinogenic endpoints will not be adjusted.
 - ESVs for Surface Water – ESVs for surface water (freshwater) from the literature compiled for use at WPNSTA Yorktown (Appendix B).
 - Groundwater data also will be screened against the federal MCLs to assist in the nature and extent of contamination evaluation.
- Surface water, groundwater seep (if collected), and pore water (if collected) data will be screened against the PALs, which are based on the following human health screening values and ESVs:
 - Human Health Screening Criteria for Surface Water – USEPA Tap Water RSLs x 10. RSLs based on non-carcinogenic effects will be divided by 10 to account for exposure to more than one constituent that affects the same organ. RSLs based on carcinogenic endpoints will not be adjusted.
 - ESVs for Surface Water – Ecological freshwater screening values from the literature compiled for use at WPNSTA Yorktown (**Appendix B**).
- Soil and groundwater data also will be screened against the 2011 Yorktown background dataset 95 percent Upper Tolerance Limits (UTLs) (CH2M HILL, 2011) to help distinguish site-related contaminants from background constituent concentrations. Further, the determination of presence of contamination (versus background) will take into consideration professional judgment evaluations such as nature of the constituents versus those likely released, presence of other constituents in the dataset, and magnitude and frequency of exceedances.
- Project indicator levels (PILS) are medium-specific standards and were developed to evaluate the fate and transport of contaminants with regard to ecological receptors. See **Worksheets #15-1a** through **15-4i** for a detailed list of the PALs and PILs for each constituent by medium.

What will the data be used for?

- The data will be used to determine the nature and extent of contamination and associated risks attributable to historical CERCLA-related releases at Former Loading Plant No. 1 and whether the site warrants further investigation, removal, or remediation. This determination will be based on quantitative HHRAs and ERAs, and where applicable, base background and SSL and MCL exceedances.

What types of data are needed?

The data collected will be representative of historical activities at Sites 9 and 19 and will allow for further characterization of the site and will include the following:

- New, permanent, 2-inch-diameter groundwater monitoring wells will be installed at Sites 9 and 19 to further delineate the nature and extent of site groundwater impacts. The new monitoring wells and 12 existing wells will be sampled and analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total and dissolved metals, total and free cyanide, and perchlorate. If the total metals results for groundwater indicate that chromium could be of concern, additional media may be collected and analyzed for hexavalent chromium. To

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

provide a better understanding of site geology within the deeper portions of the shallow aquifer system at Former Loading Plant No. 1, the borings for the Yorktown-Eastover aquifer may be extended to the top of the Eastover-Calvert Confining Unit. Following characterization of the deeper soil lithology, the borings will be partially abandoned to allow for construction of the Yorktown-Eastover aquifer wells in the shallow portion of the aquifer.

- Co-located surface and subsurface soil samples will be collected within the former site building footprints to determine the nature and extent of site soil contamination. Surface soil samples will be collected at a depth of 0 to 6 inches bgs, and subsurface soil samples will be collected at a depth of 6 to 24 inches bgs. Surface and subsurface soil samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total metals, total cyanide, and perchlorate. If the total metals results for soil indicate that chromium could be of concern, additional media may be collected and analyzed for hexavalent chromium.
- Additional soil samples will be collected in the vicinity of the former TNT Conveyor Belt and Building 98 to confirm that residual TNT concentrations in this area are below site cleanup goals. The six subsurface soil samples within the eastern and western portion of the excavated area will be collected at depths of 24 to 36 inches bgs, because this depth interval corresponds with the floor of the previous excavation and at locations where residual contamination exceeding the site cleanup goal may be present. The surface and subsurface soil samples located near former Building 98 will be collected at depths of 0 to 6 inches bgs and 6 to 24 inches bgs because the presence of former Building 98 prevented the collection of surface and subsurface soils in this area at the time of the excavation activities. These soil samples collected in the TNT Conveyor Belt area will be analyzed for 2,4,6-TNT only.
- Additional soil samples will be collected in the vicinity of the former TNT Conveyor Belt to confirm the presence and thickness of the backfill layer installed over aluminum-impacted soil placed at the base of the trench during the 1998 RA. The thickness of the backfill was not well documented during the RA. To confirm the depth of backfill, six subsurface soil samples will be collected from within the previous excavation area between 12 and 24 inches bgs and analyzed for aluminum and pH.
- Co-located surface water and sediment samples will be collected within the site drainage channels to evaluate contaminant nature and extent. Surface water will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total and dissolved metals, total and free cyanide, and perchlorate. Sediment will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total metals, total cyanide, and perchlorate. If the total metals results for surface water and sediment indicate that chromium could be of concern, additional samples may be collected and analyzed for hexavalent chromium.
- Both total and dissolved metals and total and free cyanide data will be included in the ERA screening tables. However, the dissolved metals and free cyanide data will be used preferentially during COPC selection because the dissolved metal/free cyanide fraction in water is more representative of the bioavailable fraction to aquatic receptors than the total metal/cyanide fraction. This is reflected in how the most recent Ambient Water Quality Criteria (AWQC) have been developed for many metals; that is, they are based on the dissolved fraction. The AWQC value for cyanide is based on free (not total) cyanide.
- Photoionization detector (PID) organic vapor data will be collected during sampling of Former Loading Plant No. 1 groundwater monitoring wells and site soils. In addition, geological data will be collected during the installation of the new monitoring wells to characterize site lithology.

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

- Groundwater seep and pore water samples may be collected and analyzed for select analytes based on the groundwater sampling results, groundwater flow direction, and contaminant extent. The timeframe available for seep sampling varies seasonally. Seep sampling may only be possible during the late winter and early spring. As the groundwater seep sampling is contingent upon the identification of seeps and the site analytical results, this sampling will not be performed until early 2015, if determined to be necessary.
- The physical parameters for surface water, groundwater seeps (if collected), and pore water (if collected) will include hardness. Physical parameters for sediment will include pH, TOC, AVS/SEM and grain size. These physical parameters will be collected to evaluate the fate and transport of contaminants with regard to ecological receptors as detailed in Table 1.

TABLE 1
 Project Indicator Levels

| Parameter | PIL | Justification |
|------------|---|---|
| AVS/SEM | Not available | The ratio of SEM to AVS will be used to evaluate the potential bioavailability of certain metals in sediment. |
| Grain size | Not available | Grain size data will be used to characterize sediment conditions in terms of habitat for certain invertebrates. |
| Hardness | 0-75 milligrams per liter (mg/L), 75-150 mg/L, 150-300 mg/L, and 300 and up | Hardness data will be used to adjust the freshwater ESVs for certain metals to reflect site-specific conditions. Additionally, classification of water hardness content is based on the values presented from soft to very hard. |
| pH | 6 - 8.5 | A pH value ranging from 6 to 8.5 is ideal for supporting microbial populations needed for natural attenuation. Data for pH in soil will be used to determine the ESV for certain metals (aluminum and iron). Data for pH in sediment will be used to evaluate habitat conditions. |
| TOC | > 20 mg/L | TOC is an indicator of the total amount of organic matter available to microbial communities to use as a carbon source in the degradation of VOCs. TOC data in sediment will be used to adjust equilibrium partitioning-based ESVs and to evaluate habitat conditions. TOC data in soil will be used to help evaluate fate, transport, and bioavailability. |

- Prior to groundwater sampling from permanent monitoring wells, depth to groundwater will be measured. A groundwater elevation contour map will be included as a product of the investigation.
- The standard operating procedures (SOPs) for laboratory and sampling techniques referenced in this UFP-SAP, **Worksheets #21 and #23**, will be adhered to.

Are there any special data quality needs, field or laboratory, in order to support environmental decisions?

The offsite laboratory analytical data will be of the quantity and quality necessary to provide technically sound and defensible assessments with respect to the aforementioned project objectives. QC sample requirements are detailed in **Worksheet #20**. For action decisions, the laboratory will follow the Measurement Performance Criteria (MPC) in **Worksheet #12** for field QC samples and **Worksheets #24 and #28** for laboratory QC samples.

These MPC are consistent with the DoD Quality Systems Manual (QSM) as applicable, and laboratory in-house limits where the QSM does not apply.

When the laboratory LOD for a specific constituent is greater than the corresponding PAL, any detection of this constituent above a corresponding 95 percent background UTL will be considered potentially site-related except if it is qualified with a B for possible blank contamination. In those cases where this specific constituent is not detected above the LOD, the analyte will be considered not present.

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

In efforts to reach lower limits, the laboratory will report concentrations between the LOQ and DL as estimated. These results will have a J qualifier applied to them indicating that they are quantitative estimates.

Data will be validated by CH2M HILL using the procedures listed in **Worksheet #36**. A full Level IV equivalent data package and QC sampling are required for these data. A Level IV equivalent data package includes a case narrative, all field sample results, QC forms and raw data.

How much data is needed (number of samples for each analytical group, matrix, and concentration)?

- The nine new monitoring wells to be installed at Sites 9 and 19 are shown on **Figure 5**. Seven of the nine new wells will be screened in the Cornwallis Cave aquifer with one well located near Site 9, three wells located near former Building 10, and three wells located near the Powder Metal Storage, Bulk TNT Storage, and Nitrate Prep and Storage buildings. Two wells will be screened within the upper portion of the Yorktown-Eastover aquifer and will be placed in the vicinity of existing wells 19GW04 and 19GW06. The 9 new monitoring wells and 12 existing wells will be sampled and analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total and dissolved metals, total and free cyanide, and perchlorate.
- Co-located surface and subsurface soil samples will be collected at 44 locations within the former site building footprints, as shown on **Figure 6**. Surface and subsurface soil samples will be collected from 24 locations near the former Building 10 footprint. Surface and subsurface soil samples will be collected from 11 locations near the former material storage building footprints. Surface and subsurface soil samples will be collected from six locations within the former Nitrate Conveyor Belt footprint. Surface and subsurface soil samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total metals, total cyanide, and perchlorate. Physical parameters for soil will include pH and TOC to evaluate the fate and transport of contaminants with regard to ecological receptors.
- Ten additional soil samples will be collected in the vicinity of the former TNT Conveyor Belt and Building 98 to confirm that residual TNT concentrations in this area are below site cleanup goals, as shown on **Figure 8**. These samples will be collected at depths ranging from 0 to 36 inches bgs based on historical sampling results. These soil samples collected in the TNT Conveyor Belt area will be analyzed for 2,4,6-TNT.
- Twelve additional soil samples will be collected in the vicinity of the former TNT Conveyor Belt to confirm that 2 feet of backfill is present above the aluminum-impacted soil present at the base of the trench. These samples, shown on **Figure 8**, will be collected from six locations at depths of 12 to 18 inches bgs and 18 to 24 inches bgs. These soil samples will be analyzed for aluminum and pH.
- Co-located surface water and sediment samples will be collected at 17 locations, as shown on **Figure 7**. Twelve of these sample locations will be within the former Building 10 drainage channels, and five of these sample locations will be within the material storage building drainage channels. Surface water samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total and dissolved metals, total and free cyanide, and perchlorate. The physical parameter to be analyzed for surface water is hardness; water quality parameters will also be field-measured, as will water depth and flow rate. Sediment will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, explosives, total metals, total cyanide, and perchlorate. Physical parameters for sediment will include pH, TOC, AVS/SEM, and grain size to evaluate the fate and transport of contaminants with regard to ecological receptors.

The need for groundwater seep and/or pore water samples is dependent upon groundwater concentrations and observed site conditions. Groundwater results will be screened against surface water criteria to determine whether groundwater in the vicinity of groundwater seeps or pore water may be affected by site contaminants; then, sample locations and the compounds to be sampled for in each of these media will be determined by the project risk assessors and Partnering Team. A decision tree outlining the rationale for possible sampling and

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

evaluation of groundwater seep/pore water samples is presented on **Figure 9**. It is assumed that up to five groundwater seep and five pore water samples will be collected, if warranted. The physical parameter to be analyzed for groundwater seeps and pore water samples will include hardness to evaluate the fate and transport of contaminants with regard to ecological receptors. The timeframe available for seep sampling varies seasonally. Seep sampling may only be possible during the late winter and early spring. As the groundwater seep sampling is contingent upon the identification of seeps and the site analytical results, this sampling will not be performed until early 2015, if determined to be necessary.

The need for hexavalent chromium analysis of groundwater, soil, sediment or surface water is dependent upon total chromium concentrations in those site media and whether total chromium concentrations are determined to be of concern for each media. The need for hexavalent chromium analysis for each site sample will be determined by the project risk assessors and Partnering Team.

Sample locations are intended to fill data gaps in the current dataset such that the nature and extent of contamination and potential risks can be adequately assessed. Target analytical concentrations (that is, quantitation limits [QLs]) are listed in **Worksheet #15**.

Where, when, and how should the data be collected/generated?

The data will be collected and generated in accordance with the SOPs contained in this SAP. Fieldwork is tentatively scheduled to begin in March 2014. The fieldwork will be conducted in more than one mobilization as detailed in the project schedule (**Worksheet #16**). Multiple mobilizations are necessary to allow for evaluation of groundwater data to determine whether groundwater seep and/or pore water samples and hexavalent chromium samples are warranted. Validated data would be available for development of screening tables approximately 10 weeks after the lab receives each set of samples.

How will the data be reported?

An RI Report will be prepared that presents the data, evaluation of results, including HHRAs and ERAs, and recommendations for NFA, further investigation, RA, or other remediation. In general, CERCLA guidance will be followed. More detail is provided in the Yorktown and Cheatham Annex Master QAPP.

SAP Worksheet #12-1—Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: VOCs

Concentration Level: Medium

| QC Sample | Analytical Group ¹ | Frequency | Data Quality Indicators (DQIs) | MPC |
|------------------------------|-------------------------------|---|--------------------------------|--|
| Field Duplicate ² | VOCs | 1 per 10 field samples of similar matrix | Precision | Relative Percent Difference (RPD) ≤ 30% |
| Equipment Blank | | 1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Trip Blank | | 1 per cooler to the laboratory containing VOC samples | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Cooler Temperature Indicator | | 1 per cooler to the laboratory | Representativeness | Temperature ≤ 6 degrees Celsius (°C), not frozen |

Notes:

¹ Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

² Field QA/QC will be collected separately for each matrix.

SAP Worksheet #12-2—Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: SVOCs including 1,4-dioxane, Explosives, Perchlorate

Concentration Level: Medium

| QC Sample | Analytical Group ¹ | Frequency | DQIs | MPC |
|------------------------------|---|---|----------------------|---------------------------------------|
| Field Duplicate ² | SVOCs including 1,4-Dioxane, Explosives, Perchlorate | 1 per 10 field samples of similar matrix | Precision | RPD ≤ 30% |
| Equipment Blank | | 1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Cooler Temperature Indicator | | 1 per cooler to the laboratory | Representativeness | Temperature ≤ 6 °C, not frozen |

Notes:

¹ Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

² Field QA/QC will be collected separately for each matrix.

SAP Worksheet #12-3—Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: Total and/or Dissolved Metals, Hexavalent Chromium, Cyanide, Free Cyanide

Concentration Level: Medium / Low

| QC Sample | Analytical Group ¹ | Frequency | DQIs | MPC |
|------------------------------|---|---|----------------------|---------------------------------------|
| Field Duplicate ² | Total and Dissolved Metals, Cyanide, Free Cyanide | 1 per 10 field samples of similar matrix | Precision | RPD ≤ 20% |
| Equipment Blank | | 1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Cooler Temperature Indicator | | 1 per cooler to the laboratory | Representativeness | Temperature ≤ 6 °C, not frozen |

Notes:

¹ Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

² Field QA/QC will be collected separately for each matrix.

SAP Worksheet #12-4—Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: Wet Chemistry (Hardness)

Concentration Level: Medium

| QC Sample | Analytical Group | Frequency | DQIs | MPC |
|------------------------------|------------------|--------------------------------|--------------------|-------------------------------------|
| Cooler Temperature Indicator | Wet Chemistry | 1 per cooler to the laboratory | Representativeness | Temperature ≤ 6 °C, not frozen |

SAP Worksheet #12-5—Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: VOCs

Concentration Level: Medium

| QC Sample | Analytical Group | Frequency | DQIs | MPC |
|------------------------------|------------------|---|----------------------|---------------------------------------|
| Field Duplicate ¹ | VOCs | 1 per 10 field samples of similar matrix | Precision | RPD \leq 30% |
| Equipment Blank | | 1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Trip Blank | | 1 per cooler to the laboratory containing VOC samples | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Cooler Temperature Indicator | | 1 per cooler to the laboratory | Representativeness | Temperature \leq 6 °C, not frozen |

Notes:

¹ Field QA/QC will be collected separately for each matrix.

SAP Worksheet #12-6—Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: SVOCs including 1,4-dioxane, Explosives, Perchlorate

Concentration Level: Medium

| QC Sample | Analytical Group ¹ | Frequency | DQIs | MPC |
|------------------------------|---|---|----------------------|---------------------------------------|
| Field Duplicate ² | SVOCs including 1,4-dioxane, Explosives, Perchlorate | 1 per 10 field samples of similar matrix | Precision | RPD ≤ 30% |
| Equipment Blank | | 1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Cooler Temperature Indicator | | 1 per cooler to the laboratory | Representativeness | Temperature ≤ 6 °C, not frozen |

Notes:

¹ Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

² Field QA/QC will be collected separately for each media.

SAP Worksheet #12-7—Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Metals, Hexavalent Chromium, Cyanide

Concentration Level: Medium / Low

| QC Sample | Analytical Group ¹ | Frequency | DQIs | MPC |
|------------------------------|--------------------------------------|---|----------------------|---------------------------------------|
| Field Duplicate ² | Metals, Hexavalent Chromium, Cyanide | 1 per 10 field samples of similar matrix | Precision | RPD ≤ 20% |
| Equipment Blank | | 1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment | Bias / Contamination | No target analytes detected > 1/2 LOQ |
| Cooler Temperature Indicator | | 1 per cooler to the laboratory | Representativeness | Temperature ≤ 6 °C, not frozen |

Notes:

¹ Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

² Field QA/QC will be collected separately for each media.

SAP Worksheet #12-8—Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Wet Chemistry (pH, TOC), AVS/SEM

Concentration Level: Low

| QC Sample | Analytical Group ¹ | Frequency | DQIs | MPC |
|------------------------------|-------------------------------|--------------------------------|--------------------|------------------------------------|
| Cooler Temperature Indicator | Wet Chemistry AVS/SEM | 1 per cooler to the laboratory | Representativeness | Temperature \pm 6 °C, not frozen |

Notes:

¹ Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

[\(UFP-QAPP Manual Section 2.7\)](#)

| Secondary Data | Data Source | Data Generator(s) | How Data Will Be Used | Limitations on Data Use |
|--------------------------------|--|--------------------------------------|---|-------------------------|
| Sites 9 and 19 Historical Data | Baker Environmental, Inc., 1993. <i>Final Round One Remedial Investigation Report, Site 1-9, 11, 12, 16-19, and 21, Naval Weapons Station, Yorktown, Virginia.</i> July. | Baker Environmental, Inc. | Data used to determine the constituents of concern (COCs) and potential human health and ecological risk. Additionally, these data were used to propose sample location for the RI. | None known |
| Sites 9 and 19 Historical Data | Baker Environmental, Inc., 1997. <i>Final Round Two Remedial Investigation Report for Sites 9 and 19, Naval Weapons Station, Yorktown, Virginia.</i> July. | Baker Environmental, Inc. | Data used to determine the COCs and potential human health and ecological risk. Additionally, these data were used to propose sample location for the RI. | None known |
| Site 19 Historical Data | OHM Remediation, 2000. <i>Draft Contractor Closeout Report for Site 19 Bioremediation, Naval Weapons Station Yorktown, Yorktown, Virginia.</i> April. | OHM Remediation Services Corporation | Data used to determine the proposed sample locations to further evaluate potential impacts at Site 19. | None known |
| Yorktown Background Dataset | CH2M HILL, 2011. <i>Background Study Report, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia.</i> May. | CH2M HILL | Soil and groundwater datasets will be used to determine if contaminant levels exceed Station background concentrations. | None Known |

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SAP Worksheet #14—Summary of Project Tasks

[\(UFP-QAPP Manual Section 2.8.1\)](#)

Project Logistics

- In general, work will be performed in Level D personal protective equipment (PPE), which includes hardhat, safety glasses, safety toed boots, and hearing protection. Optional PPE includes the use of Tyvek coveralls as necessary. Upgrades to higher levels of PPE are discussed in the HSP, which will be provided as a separate document from this UFP-SAP.
- Field investigation activities will be performed over separate mobilizations, as follows:
 - Mobilization #1: Groundwater monitoring well installation, groundwater sampling, soil sampling, surface water/sediment sampling
 - Mobilization #2: Optional groundwater seep and pore water sampling and optional media to be sampled for hexavalent chromium analysis
- Well installation, development, and sampling will take place during normal working hours.
- Following the investigation activities, the site will be restored to its original condition.

Project Tasks

- Applicable SOPs for project tasks outlined in this section are listed on **Worksheet #21** and provided in **Appendix A**.

Analytical Laboratory

- An analytical laboratory has been procured to perform the analyses proposed for this RI. This UFP-SAP has been prepared in conjunction with the subcontracted laboratory to present a detailed description of the analytical methods to be used during this investigation.

Utility Clearance

- Utilities will be cleared before beginning intrusive activities. CH2M HILL will coordinate utility clearance with Miss Utility of Virginia and the base's approving authority. Additionally, a separate utilities subcontractor will be procured to ensure the accuracy of the utility markings. Any proposed soil sampling and monitoring well locations interfering with utility locations will be relocated to avoid impact to utilities while continuing to meet the intent of the sampling rationale.

Investigation Activities

- **Soil Sampling**-- Forty-four co-located surface and subsurface soil samples will be collected at Sites 9 and 19. Proposed sampling locations are shown on **Figure 6**. Soil samples will be collected using hand augers. Surface soil samples will be collected at a depth of 0 to 6 inches bgs, and subsurface soil samples will be collected at a depth of 6 to 24 inches bgs. Soil samples will be sampled for VOCs, SVOCs including PAHs, 1,4-dioxane, total metals, total cyanide, explosives, perchlorate, pH, and TOC.
- Soil samples will be collected at eight additional locations within the former TNT Conveyor Belt trench to confirm residual TNT concentrations remaining following the previous RA. One sample will be collected six locations (at the eastern and western ends of the trench), shown on **Figure 8**, at a depth of 24 to 36 inches bgs. Additionally, two co-located soil samples will be collected from the two easternmost sample locations near the former conveyor belt, shown on **Figure 8**, at depths of 0 to 6 inches bgs and 6 to 24 inches bgs. These soil samples will be analyzed for 2,4,6-TNT only and will be collected using a direct-push technology (DPT) rig.

SAP Worksheet #14—Summary of Project Tasks (continued)

- Soil samples will be collected at six additional locations within the former TNT conveyor belt trench to confirm the presence 2 feet of backfill above the aluminum-impacted soil located at the base of the trench, as shown on **Figure 8**. Co-located soil samples will be collected from a depth of 12 to 18 inches bgs and 18 to 24 inches bgs. These soil samples will be analyzed for aluminum and pH and will be collected using a DPT rig.
- **Monitoring Well Installation** – Up to nine permanent monitoring wells will be installed at Sites 9 and 19. Seven of the new wells will be installed within the Cornwallis Cave aquifer, and two of the new wells will be installed at the top of the Yorktown-Eastover aquifer. The borings for the Yorktown-Eastover aquifer wells may be extended to the top of the Eastover-Calvert Confining Unit to allow for further characterization of this aquifer. After reaching the top of the Eastover-Calvert Confining Unit (a depth of approximately 110 feet bgs), the borings will be partially abandoned to allow for construction of the Yorktown-Eastover aquifer wells in the shallow portion of the aquifer.

Wells will be installed using hollow stem auger methods. Proposed monitoring well locations are shown on **Figure 5**. New monitoring well depths will be determined through the use of historical site information and observed field conditions. Cornwallis Cave aquifer monitoring wells will be approximately 30 feet in depth, and the Yorktown-Eastover aquifer monitoring wells will be approximately 60 feet in depth. Each new monitoring well will be constructed with 2-inch nominal-diameter Schedule 40 polyvinyl chloride (PVC) screen and riser. The monitoring well screen will be machine-slotted 0.010-inch and 10 feet long.

A silica sand filter pack will be placed around the annular space of the well screen from the bottom of the boring extending to 2 feet above the top of the screen. A 2-foot-thick bentonite layer will be placed above the sand filter pack. After the bentonite has been hydrated, a cement-bentonite grout will be placed in the remaining annular space. The monitoring wells will be completed with stickup casing with a watertight steel cover. A locking watertight cap will be placed on the PVC pipe and the wells clearly marked. Wells will be surrounded with bollards and locked.

- **Monitoring Well Development** – Each new and existing monitoring well will be developed using a submersible pump. At least three well volumes of water will be removed, in addition to the volume of any water added during the well installation process. Development will continue until the water is clear and free of sediment or until 6 hours of development have passed, whichever comes first. Development information, including readings of turbidity, pH, specific conductivity, temperature, and gallons removed, will be recorded in the field logbook.
- **Water-Level Survey** – A complete round of water levels will be recorded from the monitoring wells. Depth to water and time measured will be recorded in the field logbook.
- **Monitoring Well Groundwater Sampling** – Nine new monitoring wells and twelve existing permanent groundwater monitoring wells will be purged using a submersible pump or peristaltic pump following low-flow sampling protocol prior to sampling. Groundwater quality parameters (pH, specific conductance, turbidity, dissolved oxygen [DO], temperature, salinity, and oxidation-reduction potential [ORP]) should be recorded and allowed to stabilize before a sample is collected. Groundwater samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, total/dissolved metals, total/free cyanide, explosives, and perchlorate.

SAP Worksheet #14—Summary of Project Tasks (continued)

- **Surface Water Sampling** – Seventeen surface water samples (to be co-located with sediment samples) will be collected at Sites 9 and 19 no more than two days after a rain event. Proposed sample locations are shown on **Figure 7**. All sample locations should be approached from downstream to avoid disturbing the bottom sediment as much as possible. Sampling will proceed from downstream to upstream locations. Prior to sample collection, water quality data will be measured from the top, middle, and bottom of the water column (where applicable) using a Horiba U-22 water quality meter (pH, conductivity, turbidity, DO, temperature, salinity, and ORP); water depth and flow rate will also be measured. To facilitate sample collection, a clean, unpreserved sample container will be gently submerged within the surface water with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle. When the bottle is full, it will be gently removed from the water and the surface water sample transferred to the laboratory-supplied bottleware. Surface water analytes will be sampled for VOCs, SVOCs including PAHs, 1,4-dioxane, total/dissolved metals, total/free cyanide, explosives, perchlorate, and hardness.
- **Sediment Sampling** – Seventeen sediment samples (to be co-located with surface water samples) will be collected at Sites 9 and 19 no more than two days after a rain event. Proposed sample locations are shown on **Figure 7**. Sampling will proceed from downstream to upstream locations. Sediment samples will be collected from 0 to 4 inches bgs. With the exception of samples for VOCs and AVS/SEM analyses, collected sediment will be homogenized in stainless steel bowls prior to placement in laboratory-prepared sample containers. Samples collected for VOCs and AVS/SEM analyses will be placed directly into sample containers. Sediment samples will be analyzed for VOCs, SVOCs including PAHs, 1,4-dioxane, total metals, total cyanide, explosives, perchlorate, pH, TOC, AVS/SEM, and grain size.
- **Groundwater Seep and Pore Water Sampling** – Up to 10 groundwater seep (or pore water samples if the seep is not flowing) may be collected based on the presence of groundwater seeps and groundwater analytical results. If collected, groundwater seep samples will be collected directly from the seep into a clean, laboratory-prepared sample container and transferred to preserved containers as necessary. Groundwater seep or pore water analytes will be selected based on groundwater analytical results, and will include hardness. Passive diffusion bags will be used for pore water sampling. The sample depth and method will be refined once pore water sampling locations have been selected.

Equipment Decontamination

- All non-disposable sampling equipment will be decontaminated before use and immediately after each use in accordance with applicable SOPs (**Appendix A**). The water-level indicator will be rinsed with deionized (DI) water between each measurement. Heavy equipment such as drill rig (augers, rods, or split spoons) will be steam-cleaned before use at each new monitoring well location. Monitoring well risers and screens will also be steam-cleaned using the same procedure, unless they are certified by the manufacturer as clean and the plastic seals are intact. A decontamination pad will be set up to prevent runoff of the decontamination water and to allow easy collection of decontamination fluids.

Investigation-derived Waste Handling

- Investigation-derived waste (IDW) generated during investigation activities at Sites 9 and 19 will include disposable PPE and sampling supplies, soil cuttings, well purge water, and solutions used to decontaminate drilling and hand-augering equipment. Aqueous IDW and soil cuttings will be containerized in approved 55-gallon drums and will be managed using the procedure described below. Approximately 44 soil and 40 aqueous drums for IDW are estimated to be generated during the field effort. Used PPE and sampling supplies will be placed in opaque contractor's bags and disposed of in an on-base dumpster.

SAP Worksheet #14—Summary of Project Tasks (continued)

IDW Management Procedure

The process for coordinating the location of an IDW storage area includes:

- Informing the Navy COR, Bryan Peed, of the number of IDW drums to be generated during the investigation.
- Coordinating with the Navy COR, the Base Environmental Director, and Base IDW Coordinator to identify a location for IDW (including providing the number of drums and a figure with proposed IDW storage area).
- Site visit with the Base Environmental Director and/or the Base IDW Coordinator to field-verify the location.
- The following considerations will be given to the IDW Storage Area:
 - Size (number of drums) requirement, levelness, and firmness of ground if not stored on asphalt or concrete
 - Accessibility to vehicles (height, width, turning radius), including semi-trailer
 - Protectiveness - sheltering, away from heavy traffic areas, limited accessibility to base employees if possible

The process for preparing an IDW storage area includes:

- Construction of a secondary containment area that requires:
 - Ability to contain 10 percent of total volume of material to be stored
 - Minimum 6-mil poly sheeting flooring wrapped over minimum 4-inch side wall
- Pallets will be required to keep all drums directly off the poly sheeting
- Poly or other weatherproof tarp capable of preventing infiltration into the secondary containment
- Metal or fabric strapping capable of securing drums to each other and securing a tarp over the containment area
- A sign will be placed in plain view stating the purpose of the area, and contact information
- IDW Spill Control Kit to be kept on site at all times that will include:
 - A fire extinguisher
 - Spill pads
 - Nitrile gloves
 - Trash bags and paper towels
 - Forms - additional drum labels and inspection forms, pens, markers

The process for filling and storing IDW drums will include:

- All drums used for IDW must be new or reconditioned 55-gallon Department-of-Transportation-approved drums with open top.
- Drums may only be filled to approximately $\frac{3}{4}$ full to meet weight requirements for transport.
- Any excess material will be cleaned from the side of the drum.
- The cover of the drum will be secured to prevent any leakage from the drum should it be placed on its side.
- The filled drum will be placed on a pallet within the secondary storage container.

SAP Worksheet #14—Summary of Project Tasks (continued)

- Labels will be affixed to the drum in accordance with the SOP included in **Appendix A**. The label will be affixed to the drum so that it is facing outward where it can be read by an inspector.
- Once the IDW operations have been completed for the day, a tarp will be placed over the drums and secured. The tarp will be placed in a way that prevents any precipitation from collecting in the secondary containment.

The process for inspecting the IDW storage area will include:

- On a weekly basis, all aspects of the IDW storage area will be inspected.
- The condition of the tarp, sidewalls, and poly sheeting will be inspected for any holes or breaks. Any deficiencies will be corrected at the time of the inspection.
- The drums will be inspected to be sure that no leaks or breaching of the drum has occurred or is imminent. All labels will be inspected to be sure that they are still properly affixed to the drum and that the information on them is current.
- The pallets will be inspected to be sure that there is no rotting or breakage on the wood.
- The inspection sheet provided by the base will be completed and kept with the IDW Spill Control Kit.
- Any deficiencies that cannot be corrected at the time of the inspection will be communicated to the Navy COR, the Base Environmental Director, and/or the Base IDW Coordinator.

The process for characterizing, profiling, and removal of the IDW from the base includes:

- Sampling of the IDW drums will be conducted by CH2MHILL and the parameters for disposal will be determined based on the contracted receiving facilities requirements.
- Sampling results received by CH2M HILL will be forwarded to the IDW receiving facility and a waste profile will be generated to make the determination regarding the material being considered hazardous or non-hazardous.
- Sampling results and the waste profile will be forwarded to the Navy COR for review.
- Once the Navy approves of the profile, CH2M HILL will schedule a pickup date and time. This will be coordinated with the Navy COR to be sure that a Navy representative is present to sign the appropriate disposal forms.

Quality Control

- Implement SOPs for field activities (**Appendix A**) being performed.
- Summary of daily field activities will be documented in a field logbook; this logbook will also detail sampling activities and information regarding boring logs, well construction, and well development.
- QC samples to be collected are outlined on **Worksheet #20**.

Surveying

- Soil, surface water, sediment, groundwater seep, and pore water sampling locations, and newly installed monitoring wells, will be horizontally (± 0.1 feet) and vertically (± 0.01 feet) located by a Virginia-licensed surveyor.

SAP Worksheet #14—Summary of Project Tasks (continued)

Analytical Tasks

- The laboratory will maintain, test, inspect and calibrate analytical instruments (**Worksheets #24 and #25**).
- The laboratory will process and prepare samples for analysis.

Data Management

- See **Worksheets #34-36** for discussion of data management procedures.
- The PC (Clairette Campbell) is responsible for data tracking and storage.
- Monica Marrow of Critigen will coordinate data archiving and retrieval.

Project Assessment/Audit

- **Worksheets #31 and #32**

Data Review

- DV (**Worksheets #35 and #36**)

SAP Worksheet #15-1a—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: VOCs

| Analyte | CAS # | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|---|----------|--|--|-------------------------|-------------------------------------|--------------------------|-----|------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,1,1-Trichloroethane | 71-55-6 | 750 | 11 | 200 | 5.5 | 1 | 0.5 | 0.40 | 65 | 130 | 30 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.066 | 610 | NC | 0.033 | 1 | 0.5 | 0.31 | 80 | 130 | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113) | 76-13-1 | 5300 | NC | NC | 2650 | 1 | 0.5 | 0.45 | 63 | 138 | |
| 1,1,2-Trichloroethane | 79-00-5 | 0.041 | 1200 | 5 | 0.0205 | 1 | 0.5 | 0.38 | 75 | 125 | |
| 1,1-Dichloroethane | 75-34-3 | 2.4 | 47 | NC | 1.2 | 1 | 0.5 | 0.36 | 70 | 135 | |
| 1,1-Dichloroethene | 75-35-4 | 26 | 25 | 7 | 3.5 | 1 | 0.5 | 0.47 | 70 | 130 | |
| 1,2,3-Trichlorobenzene | 87-61-6 | 0.52 | 8 | NC | 0.26 | 1 | 0.5 | 0.20 | 55 | 140 | |
| 1,2,4-Trichlorobenzene | 120-82-1 | 0.39 | 110 | 70 | 0.195 | 1 | 0.5 | 0.20 | 65 | 135 | |
| 1,2-Dibromo-3-chloropropane | 96-12-8 | 0.00032 | NC | 0.2 | 0.00016 | 1 | 0.5 | 0.46 | 50 | 130 | |
| 1,2-Dibromoethane | 106-93-4 | 0.0065 | NC | 0.05 | 0.00325 | 1 | 0.5 | 0.41 | 74 | 129 | |
| 1,2-Dichlorobenzene | 95-50-1 | 28 | 14 | 600 | 7 | 1 | 0.5 | 0.45 | 70 | 120 | |
| 1,2-Dichloroethane | 107-06-2 | 0.15 | 910 | 5 | 0.075 | 1 | 0.5 | 0.48 | 70 | 130 | |
| 1,2-Dichloropropane | 78-87-5 | 0.38 | 525 | 5 | 0.19 | 1 | 0.5 | 0.46 | 75 | 125 | |
| 1,3-Dichlorobenzene | 541-73-1 | NC | 71 | NC | 35.5 | 1 | 0.5 | 0.43 | 75 | 125 | |
| 1,4-Dichlorobenzene | 106-46-7 | 0.42 | 15 | 75 | 0.21 | 1 | 0.5 | 0.32 | 75 | 125 | |
| 2-Butanone | 78-93-3 | 490 | 14000 | NC | 245 | 5 | 2.5 | 1.32 | 30 | 150 | |
| 2-Hexanone | 591-78-6 | 3.4 | 99 | NC | 1.7 | 5 | 2.5 | 1.94 | 55 | 130 | |
| 4-Methyl-2-pentanone | 108-10-1 | 100 | 170 | NC | 50 | 5 | 2.5 | 2.10 | 60 | 135 | |
| Acetone | 67-64-1 | 1200 | 1500 | NC | 600 | 5 | 2.5 | 0.50 | 40 | 140 | |
| Benzene | 71-43-2 | 0.39 | 130 | 5 | 0.195 | 1 | 0.5 | 0.32 | 80 | 120 | |
| Bromochloromethane | 74-97-5 | 8.3 | NC | NC | 4.15 | 1 | 0.5 | 0.20 | 65 | 130 | |
| Bromodichloromethane | 75-27-4 | 0.12 | NC | 80 | 0.06 | 1 | 0.5 | 0.36 | 75 | 120 | |
| Bromoform | 75-25-2 | 7.9 | 320 | 80 | 3.95 | 1 | 0.5 | 0.47 | 70 | 130 | |
| Bromomethane | 74-83-9 | 0.7 | 110 | NC | 0.35 | 1 | 0.5 | 0.20 | 30 | 145 | |
| Carbon disulfide | 75-15-0 | 72 | 0.92 | NC | 0.46 | 1 | 0.5 | 0.20 | 35 | 160 | |
| Carbon tetrachloride | 56-23-5 | 0.39 | 240 | 5 | 0.195 | 1 | 0.5 | 0.20 | 65 | 140 | |
| Chlorobenzene | 108-90-7 | 7.2 | 64 | 100 | 3.6 | 1 | 0.5 | 0.49 | 80 | 120 | |
| Chloroethane | 75-00-3 | 2100 | NC | NC | 1050 | 1 | 0.5 | 0.20 | 60 | 135 | |
| Chloroform | 67-66-3 | 0.19 | 28 | 80 | 0.095 | 1 | 0.5 | 0.34 | 65 | 135 | |
| Chloromethane | 74-87-3 | 19 | 5500 | NC | 9.5 | 1 | 0.5 | 0.20 | 40 | 125 | |

SAP Worksheet #15-1a—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater
 Analytical Group: VOCs

| Analyte | CAS # | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|------------------------------------|---------------|--|--|-------------------------|-------------------------------------|--------------------------|-----|------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| cis-1,2-Dichloroethene | 156-59-2 | 2.8 | 590 | 70 | 1.4 | 1 | 0.5 | 0.35 | 70 | 125 | |
| cis-1,3-Dichloropropene | 6923-20-2 | 0.41 | 24.4 | NC | 0.205 | 1 | 0.5 | 0.31 | 70 | 130 | |
| Cyclohexane | 110-82-7 | 1300 | NC | NC | 650 | 1 | 0.5 | 0.20 | 67 | 132 | |
| Dibromochloromethane | 124-48-1 | 0.15 | NC | 80 | 0.075 | 1 | 0.5 | 0.20 | 71 | 131 | |
| Dichlorodifluoromethane (Freon-12) | 75-71-8 | 19 | NC | NC | 9.5 | 1 | 0.5 | 0.20 | 30 | 155 | |
| Ethylbenzene | 100-41-4 | 1.3 | 290 | 700 | 0.65 | 1 | 0.5 | 0.20 | 75 | 125 | |
| Isopropylbenzene | 98-82-8 | 39 | 2.6 | NC | 1.3 | 1 | 0.5 | 0.45 | 75 | 125 | |
| m- and p-Xylene | m- & p-XYLENE | 19 | 13 | NC | 6.5 | 2 | 1 | 0.95 | 75 | 130 | |
| Methyl acetate | 79-20-9 | 1600 | NC | NC | 800 | 1 | 0.5 | 0.20 | 51 | 158 | |
| Methylcyclohexane | 108-87-2 | NC | NC | NC | N/A | 1 | 0.5 | 0.20 | 71 | 125 | |
| Methylene chloride | 75-09-2 | 8.4 | 2200 | 5 | 2.5 | 1 | 0.5 | 0.41 | 55 | 140 | |
| Methyl-tert-butyl ether (MTBE) | 1634-04-4 | 12 | 11070 | NC | 6 | 1 | 0.5 | 0.35 | 65 | 125 | |
| o-Xylene | 95-47-6 | 19 | 13 | NC | 6.5 | 1 | 0.5 | 0.43 | 80 | 120 | |
| Styrene | 100-42-5 | 110 | 72 | 100 | 36 | 1 | 0.5 | 0.36 | 65 | 135 | |
| Tetrachloroethene | 127-18-4 | 3.5 | 98 | 5 | 1.75 | 1 | 0.5 | 0.27 | 45 | 150 | |
| Toluene | 108-88-3 | 86 | 9.8 | 1000 | 4.9 | 1 | 0.5 | 0.37 | 75 | 120 | |
| trans-1,2-Dichloroethene | 156-60-5 | 8.6 | 590 | 100 | 4.3 | 1 | 0.5 | 0.41 | 60 | 140 | |
| trans-1,3-Dichloropropene | 110-57-6 | 0.41 | 24.4 | NC | 0.205 | 1 | 0.5 | 0.29 | 55 | 140 | |
| Trichloroethene | 79-01-6 | 0.26 | 47 | 5 | 0.13 | 1 | 0.5 | 0.28 | 70 | 125 | |
| Trichlorofluoromethane (Freon-11) | 75-69-4 | 110 | NC | NC | 55 | 1 | 0.5 | 0.35 | 60 | 145 | |
| Vinyl chloride | 75-01-4 | 0.015 | 930 | 2 | 0.0075 | 1 | 0.5 | 0.34 | 50 | 145 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

LCL = Lower Control Limit

LCS = laboratory control sample

MS = matrix spike

MSD = matrix spike duplicate

N/A = not applicable

UCL = Upper Control Limit

Worksheet #15-1b—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: SVOCs including 1,4-dioxane

| Analyte | CAS # | Full Scan or SIM | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|------------------------------|---------------|------------------|--|--|-------------------------|-------------------------------------|--------------------------|------|------|---|-----|-----|
| | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,1-Biphenyl | 92-52-4 | Full Scan | 0.083 | 14 | NC | 0.0415 | 10 | 5 | 0.15 | 65 | 117 | 30 |
| 1,2,4,5-Tetrachlorobenzene | 95-94-3 | Full Scan | 0.12 | 3 | NC | 0.06 | 10 | 5 | 0.20 | 60 | 105 | |
| 1,4-Dioxane | 123-91-1 | 8270 SIM | 0.67 | NC | NC | 0.335 | 0.1 | 0.05 | 0.05 | 70 | 130 | |
| 2,2'-Oxybis(1-chloropropane) | 108-60-1 | Full Scan | 0.31 | NC | NC | 0.155 | 10 | 5 | 0.17 | 60 | 113 | |
| 2,3,4,6-Tetrachlorophenol | 58-90-2 | Full Scan | 17 | 1.2 | NC | 0.6 | 10 | 5 | 5 | 66 | 110 | |
| 2,4,5-Trichlorophenol | 95-95-4 | Full Scan | 89 | 63 | NC | 31.5 | 10 | 5 | 0.40 | 50 | 110 | |
| 2,4,6-Trichlorophenol | 88-06-2 | Full Scan | 0.9 | 4.9 | NC | 0.45 | 10 | 5 | 0.56 | 50 | 115 | |
| 2,4-Dichlorophenol | 120-83-2 | Full Scan | 3.5 | 11 | NC | 1.75 | 10 | 5 | 0.66 | 50 | 105 | |
| 2,4-Dimethylphenol | 105-67-9 | Full Scan | 27 | 100 | NC | 13.5 | 10 | 5 | 0.71 | 30 | 110 | |
| 2,4-Dinitrophenol | 51-28-5 | Full Scan | 3 | 19 | NC | 1.5 | 10 | 5 | 2.10 | 15 | 140 | |
| 2,4-Dinitrotoluene | 121-14-2 | Full Scan | 0.2 | 44 | NC | 0.1 | 10 | 5 | 1.03 | 50 | 120 | |
| 2,6-Dinitrotoluene | 606-20-2 | Full Scan | 1.5 | 81 | NC | 0.75 | 10 | 5 | 0.32 | 50 | 115 | |
| 2-Chloronaphthalene | 91-58-7 | Full Scan | 55 | 0.4 | NC | 0.2 | 10 | 5 | 0.16 | 50 | 105 | |
| 2-Chlorophenol | 95-57-8 | Full Scan | 7.1 | 24 | NC | 3.55 | 10 | 5 | 0.54 | 35 | 105 | |
| 2-Methylnaphthalene | 91-57-6 | Full Scan | 2.7 | 330 | NC | 1.35 | 10 | 5 | 0.32 | 45 | 105 | |
| 2-Methylphenol | 95-48-7 | Full Scan | 72 | 13 | NC | 6.5 | 10 | 5 | 0.24 | 40 | 110 | |
| 2-Nitroaniline | 88-74-4 | Full Scan | 15 | NC | NC | 7.5 | 10 | 5 | 0.49 | 50 | 115 | |
| 2-Nitrophenol | 88-75-5 | Full Scan | 7.1 | 1920 | NC | 3.55 | 10 | 5 | 0.52 | 40 | 115 | |
| 3,3'-Dichlorobenzidine | 91-94-1 | Full Scan | 140 | 4.5 | NC | 2.25 | 10 | 5 | 2.00 | 20 | 110 | |
| 3- and 4-Methylphenol | m- & p-CRESOL | Full Scan | 0.11 | 543 | NC | 0.055 | 10 | 5 | 0.38 | 30 | 110 | |
| 3-Nitroaniline | 99-09-2 | Full Scan | NC | NC | NC | N/A | 10 | 5 | 1.09 | 20 | 125 | |
| 4,6-Dinitro-2-methylphenol | 534-52-1 | Full Scan | 0.12 | 2.3 | NC | 0.06 | 10 | 5 | 0.74 | 40 | 130 | |
| 4-Bromophenyl-phenylether | 101-55-3 | Full Scan | NC | 1.5 | NC | 0.75 | 10 | 5 | 0.23 | 50 | 115 | |
| 4-Chloro-3-methylphenol | 59-50-7 | Full Scan | 110 | 0.3 | NC | 0.15 | 10 | 5 | 0.40 | 45 | 110 | |
| 4-Chloroaniline | 106-47-8 | Full Scan | 0.32 | 232 | NC | 0.16 | 10 | 5 | 2.86 | 15 | 110 | |
| 4-Chlorophenyl-phenylether | 7005-72-3 | Full Scan | 2.7 | NC | NC | 1.35 | 10 | 5 | 0.21 | 50 | 110 | |
| 4-Nitroaniline | 100-01-6 | Full Scan | 3.3 | NC | NC | 1.65 | 10 | 5 | 1.36 | 35 | 120 | |
| 4-Nitrophenol | 100-02-7 | Full Scan | 0.12 | 300 | NC | 0.06 | 10 | 5 | 2.00 | 10 | 130 | |
| Acenaphthene | 83-32-9 | Full Scan | 40 | 23 | NC | 11.5 | 10 | 5 | 0.21 | 45 | 110 | |
| Acenaphthylene | 208-96-8 | Full Scan | 40 | 4840 | NC | 20 | 10 | 5 | 0.70 | 50 | 105 | |

Worksheet #15-1b—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater
 Analytical Group: SVOCs including 1,4-dioxane

| Analyte | CAS # | Full Scan or SIM | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|----------------------------|-----------|------------------|--|--|-------------------------|-------------------------------------|--------------------------|------|------|---|-----|-----|
| | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Acetophenone | 98-86-2 | Full Scan | 150 | NC | NC | 75 | 10 | 5 | 0.14 | 64 | 120 | |
| Anthracene | 120-12-7 | 8270 SIM | 130 | 0.73 | NC | 0.365 | 0.10 | 0.05 | 0.02 | 55 | 110 | |
| Atrazine | 1912-24-9 | Full Scan | 0.26 | 1.8 | 3 | 0.13 | 10 | 5 | 0.40 | 53 | 130 | |
| Benzaldehyde | 100-52-7 | Full Scan | 150 | NC | NC | 75 | 10 | 5 | 0.77 | 10 | 109 | |
| Benzo(a)anthracene | 56-55-3 | 8270 SIM | 0.029 | 0.027 | NC | 0.0135 | 0.10 | 0.05 | 0.02 | 55 | 110 | |
| Benzo(a)pyrene | 50-32-8 | 8270 SIM | 0.0029 | 0.014 | 0.2 | 0.00145 | 0.10 | 0.05 | 0.02 | 55 | 110 | |
| Benzo(b)fluoranthene | 205-99-2 | 8270 SIM | 0.029 | 9.07 | NC | 0.0145 | 0.10 | 0.05 | 0.02 | 45 | 120 | |
| Benzo(g,h,i)perylene | 191-24-2 | 8270 SIM | 8.7 | 7.64 | NC | 3.82 | 0.10 | 0.05 | 0.02 | 45 | 125 | |
| Benzo(k)fluoranthene | 207-08-9 | 8270 SIM | 0.29 | 9.07 | NC | 0.145 | 0.10 | 0.05 | 0.02 | 45 | 125 | |
| bis(2-Chloroethoxy)methane | 111-91-1 | Full Scan | 4.6 | NC | NC | 2.3 | 10 | 5 | 0.55 | 45 | 105 | |
| bis(2-Chloroethyl)ether | 111-44-4 | Full Scan | 0.012 | 1900 | NC | 0.006 | 10 | 5 | 0.55 | 35 | 110 | |
| bis(2-Ethylhexyl)phthalate | 117-81-7 | Full Scan | 4.8 | 32 | 6 | 2.4 | 10 | 5 | 0.16 | 40 | 125 | |
| Butylbenzylphthalate | 85-68-7 | Full Scan | 14 | 19 | NC | 7 | 10 | 5 | 0.19 | 45 | 115 | |
| Caprolactam | 105-60-2 | Full Scan | 770 | NC | NC | 385 | 10 | 5 | 2.00 | 10 | 130 | |
| Carbazole | 86-74-8 | Full Scan | NC | NC | NC | N/A | 10 | 5 | 0.22 | 50 | 115 | |
| Chrysene | 218-01-9 | Full Scan | 2.9 | NC | NC | 1.45 | 10 | 5 | 0.18 | 55 | 110 | |
| Dibenz(a,h)anthracene | 53-70-3 | 8270 SIM | 0.0029 | NC | NC | 0.00145 | 0.10 | 0.05 | 0.02 | 40 | 125 | |
| Dibenzofuran | 132-64-9 | Full Scan | 0.58 | 3.7 | NC | 0.29 | 10 | 5 | 0.24 | 55 | 105 | |
| Diethylphthalate | 84-66-2 | Full Scan | 1100 | 270 | NC | 135 | 10 | 5 | 0.38 | 40 | 120 | |
| Dimethyl phthalate | 131-11-3 | Full Scan | NC | 330 | NC | 165 | 10 | 5 | 0.22 | 25 | 125 | |
| Di-n-butylphthalate | 84-74-2 | Full Scan | 67 | 35 | NC | 17.5 | 10 | 5 | 2.00 | 55 | 115 | |
| Di-n-octylphthalate | 117-84-0 | Full Scan | 19 | 22 | NC | 9.5 | 10 | 5 | 0.51 | 35 | 135 | |
| Fluoranthene | 206-44-0 | 8270 SIM | 63 | 8.1 | NC | 4.05 | 0.10 | 0.05 | 0.02 | 55 | 115 | |
| Fluorene | 86-73-7 | 8270 SIM | 22 | 3.9 | NC | 1.95 | 0.10 | 0.05 | 0.02 | 50 | 110 | |
| Hexachlorobenzene | 118-74-1 | Full Scan | 0.042 | 3.68 | 1 | 0.021 | 10 | 5 | 0.18 | 50 | 110 | |
| Hexachlorobutadiene | 87-68-3 | Full Scan | 0.26 | 1.3 | NC | 0.13 | 10 | 5 | 0.25 | 25 | 105 | |
| Hexachlorocyclopentadiene | 77-47-4 | Full Scan | 2.2 | 1.04 | 50 | 0.52 | 10 | 5 | 0.24 | 42 | 121 | |
| Hexachloroethane | 67-72-1 | Full Scan | 0.51 | 12 | NC | 0.255 | 10 | 5 | 0.25 | 30 | 100 | |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | 8270 SIM | 0.029 | 4.31 | NC | 0.0145 | 0.10 | 0.05 | 0.02 | 45 | 125 | |
| Isophorone | 78-59-1 | Full Scan | 67 | 1170 | NC | 33.5 | 10 | 5 | 0.30 | 50 | 110 | |

Worksheet #15-1b—Reference Limits and Evaluation Table (continued)

Matrix: Groundwater
 Analytical Group: SVOCs including 1,4-dioxane

| Analyte | CAS # | Full Scan or SIM | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|----------------------------|----------|------------------|--|--|-------------------------|-------------------------------------|--------------------------|------|------|---|-----|-----|
| | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Naphthalene | 91-20-3 | 8270 SIM | 0.14 | 12 | NC | 0.07 | 0.10 | 0.05 | 0.02 | 40 | 100 | |
| Nitrobenzene | 98-95-3 | Full Scan | 0.12 | 270 | NC | 0.06 | 10 | 5 | 0.68 | 45 | 110 | |
| n-Nitroso-di-n-propylamine | 621-64-7 | Full Scan | 0.0093 | NC | NC | 0.00465 | 10 | 5 | 0.20 | 35 | 130 | |
| n-Nitrosodiphenylamine | 86-30-6 | Full Scan | 10 | 210 | NC | 5 | 10 | 5 | 0.60 | 50 | 110 | |
| Pentachlorophenol | 87-86-5 | Full Scan | 0.035 | 14.954 | 1 | 0.0175 | 10 | 5 | 1.72 | 40 | 115 | |
| Phenanthrene | 85-01-8 | 8270 SIM | 130 | 6.3 | NC | 3.15 | 0.10 | 0.05 | 0.02 | 50 | 115 | |
| Phenol | 108-95-2 | Full Scan | 450 | 110 | NC | 55 | 10 | 5 | 0.21 | 10 | 130 | |
| Pyrene | 129-00-0 | 8270 SIM | 8.7 | 0.025 | NC | 0.0125 | 0.10 | 0.05 | 0.02 | 50 | 130 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

SIM = selected ion monitoring

Worksheet #15-1c—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: Total Metals

| Analyte | CAS # | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | 95% UTLs (Cornwallis Cave Aquifer) ¹ (µg/L) | 95%UTLs (Yorktown-Eastover Aquifer) ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|--------------|-----------|--|--|-------------------------|--|---|-------------------------------------|--------------------------|-----|-------|---|-----|-----|
| | | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Aluminum | 7429-90-5 | 1600 | 87 | NC | 2230 | 2230 | 43.5 | 20 | 10 | 4.97 | 80 | 120 | 20 |
| Antimony | 7440-36-0 | 0.6 | 30 | 6 | NC | NC | 0.3 | 2 | 1 | 0.14 | | | |
| Arsenic | 7440-38-2 | 0.045 | 150 | 10 | 2.28 | 2.28 | 0.0225 | 1 | 0.5 | 0.18 | | | |
| Barium | 7440-39-3 | 290 | 4 | 2000 | 118 | 118 | 2 | 10 | 5 | 0.1 | | | |
| Beryllium | 7440-41-7 | 1.6 | 0.66 | 4 | 2.45 | 2.45 | 0.33 | 1 | 0.5 | 0.09 | | | |
| Cadmium | 7440-43-9 | 0.69 | 0.271 | 5 | 0.605 | 0.605 | 0.1355 | 1 | 0.5 | 0.13 | | | |
| Calcium | 7440-70-2 | NC | NC | NC | 158000 | 169000 | 79000 | 500 | 250 | 9.06 | | | |
| Chromium | 7440-47-3 | 0.031 | 11.4 | 100 | 15.1 | 15.1 | 0.0155 | 2 | 1 | 0.04 | | | |
| Cobalt | 7440-48-4 | 0.47 | 23 | NC | 20.6 | 20.6 | 0.235 | 1 | 0.5 | 0.05 | | | |
| Copper | 7440-50-8 | 62 | 9.329 | 1300 | NC | NC | 4.6645 | 2 | 1 | 0.04 | | | |
| Iron | 7439-89-6 | 1100 | 1000 | NC | 3590 | 894 | 447 | 200 | 100 | 10.28 | | | |
| Lead | 7439-92-1 | 15 | 3.182 | 15 | NC | NC | 1.591 | 1 | 0.5 | 0.04 | | | |
| Magnesium | 7439-95-4 | NC | NC | NC | 3600 | 11500 | 1800 | 500 | 250 | 4.95 | | | |
| Manganese | 7439-96-5 | 32 | 120 | NC | 57.9 | 57.9 | 16 | 1 | 0.5 | 0.05 | | | |
| Mercury | 7439-97-6 | 0.43 | 0.91 | 2 | NC | NC | 0.215 | 0.200 | 0.1 | 0.09 | | | |
| Nickel | 7440-02-0 | 30 | 52.163 | NC | 11.4 | 11.4 | 5.7 | 1 | 0.5 | 0.06 | | | |
| Potassium | 7440-09-7 | NC | NC | NC | 3490 | 12700 | 1745 | 500 | 250 | 12.22 | | | |
| Selenium | 7782-49-2 | 7.8 | 5 | 50 | NC | NC | 2.5 | 5 | 2.5 | 0.7 | | | |
| Silver | 7440-22-4 | 7.1 | 0.36 | NC | NC | NC | 0.18 | 1 | 0.5 | 0.03 | | | |
| Sodium | 7440-23-5 | NC | NC | NC | 9920 | 64500 | 4960 | 500 | 250 | 5.32 | | | |
| Thallium | 7440-28-0 | 0.016 | 12 | 2 | NC | NC | 0.008 | 1 | 0.5 | 0.02 | | | |
| Vanadium | 7440-62-2 | 7.8 | 20 | NC | 26.2 | 26.2 | 3.9 | 5 | 2.5 | 0.15 | | | |
| Zinc | 7440-66-6 | 470 | 119.816 | NC | 4.52 | 4.52 | 2.26 | 2 | 1 | 0.09 | | | |
| Cyanide | 57-12-5 | 0.14 | 5.2 | 200 | NC | NC | 0.07 | 5 | 2.5 | 2.5 | 85 | 115 | |
| Free Cyanide | TBD | 0.14 | 5.2 | 200 | NC | NC | 0.07 | 5 | 2.5 | 2.5 | | | |

Notes:
 Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

TBD indicates that the identifier for free cyanide is TBD.

Worksheet #15-1d—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: Hexavalent Chromium

| Analyte | CAS # | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|---------------------|------------|--|--|-------------------------|-------------------------------------|--------------------------|-----|----|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Hexavalent Chromium | 18540-29-9 | 0.031 | 11.4 | NC | 0.0155 | 10 | 10 | 3 | 70 | 130 | 20 |

Notes:

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-1e—Reference Limits and Evaluation Table

Matrix: Groundwater

Analytical Group: Dissolved Metals

| Analyte | CAS # | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | 95% UTLs (Cornwallis Cave Aquifer) ¹ (µg/L) | 95%UTLs (Yorktown-Eastover Aquifer) ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|-----------|-----------|--|--|-------------------------|--|---|-------------------------------------|--------------------------|-----|-------|---|-----|-----|
| | | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Aluminum | 7429-90-5 | 1600 | 87 | NC | NC | NC | 43.5 | 20 | 10 | 4.97 | 80 | 120 | 20 |
| Antimony | 7440-36-0 | 0.6 | 30 | 6 | NC | NC | 0.3 | 2 | 1 | 0.14 | | | |
| Arsenic | 7440-38-2 | 0.045 | 150 | 10 | 1.37 | 1.37 | 0.0225 | 1 | 0.5 | 0.18 | | | |
| Barium | 7440-39-3 | 290 | 4 | 2000 | 127 | 127 | 2 | 10 | 5 | 0.1 | | | |
| Beryllium | 7440-41-7 | 1.6 | 0.66 | 4 | NC | NC | 0.33 | 1 | 0.5 | 0.09 | | | |
| Cadmium | 7440-43-9 | 0.69 | 0.246 | 5 | 0.177 | 0.177 | 0.0885 | 1 | 0.5 | 0.13 | | | |
| Calcium | 7440-70-2 | NC | NC | NC | 148000 | 113000 | 56500 | 500 | 250 | 9.06 | | | |
| Chromium | 7440-47-3 | 0.031 | 11 | 100 | 6.04 | 6.04 | 0.0155 | 2 | 1 | 0.04 | | | |
| Cobalt | 7440-48-4 | 0.47 | 23 | NC | NC | NC | 0.235 | 1 | 0.5 | 0.05 | | | |
| Copper | 7440-50-8 | 62 | 8.956 | 1300 | NC | NC | 4.478 | 2 | 1 | 0.04 | | | |
| Iron | 7439-89-6 | 1100 | 1000 | NC | 631 | 275 | 137.5 | 200 | 100 | 10.28 | | | |
| Lead | 7439-92-1 | 15 | 2.517 | 15 | NC | NC | 1.2585 | 1 | 0.5 | 0.04 | | | |
| Magnesium | 7439-95-4 | NC | NC | NC | 3880 | 11200 | 1940 | 500 | 250 | 4.95 | | | |
| Manganese | 7439-96-5 | 32 | 120 | NC | 49.5 | 49.5 | 16 | 1 | 0.5 | 0.05 | | | |
| Mercury | 7439-97-6 | 0.43 | 0.77 | 2 | NC | NC | 0.215 | 0.200 | 0.1 | 0.09 | | | |
| Nickel | 7440-02-0 | 30 | 52.007 | NC | NC | NC | 15 | 1 | 0.5 | 0.06 | | | |
| Potassium | 7440-09-7 | NC | NC | NC | 1710 | 12600 | 855 | 500 | 250 | 12.22 | | | |
| Selenium | 7782-49-2 | 7.8 | 4.61 | 50 | NC | NC | 2.305 | 5 | 2.5 | 0.7 | | | |
| Silver | 7440-22-4 | 7.1 | 0.36 | NC | NC | NC | 0.18 | 1 | 0.5 | 0.03 | | | |
| Sodium | 7440-23-5 | NC | NC | NC | 10000 | 62800 | 5000 | 500 | 250 | 5.32 | | | |
| Thallium | 7440-28-0 | 0.016 | 12 | 2 | NC | NC | 0.008 | 1 | 0.5 | 0.02 | | | |
| Vanadium | 7440-62-2 | 7.8 | 20 | NC | NC | NC | 3.9 | 5 | 2.5 | 0.15 | | | |
| Zinc | 7440-66-6 | 470 | 118.139 | NC | NC | NC | 59.0695 | 2 | 1 | 0.09 | | | |

Notes:

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-1f—Reference Limits and Evaluation Table

Matrix: Groundwater
 Analytical Group: Explosives

| Analyte | CAS # | Adjusted Tapwater RSLs ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|--|------------|--|--|-------------------------------------|--------------------------|-----|--------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) | 2691-41-0 | 78 | 330 | 39 | 0.4 | 0.2 | 0.1149 | 80 | 115 | 30 |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | 121-82-4 | 0.61 | 186 | 0.305 | 0.4 | 0.2 | 0.0842 | 50 | 160 | |
| 1,3,5-Trinitrobenzene (1,3,5-TNB) | 99-35-4 | 46 | 11 | 5.5 | 0.4 | 0.2 | 0.0399 | 65 | 140 | |
| 1,3-Dinitrobenzene (1,3-DNB) | 99-65-0 | 0.15 | 17 | 0.075 | 0.4 | 0.2 | 0.0567 | 45 | 160 | |
| Methyl-2,4,6-trinitrophenylnitramine (Tetryl) | 479-45-8 | 6.1 | NC | 3.05 | 0.4 | 0.2 | 0.0734 | 20 | 175 | |
| Nitrobenzene (NB) | 98-95-3 | 0.12 | 270 | 0.06 | 0.4 | 0.2 | 0.0935 | 50 | 140 | |
| 2,4,6-Trinitrotoluene (2,4,6-TNT) | 118-96-7 | 0.76 | 93 | 0.38 | 0.4 | 0.2 | 0.0495 | 50 | 145 | |
| 4-Amino-2,6-dinitrotoluene (4-Am-DNT) | 19406-51-0 | 3 | 19 | 1.5 | 0.4 | 0.2 | 0.0853 | 55 | 155 | |
| 2-Amino-4,6-dinitrotoluene (2-Am-DNT) | 35572-78-2 | 3 | 19 | 1.5 | 0.4 | 0.2 | 0.0675 | 50 | 155 | |
| 2,4-Dinitrotoluene (2,4-DNT) | 121-14-2 | 0.2 | 44 | 0.1 | 0.4 | 0.2 | 0.0743 | 60 | 135 | |
| 2,6-Dinitrotoluene (2,6-DNT) | 606-20-2 | 1.5 | 81 | 0.75 | 0.4 | 0.2 | 0.047 | 60 | 135 | |
| 2-Nitrotoluene (2-NT) | 88-72-2 | 0.27 | 3400 | 0.135 | 0.4 | 0.2 | 0.172 | 45 | 135 | |
| 3-Nitrotoluene (3-NT) | 99-08-1 | 0.13 | 750 | 0.065 | 0.4 | 0.2 | 0.1519 | 50 | 130 | |
| 4-Nitrotoluene (4-NT) | 99-99-0 | 3.7 | 1900 | 1.85 | 0.4 | 0.2 | 0.1668 | 50 | 130 | |
| PETN | 78-11-5 | 3 | 85000 | 1.5 | 10 | 5 | 0.752 | 46 | 143 | |
| Nitroglycerin | 55-63-0 | 0.15 | 138 | 0.075 | 0.2 | 0.1 | 0.026 | 57 | 145 | |
| Perchlorate | 14797-73-0 | 1.1 | 9300 | 0.55 | 0.4 | 0.2 | 0.3318 | 80 | 120 | 15 |

Notes:
 Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

PETN = pentaerythrite tetranitrate

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Worksheet #15-2a—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: VOCs

| Analyte | CAS # | Adjusted Tapwater RSLs x 10 for SW ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|---|----------|--|------------------------------------|--|-----------------------------|-----|------|--|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,1,1-Trichloroethane | 71-55-6 | 7500 | 11 | 5.5 | 1 | 0.5 | 0.40 | 65 | 130 | 30 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 0.66 | 610 | 0.33 | 1 | 0.5 | 0.31 | 80 | 130 | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113) | 76-13-1 | 53000 | NC | 26500 | 1 | 0.5 | 0.45 | 63 | 138 | |
| 1,1,2-Trichloroethane | 79-00-5 | 0.41 | 1200 | 0.205 | 1 | 0.5 | 0.38 | 75 | 125 | |
| 1,1-Dichloroethane | 75-34-3 | 24 | 47 | 12 | 1 | 0.5 | 0.36 | 70 | 135 | |
| 1,1-Dichloroethene | 75-35-4 | 260 | 25 | 12.5 | 1 | 0.5 | 0.47 | 70 | 130 | |
| 1,2,3-Trichlorobenzene | 87-61-6 | 5.2 | 8 | 2.6 | 1 | 0.5 | 0.20 | 55 | 140 | |
| 1,2,4-Trichlorobenzene | 120-82-1 | 3.9 | 110 | 1.95 | 1 | 0.5 | 0.20 | 65 | 135 | |
| 1,2-Dibromo-3-chloropropane | 96-12-8 | 0.0032 | NC | 0.0016 | 1 | 0.5 | 0.46 | 50 | 130 | |
| 1,2-Dibromoethane | 106-93-4 | 0.065 | NC | 0.0325 | 1 | 0.5 | 0.41 | 74 | 129 | |
| 1,2-Dichlorobenzene | 95-50-1 | 280 | 14 | 7 | 1 | 0.5 | 0.45 | 70 | 120 | |
| 1,2-Dichloroethane | 107-06-2 | 1.5 | 910 | 0.75 | 1 | 0.5 | 0.48 | 70 | 130 | |
| 1,2-Dichloropropane | 78-87-5 | 3.8 | 525 | 1.9 | 1 | 0.5 | 0.46 | 75 | 125 | |
| 1,3-Dichlorobenzene | 541-73-1 | NC | 71 | 35.5 | 1 | 0.5 | 0.43 | 75 | 125 | |
| 1,4-Dichlorobenzene | 106-46-7 | 4.2 | 15 | 2.1 | 1 | 0.5 | 0.32 | 75 | 125 | |
| 2-Butanone | 78-93-3 | 4900 | 14000 | 2450 | 5 | 2.5 | 1.32 | 30 | 150 | |
| 2-Hexanone | 591-78-6 | 34 | 99 | 17 | 5 | 2.5 | 1.94 | 55 | 130 | |
| 4-Methyl-2-pentanone | 108-10-1 | 1000 | 170 | 85 | 5 | 2.5 | 2.10 | 60 | 135 | |
| Acetone | 67-64-1 | 12000 | 1500 | 750 | 5 | 2.5 | 0.50 | 40 | 140 | |
| Benzene | 71-43-2 | 3.9 | 130 | 1.95 | 1 | 0.5 | 0.32 | 80 | 120 | |
| Bromochloromethane | 74-97-5 | 83 | NC | 41.5 | 1 | 0.5 | 0.20 | 65 | 130 | |
| Bromodichloromethane | 75-27-4 | 1.2 | NC | 0.6 | 1 | 0.5 | 0.36 | 75 | 120 | |
| Bromoform | 75-25-2 | 79 | 320 | 39.5 | 1 | 0.5 | 0.47 | 70 | 130 | |
| Bromomethane | 74-83-9 | 7 | 110 | 3.5 | 1 | 0.5 | 0.20 | 30 | 145 | |
| Carbon disulfide | 75-15-0 | 720 | 0.92 | 0.46 | 1 | 0.5 | 0.20 | 35 | 160 | |
| Carbon tetrachloride | 56-23-5 | 3.9 | 240 | 1.95 | 1 | 0.5 | 0.20 | 65 | 140 | |
| Chlorobenzene | 108-90-7 | 72 | 64 | 32 | 1 | 0.5 | 0.49 | 80 | 120 | |
| Chloroethane | 75-00-3 | 21000 | NC | 10500 | 1 | 0.5 | 0.20 | 60 | 135 | |
| Chloroform | 67-66-3 | 1.9 | 28 | 0.95 | 1 | 0.5 | 0.34 | 65 | 135 | |
| Chloromethane | 74-87-3 | 190 | 5500 | 95 | 1 | 0.5 | 0.20 | 40 | 125 | |

Worksheet #15-2a—Reference Limits and Evaluation Table (continued)

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: VOCs

| Analyte | CAS # | Adjusted Tapwater RSLs x 10 for SW ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|------------------------------------|---------------|--|------------------------------------|--|-----------------------------|-----|------|--|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| cis-1,2-Dichloroethene | 156-59-2 | 28 | 590 | 14 | 1 | 0.5 | 0.35 | 70 | 125 | |
| cis-1,3-Dichloropropene | 6923-20-2 | 4.1 | 24.4 | 2.05 | 1 | 0.5 | 0.31 | 70 | 130 | |
| Cyclohexane | 110-82-7 | 13000 | NC | 6500 | 1 | 0.5 | 0.20 | 67 | 132 | |
| Dibromochloromethane | 124-48-1 | 1.5 | NC | 0.75 | 1 | 0.5 | 0.20 | 71 | 131 | |
| Dichlorodifluoromethane (Freon-12) | 75-71-8 | 190 | NC | 95 | 1 | 0.5 | 0.20 | 30 | 155 | |
| Ethylbenzene | 100-41-4 | 13 | 290 | 6.5 | 1 | 0.5 | 0.20 | 75 | 125 | |
| Isopropylbenzene | 98-82-8 | 390 | 2.6 | 1.3 | 1 | 0.5 | 0.45 | 75 | 125 | |
| m- and p-Xylene | m- & p-XYLENE | 190 | 13 | 6.5 | 2 | 1 | 0.95 | 75 | 130 | |
| Methyl acetate | 79-20-9 | 16000 | NC | 8000 | 1 | 0.5 | 0.20 | 51 | 158 | |
| Methylcyclohexane | 108-87-2 | NC | NC | N/A | 1 | 0.5 | 0.20 | 71 | 125 | |
| Methylene chloride | 75-09-2 | 84 | 2200 | 42 | 1 | 0.5 | 0.41 | 55 | 140 | |
| Methyl-tert-butyl ether (MTBE) | 1634-04-4 | 120 | 11070 | 60 | 1 | 0.5 | 0.35 | 65 | 125 | |
| o-Xylene | 95-47-6 | 190 | 13 | 6.5 | 1 | 0.5 | 0.43 | 80 | 120 | |
| Styrene | 100-42-5 | 1100 | 72 | 36 | 1 | 0.5 | 0.36 | 65 | 135 | |
| Tetrachloroethene | 127-18-4 | 35 | 98 | 17.5 | 1 | 0.5 | 0.27 | 45 | 150 | |
| Toluene | 108-88-3 | 860 | 9.8 | 4.9 | 1 | 0.5 | 0.37 | 75 | 120 | |
| trans-1,2-Dichloroethene | 156-60-5 | 86 | 590 | 43 | 1 | 0.5 | 0.41 | 60 | 140 | |
| trans-1,3-Dichloropropene | 110-57-6 | 4.1 | 24.4 | 2.05 | 1 | 0.5 | 0.29 | 55 | 140 | |
| Trichloroethene | 79-01-6 | 2.6 | 47 | 1.3 | 1 | 0.5 | 0.28 | 70 | 125 | |
| Trichlorofluoromethane (Freon-11) | 75-69-4 | 1100 | NC | 550 | 1 | 0.5 | 0.35 | 60 | 145 | |
| Vinyl chloride | 75-01-4 | 0.15 | 930 | 0.075 | 1 | 0.5 | 0.34 | 50 | 145 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally, the adjusted RSLs are multiplied by 10 for surface water evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v.4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-2b—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seeps
 Analytical Group: SVOCs including 1,4-dioxane

| Analyte | CAS # | Full Scan or SIM | Adjusted Tapwater RSLs x 10 for Surface Water ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|------------------------------|---------------|------------------|---|---------------------------------|-------------------------------------|--------------------------|------|------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,4-Dioxane (SIM) | 123-91-1 | 8270 SIM | 6.7 | NC | 3.35 | 0.1 | 0.05 | 0.05 | 65 | 117 | 30 |
| 1,1-Biphenyl | 92-52-4 | Full Scan | 0.83 | 14 | 0.415 | 10 | 5 | 0.15 | 60 | 105 | |
| 1,2,4,5-Tetrachlorobenzene | 95-94-3 | Full Scan | 1.2 | 3 | 0.6 | 10 | 5 | 0.20 | 70 | 130 | |
| 2,2'-Oxybis(1-chloropropane) | 108-60-1 | Full Scan | 3.1 | NC | 1.55 | 10 | 5 | 0.17 | 60 | 113 | |
| 2,3,4,6-Tetrachlorophenol | 58-90-2 | Full Scan | 170 | 1.2 | 0.6 | 10 | 5 | 5 | 66 | 110 | |
| 2,4,5-Trichlorophenol | 95-95-4 | Full Scan | 890 | 63 | 31.5 | 10 | 5 | 0.40 | 50 | 110 | |
| 2,4,6-Trichlorophenol | 88-06-2 | Full Scan | 9 | 4.9 | 2.45 | 10 | 5 | 0.56 | 50 | 115 | |
| 2,4-Dichlorophenol | 120-83-2 | Full Scan | 35 | 11 | 5.5 | 10 | 5 | 0.66 | 50 | 105 | |
| 2,4-Dimethylphenol | 105-67-9 | Full Scan | 270 | 100 | 50 | 10 | 5 | 0.71 | 30 | 110 | |
| 2,4-Dinitrophenol | 51-28-5 | Full Scan | 30 | 19 | 9.5 | 10 | 5 | 2.10 | 15 | 140 | |
| 2,4-Dinitrotoluene | 121-14-2 | Full Scan | 2 | 44 | 1 | 10 | 5 | 1.03 | 50 | 120 | |
| 2,6-Dinitrotoluene | 606-20-2 | Full Scan | 15 | 81 | 7.5 | 10 | 5 | 0.32 | 50 | 115 | |
| 2-Chloronaphthalene | 91-58-7 | Full Scan | 550 | 0.4 | 0.2 | 10 | 5 | 0.16 | 50 | 105 | |
| 2-Chlorophenol | 95-57-8 | Full Scan | 71 | 24 | 12 | 10 | 5 | 0.54 | 35 | 105 | |
| 2-Methylnaphthalene | 91-57-6 | Full Scan | 27 | 330 | 13.5 | 10 | 5 | 0.32 | 45 | 105 | |
| 2-Methylphenol | 95-48-7 | Full Scan | 720 | 13 | 6.5 | 10 | 5 | 0.24 | 40 | 110 | |
| 2-Nitroaniline | 88-74-4 | Full Scan | 150 | NC | 75 | 10 | 5 | 0.49 | 50 | 115 | |
| 2-Nitrophenol | 88-75-5 | Full Scan | 71 | 1920 | 35.5 | 10 | 5 | 0.52 | 40 | 115 | |
| 3,3'-Dichlorobenzidine | 91-94-1 | Full Scan | 1.1 | 4.5 | 0.55 | 10 | 5 | 2.00 | 20 | 110 | |
| 3- and 4-Methylphenol | m- & p-CRESOL | Full Scan | 1400 | 543 | 271.5 | 10 | 5 | 0.38 | 30 | 110 | |
| 3-Nitroaniline | 99-09-2 | Full Scan | NC | NC | N/A | 10 | 5 | 1.09 | 20 | 125 | |
| 4,6-Dinitro-2-methylphenol | 534-52-1 | Full Scan | 1.2 | 2.3 | 0.6 | 10 | 5 | 0.74 | 40 | 130 | |
| 4-Bromophenyl-phenylether | 101-55-3 | Full Scan | NC | 1.5 | 0.75 | 10 | 5 | 0.23 | 50 | 115 | |
| 4-Chloro-3-methylphenol | 59-50-7 | Full Scan | 1100 | 0.3 | 0.15 | 10 | 5 | 0.40 | 45 | 110 | |
| 4-Chloroaniline | 106-47-8 | Full Scan | 3.2 | 232 | 1.6 | 10 | 5 | 2.86 | 15 | 110 | |
| 4-Chlorophenyl-phenylether | 7005-72-3 | Full Scan | 27 | NC | 13.5 | 10 | 5 | 0.21 | 50 | 110 | |
| 4-Nitroaniline | 100-01-6 | Full Scan | 33 | NC | 16.5 | 10 | 5 | 1.36 | 35 | 120 | |
| 4-Nitrophenol | 100-02-7 | Full Scan | 1.2 | 300 | 0.6 | 10 | 5 | 2.00 | 10 | 130 | |
| Acenaphthene | 83-32-9 | Full Scan | 400 | 23 | 11.5 | 10 | 5 | 0.21 | 45 | 110 | |
| Acenaphthylene | 208-96-8 | Full Scan | 400 | 4840 | 200 | 10 | 5 | 0.70 | 50 | 105 | |

Worksheet #15-2b—Reference Limits and Evaluation Table (continued)

Matrix: Surface Water, Pore Water, Seeps
 Analytical Group: SVOCs including 1,4-dioxane

| Analyte | CAS # | Full Scan or SIM | Adjusted Tapwater RSLs x 10 for SW ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|----------------------------|-----------|------------------|--|---------------------------------|-------------------------------------|--------------------------|------|------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Acetophenone | 98-86-2 | Full Scan | 1500 | NC | 750 | 10 | 5 | 0.14 | 64 | 120 | |
| Anthracene | 120-12-7 | 8270 SIM | 1300 | 0.73 | 0.365 | 0.10 | 0.05 | 0.02 | 55 | 110 | |
| Atrazine | 1912-24-9 | Full Scan | 2.6 | 1.8 | 0.9 | 10 | 5 | 0.40 | 53 | 130 | |
| Benzaldehyde | 100-52-7 | Full Scan | 1500 | NC | 750 | 10 | 5 | 0.77 | 10 | 109 | |
| Benzo(a)anthracene | 56-55-3 | 8270 SIM | 0.29 | 0.027 | 0.0135 | 0.10 | 0.05 | 0.02 | 55 | 110 | |
| Benzo(a)pyrene | 50-32-8 | 8270 SIM | 0.029 | 0.014 | 0.007 | 0.10 | 0.05 | 0.02 | 55 | 110 | |
| Benzo(b)fluoranthene | 205-99-2 | 8270 SIM | 0.29 | 9.07 | 0.145 | 0.10 | 0.05 | 0.02 | 45 | 120 | |
| Benzo(g,h,i)perylene | 191-24-2 | 8270 SIM | 87 | 7.64 | 3.82 | 0.10 | 0.05 | 0.02 | 45 | 125 | |
| Benzo(k)fluoranthene | 207-08-9 | 8270 SIM | 2.9 | 9.07 | 1.45 | 0.10 | 0.05 | 0.02 | 45 | 125 | |
| bis(2-Chloroethoxy)methane | 111-91-1 | Full Scan | 46 | NC | 23 | 10 | 5 | 0.55 | 45 | 105 | |
| bis(2-Chloroethyl)ether | 111-44-4 | Full Scan | 0.12 | 1900 | 0.06 | 10 | 5 | 0.55 | 35 | 110 | |
| bis(2-Ethylhexyl)phthalate | 117-81-7 | Full Scan | 48 | 32 | 16 | 10 | 5 | 0.16 | 40 | 125 | |
| Butylbenzylphthalate | 85-68-7 | Full Scan | 140 | 19 | 9.5 | 10 | 5 | 0.19 | 45 | 115 | |
| Caprolactam | 105-60-2 | Full Scan | 7700 | NC | 3850 | 10 | 5 | 2.00 | 10 | 130 | |
| Carbazole | 86-74-8 | Full Scan | NC | NC | N/A | 10 | 5 | 0.22 | 50 | 115 | |
| Chrysene | 218-01-9 | Full Scan | 29 | NC | 14.5 | 10 | 5 | 0.18 | 55 | 110 | |
| Dibenz(a,h)anthracene | 53-70-3 | 8270 SIM | 0.029 | NC | 0.0145 | 0.10 | 0.05 | 0.02 | 40 | 125 | |
| Dibenzofuran | 132-64-9 | Full Scan | 5.8 | 3.7 | 1.85 | 10 | 5 | 0.24 | 55 | 105 | |
| Diethylphthalate | 84-66-2 | Full Scan | 11000 | 270 | 135 | 10 | 5 | 0.38 | 40 | 120 | |
| Dimethyl phthalate | 131-11-3 | Full Scan | NC | 330 | 165 | 10 | 5 | 0.22 | 25 | 125 | |
| Di-n-butylphthalate | 84-74-2 | Full Scan | 670 | 35 | 17.5 | 10 | 5 | 2.00 | 55 | 115 | |
| Di-n-octylphthalate | 117-84-0 | Full Scan | 190 | 22 | 11 | 10 | 5 | 0.51 | 35 | 135 | |
| Fluoranthene | 206-44-0 | 8270 SIM | 630 | 8.1 | 4.05 | 0.10 | 0.05 | 0.02 | 55 | 115 | |
| Fluorene | 86-73-7 | 8270 SIM | 220 | 3.9 | 1.95 | 0.10 | 0.05 | 0.02 | 50 | 110 | |
| Hexachlorobenzene | 118-74-1 | Full Scan | 0.42 | 3.68 | 0.21 | 10 | 5 | 0.18 | 50 | 110 | |
| Hexachlorobutadiene | 87-68-3 | Full Scan | 2.6 | 1.3 | 0.65 | 10 | 5 | 0.25 | 25 | 105 | |
| Hexachlorocyclopentadiene | 77-47-4 | Full Scan | 22 | 1.04 | 0.52 | 10 | 5 | 0.24 | 42 | 121 | |
| Hexachloroethane | 67-72-1 | Full Scan | 5.1 | 12 | 2.55 | 10 | 5 | 0.25 | 30 | 100 | |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | 8270 SIM | 0.29 | 4.31 | 0.145 | 0.10 | 0.05 | 0.02 | 45 | 125 | |
| Isophorone | 78-59-1 | Full Scan | 670 | 1170 | 335 | 10 | 5 | 0.30 | 50 | 110 | |
| Naphthalene | 91-20-3 | 8270 SIM | 1.4 | 12 | 0.7 | 0.10 | 0.05 | 0.02 | 40 | 100 | |

Worksheet #15-2b—Reference Limits and Evaluation Table (continued)

Matrix: Surface Water, Pore Water, Seeps
 Analytical Group: SVOCs including 1,4-dioxane

| Analyte | CAS # | Full Scan or SIM | Adjusted Tapwater RSLs x 10 for SW ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|----------------------------|----------|------------------|--|---------------------------------|-------------------------------------|--------------------------|------|------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Nitrobenzene | 98-95-3 | Full Scan | 1.2 | 270 | 0.6 | 10 | 5 | 0.68 | 45 | 110 | |
| n-Nitroso-di-n-propylamine | 621-64-7 | Full Scan | 0.093 | NC | 0.0465 | 10 | 5 | 0.20 | 35 | 130 | |
| n-Nitrosodiphenylamine | 86-30-6 | Full Scan | 100 | 210 | 50 | 10 | 5 | 0.60 | 50 | 110 | |
| Pentachlorophenol | 87-86-5 | Full Scan | 0.35 | 14.954 | 0.175 | 10 | 5 | 1.72 | 40 | 115 | |
| Phenanthrene | 85-01-8 | 8270 SIM | 1300 | 6.3 | 3.15 | 0.10 | 0.05 | 0.02 | 50 | 115 | |
| Phenol | 108-95-2 | Full Scan | 4500 | 110 | 55 | 10 | 5 | 0.21 | 10 | 130 | |
| Pyrene | 129-00-0 | 8270 SIM | 87 | 0.025 | 0.0125 | 0.10 | 0.05 | 0.02 | 50 | 130 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally, the adjusted RSLs are multiplied by 10 for surface water evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-2c—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: Total Metals

| Analyte | CAS # | Adjusted Tapwater RSLs x 10 for Surface Water ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|--------------|-----------|---|---------------------------------|-------------------------------------|--------------------------|-----|-------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Aluminum | 7429-90-5 | 16000 | 87 | 43.5 | 20 | 10 | 4.97 | 80 | 120 | 20 |
| Antimony | 7440-36-0 | 6 | 30 | 1.2 | 2 | 1 | 0.14 | | | |
| Arsenic | 7440-38-2 | 0.45 | 150 | 0.09 | 1 | 0.5 | 0.18 | | | |
| Barium | 7440-39-3 | 2900 | 4 | 0.8 | 10 | 5 | 0.1 | | | |
| Beryllium | 7440-41-7 | 16 | 0.66 | 0.132 | 1 | 0.5 | 0.09 | | | |
| Cadmium | 7440-43-9 | 6.9 | 0.271 | 0.0542 | 1 | 0.5 | 0.13 | | | |
| Calcium | 7440-70-2 | NC | NC | N/A | 500 | 250 | 9.06 | | | |
| Chromium | 7440-47-3 | 0.31 | 11.4 | 0.062 | 2 | 1 | 0.04 | | | |
| Cobalt | 7440-48-4 | 4.7 | 23 | 0.94 | 1 | 0.5 | 0.05 | | | |
| Copper | 7440-50-8 | 620 | 9.329 | 1.8658 | 2 | 1 | 0.04 | | | |
| Iron | 7439-89-6 | 11000 | 1000 | 200 | 200 | 100 | 10.28 | | | |
| Lead | 7439-92-1 | 15 | 3.182 | 0.6364 | 1 | 0.5 | 0.04 | | | |
| Magnesium | 7439-95-4 | NC | NC | N/A | 500 | 250 | 4.95 | | | |
| Manganese | 7439-96-5 | 320 | 120 | 24 | 1 | 0.5 | 0.05 | | | |
| Mercury | 7439-97-6 | 4.3 | 0.91 | 0.182 | 0.200 | 0.1 | 0.09 | | | |
| Nickel | 7440-02-0 | 300 | 52.163 | 10.4326 | 1 | 0.5 | 0.06 | | | |
| Potassium | 7440-09-7 | NC | NC | N/A | 500 | 250 | 12.22 | | | |
| Selenium | 7782-49-2 | 78 | 5 | 1 | 5 | 2.5 | 0.7 | | | |
| Silver | 7440-22-4 | 71 | 0.36 | 0.072 | 1 | 0.5 | 0.03 | | | |
| Sodium | 7440-23-5 | NC | NC | N/A | 500 | 250 | 5.32 | | | |
| Thallium | 7440-28-0 | 0.16 | 12 | 0.032 | 1 | 0.5 | 0.02 | | | |
| Vanadium | 7440-62-2 | 78 | 20 | 4 | 5 | 2.5 | 0.15 | | | |
| Zinc | 7440-66-6 | 4700 | 119.816 | 23.9632 | 2 | 1 | 0.09 | | | |
| Cyanide | 57-12-5 | 1.4 | 5.2 | 0.28 | 5 | 2.5 | 2.5 | 85 | 115 | |
| Free Cyanide | TBD | 1.4 | 5.2 | 0.28 | 5 | 2.5 | 2.5 | | | |

Notes:

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally the adjusted RSLs are multiplied by 10 for surface water evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

TBD indicates that the identifier for free cyanide is TBD.

Worksheet #15-2d—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: Hexavalent Chromium

| Analyte | CAS # | Adjusted Tapwater RSLs x 10 for Surface Water ¹ (µg/L) | Fresh Surface Water ESVs ¹ (µg/L) | MCL ¹ (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|---------------------|------------|---|--|-------------------------|-------------------------------------|--------------------------|-----|----|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Hexavalent Chromium | 18540-29-9 | 0.31 | 11.4 | NC | 0.0155 | 10 | 10 | 3 | 70 | 130 | 20 |

Notes:

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-2e—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: Dissolved Metals

| Analyte | CAS # | Adjusted Tapwater RSLs x 10 for Surface Water ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|-----------|-----------|---|---------------------------------|-------------------------------------|--------------------------|-----|-------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Aluminum | 7429-90-5 | 16000 | 87 | 43.5 | 20 | 10 | 4.97 | 80 | 120 | 20 |
| Antimony | 7440-36-0 | 6 | 30 | 3 | 2 | 1 | 0.14 | | | |
| Arsenic | 7440-38-2 | 0.45 | 150 | 0.225 | 1 | 0.5 | 0.18 | | | |
| Barium | 7440-39-3 | 2900 | 4 | 2 | 10 | 5 | 0.1 | | | |
| Beryllium | 7440-41-7 | 16 | 0.66 | 0.33 | 1 | 0.5 | 0.09 | | | |
| Cadmium | 7440-43-9 | 6.9 | 0.246 | 0.123 | 1 | 0.5 | 0.13 | | | |
| Calcium | 7440-70-2 | NC | NC | N/A | 500 | 250 | 9.06 | | | |
| Chromium | 7440-47-3 | 0.31 | 11 | 0.155 | 2 | 1 | 0.04 | | | |
| Cobalt | 7440-48-4 | 4.7 | 23 | 2.35 | 1 | 0.5 | 0.05 | | | |
| Copper | 7440-50-8 | 620 | 8.956 | 4.478 | 2 | 1 | 0.04 | | | |
| Iron | 7439-89-6 | 11000 | 1000 | 500 | 200 | 100 | 10.28 | | | |
| Lead | 7439-92-1 | 15 | 2.517 | 1.2585 | 1 | 0.5 | 0.04 | | | |
| Magnesium | 7439-95-4 | NC | NC | N/A | 500 | 250 | 4.95 | | | |
| Manganese | 7439-96-5 | 320 | 120 | 60 | 1 | 0.5 | 0.05 | | | |
| Mercury | 7439-97-6 | 4.3 | 0.77 | 0.385 | 0.200 | 0.1 | 0.09 | | | |
| Nickel | 7440-02-0 | 300 | 52.007 | 26.0035 | 1 | 0.5 | 0.06 | | | |
| Potassium | 7440-09-7 | NC | NC | N/A | 500 | 250 | 12.22 | | | |
| Selenium | 7782-49-2 | 78 | 4.61 | 2.305 | 5 | 2.5 | 0.7 | | | |
| Silver | 7440-22-4 | 71 | 0.36 | 0.18 | 1 | 0.5 | 0.03 | | | |
| Sodium | 7440-23-5 | NC | NC | N/A | 500 | 250 | 5.32 | | | |
| Thallium | 7440-28-0 | 0.16 | 12 | 0.08 | 1 | 0.5 | 0.02 | | | |
| Vanadium | 7440-62-2 | 78 | 20 | 10 | 5 | 2.5 | 0.15 | | | |
| Zinc | 7440-66-6 | 4700 | 118.139 | 59.0695 | 2 | 1 | 0.09 | | | |

Notes:

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally the adjusted RSLs are multiplied by 10 for surface water evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-2f—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: Explosives

| Analyte | CAS # | Adjusted Tapwater RSLs x 10 ¹ for SW ¹ (µg/L) | Fresh Surface Water ESVs (µg/L) | Project QL Goal ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|--|------------|---|---------------------------------|-------------------------------------|--------------------------|-----|--------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) | 2691-41-0 | 780 | 330 | 66 | 0.4 | 0.2 | 0.1149 | 80 | 115 | 30 |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | 121-82-4 | 6.1 | 186 | 1.22 | 0.4 | 0.2 | 0.0842 | 50 | 160 | |
| 1,3,5-Trinitrobenzene (1,3,5-TNB) | 99-35-4 | 460 | 11 | 2.2 | 0.4 | 0.2 | 0.0399 | 65 | 140 | |
| 1,3-Dinitrobenzene (1,3-DNB) | 99-65-0 | 1.5 | 17 | 0.3 | 0.4 | 0.2 | 0.0567 | 45 | 160 | |
| Methyl-2,4,6-trinitrophenylnitramine (Tetryl) | 479-45-8 | 61 | NC | 12.2 | 0.4 | 0.2 | 0.0734 | 20 | 175 | |
| Nitrobenzene (NB) | 98-95-3 | 1.2 | 270 | 0.24 | 0.4 | 0.2 | 0.0935 | 50 | 140 | |
| 2,4,6-Trinitrotoluene (2,4,6-TNT) | 118-96-7 | 7.6 | 93 | 1.52 | 0.4 | 0.2 | 0.0495 | 50 | 145 | |
| 4-Amino-2,6-dinitrotoluene (4-Am-DNT) | 19406-51-0 | 30 | 19 | 3.8 | 0.4 | 0.2 | 0.0853 | 55 | 155 | |
| 2-Amino-4,6-dinitrotoluene (2-Am-DNT) | 35572-78-2 | 30 | 19 | 3.8 | 0.4 | 0.2 | 0.0675 | 50 | 155 | |
| 2,4-Dinitrotoluene (2,4-DNT) | 121-14-2 | 2 | 44 | 0.4 | 0.4 | 0.2 | 0.0743 | 60 | 135 | |
| 2,6-Dinitrotoluene (2,6-DNT) | 606-20-2 | 15 | 81 | 3 | 0.4 | 0.2 | 0.047 | 60 | 135 | |
| 2-Nitrotoluene (2-NT) | 88-72-2 | 2.7 | 3400 | 0.54 | 0.4 | 0.2 | 0.172 | 45 | 135 | |
| 3-Nitrotoluene (3-NT) | 99-08-1 | 1.3 | 750 | 0.26 | 0.4 | 0.2 | 0.1519 | 50 | 130 | |
| 4-Nitrotoluene (4-NT) | 99-99-0 | 37 | 1900 | 7.4 | 0.4 | 0.2 | 0.1668 | 50 | 130 | |
| PETN | 78-11-5 | 30 | 85000 | 6 | 0.4 | 0.2 | 0.3318 | 46 | 143 | |
| Nitroglycerin | 55-63-0 | 1.5 | 138 | 0.3 | 10 | 5 | 0.752 | 57 | 145 | |
| Perchlorate | 14797-73-0 | 11 | 9300 | 2.2 | 0.2 | 0.1 | 0.026 | 80 | 120 | 15 |

Notes:

Shading indicates instances where the PAL is lower than the LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally the adjusted RSLs are multiplied by 10 for surface water evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.1 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-2g—Reference Limits and Evaluation Table

Matrix: Surface Water, Pore Water, Seeps

Analytical Group: Wet Chemistry

| Analyte | CAS # | Project Indicator Level (PIL) ² (µg/L) | Laboratory Limits (µg/L) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|----------|----------|---|--------------------------|-------|-------|---|-----|-----|
| | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Hardness | HARDNESS | 25,000 | 6.615 | 6.615 | 6.615 | N/A | N/A | N/A |

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. The screening values used will be the most currently published values available during data evaluation.

² There are no action limits for wet chemistry analytes because they are screening data. PILs are approximate threshold values for results that will help support the ERA.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits.

Worksheet #15-3a—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: VOCs including 1,4-dioxane

| Analyte | CAS # | Adjusted Residential Soil RSLs ¹ (µg/kg) | Soil ESVs ¹ (µg/kg) | Risk-Based SSLs ¹ (µg/kg) | MCL-Based SSLs ¹ (µg/kg) | Project QL Goal ² (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|---|----------|---|--------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|---------------------------|------|------|---|-----|-----|
| | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,1,1-Trichloroethane | 71-55-6 | 640000 | 1025 | 2600 | 70 | 35 | 5 | 2.5 | 0.88 | 70 | 135 | 30 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 560 | 5000 | 0.026 | NC | 0.013 | 5 | 2.5 | 0.46 | 75 | 125 | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113) | 76-13-1 | 910000 | NC | 130000 | NC | 65000 | 5 | 2.5 | 1.33 | 60 | 138 | |
| 1,1,2-Trichloroethane | 79-00-5 | 160 | 2000 | 0.077 | 1.6 | 0.0385 | 5 | 2.5 | 0.90 | 60 | 125 | |
| 1,1-Dichloroethane | 75-34-3 | 3300 | 548 | 0.68 | NC | 0.34 | 5 | 2.5 | 0.94 | 75 | 125 | |
| 1,1-Dichloroethene | 75-35-4 | 24000 | 173 | 93 | 2.5 | 1.25 | 5 | 2.5 | 1.47 | 65 | 135 | |
| 1,2,3-Trichlorobenzene | 87-61-6 | 4900 | 1150 | 15 | NC | 7.5 | 5 | 2.5 | 0.50 | 60 | 135 | |
| 1,2,4-Trichlorobenzene | 120-82-1 | 6200 | 1270 | 2.9 | 200 | 1.45 | 5 | 2.5 | 0.70 | 65 | 130 | |
| 1,2-Dibromo-3-chloropropane | 96-12-8 | 5.4 | NC | 0.00014 | 0.086 | 0.00007 | 5 | 2.5 | 0.87 | 40 | 135 | |
| 1,2-Dibromoethane | 106-93-4 | 34 | 300 | 0.0018 | 0.014 | 0.0009 | 5 | 2.5 | 0.64 | 70 | 125 | |
| 1,2-Dichlorobenzene | 95-50-1 | 190000 | 1000 | 270 | 580 | 135 | 5 | 2.5 | 0.62 | 75 | 120 | |
| 1,2-Dichloroethane | 107-06-2 | 430 | 21900 | 0.042 | 1.4 | 0.021 | 5 | 2.5 | 0.64 | 70 | 135 | |
| 1,2-Dichloropropane | 78-87-5 | 940 | 38800 | 0.13 | 1.7 | 0.065 | 5 | 2.5 | 0.26 | 70 | 120 | |
| 1,3-Dichlorobenzene | 541-73-1 | NC | 1000 | NC | NC | 500 | 5 | 2.5 | 0.37 | 70 | 125 | |
| 1,4-Dichlorobenzene | 106-46-7 | 2400 | 1280 | 0.4 | 72 | 0.2 | 5 | 2.5 | 0.41 | 70 | 125 | |
| 1,4-Dioxane | 123-91-1 | 4900 | NC | 0.14 | NC | 0.07 | 100 | 50 | 50 | 15 | 117 | |
| 2-Butanone | 78-93-3 | 2800000 | NC | 1000 | NC | 500 | 25 | 12.5 | 3.11 | 30 | 160 | |
| 2-Hexanone | 591-78-6 | 21000 | NC | 7.9 | NC | 3.95 | 25 | 12.5 | 3.92 | 45 | 145 | |
| 4-Methyl-2-pentanone | 108-10-1 | 530000 | NC | 230 | NC | 115 | 25 | 12.5 | 2.92 | 45 | 145 | |
| Acetone | 67-64-1 | 6100000 | NC | 2400 | NC | 1200 | 25 | 12.5 | 3.02 | 20 | 160 | |
| Benzene | 71-43-2 | 1100 | 1140 | 0.2 | 2.6 | 0.1 | 5 | 2.5 | 0.38 | 75 | 125 | |
| Bromochloromethane | 74-97-5 | 16000 | NC | 21 | NC | 10.5 | 5 | 2.5 | 0.79 | 70 | 125 | |
| Bromodichloromethane | 75-27-4 | 270 | NC | 0.032 | 22 | 0.016 | 5 | 2.5 | 0.62 | 70 | 130 | |
| Bromoform | 75-25-2 | 62000 | 300 | 2.1 | 21 | 1.05 | 5 | 2.5 | 0.74 | 55 | 135 | |
| Bromomethane | 74-83-9 | 730 | NC | 1.8 | NC | 0.9 | 5 | 2.5 | 2.45 | 30 | 160 | |
| Carbon disulfide | 75-15-0 | 82000 | NC | 210 | NC | 105 | 5 | 2.5 | 1.06 | 45 | 160 | |
| Carbon tetrachloride | 56-23-5 | 610 | 3400 | 0.15 | 1.9 | 0.075 | 5 | 2.5 | 0.99 | 65 | 135 | |
| Chlorobenzene | 108-90-7 | 29000 | 2400 | 49 | 68 | 24.5 | 5 | 2.5 | 0.50 | 75 | 125 | |
| Chloroethane | 75-00-3 | 1500000 | 5000 | 5900 | NC | 2500 | 5 | 2.5 | 1.40 | 40 | 155 | |
| Chloroform | 67-66-3 | 290 | 1844 | 0.053 | 22 | 0.0265 | 5 | 2.5 | 0.74 | 70 | 125 | |

Worksheet #15-3a—Reference Limits and Evaluation Table (continued)

Matrix: Surface Soil, Subsurface Soil
 Analytical Group: VOCs including 1,4-dioxane

| Analyte | CAS # | Adjusted Residential Soil RSLs ¹ (µg/kg) | Soil ESVs ¹ (µg/kg) | Risk-Based SSLs ¹ (µg/kg) | MCL-Based SSLs ¹ (µg/kg) | Project QL Goal ² (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|------------------------------------|------------|---|--------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|---------------------------|-----|------|---|-----|-----|
| | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Chloromethane | 74-87-3 | 1200 | 5000 | 49 | NC | 24.5 | 5 | 2.5 | 0.86 | 50 | 130 | |
| cis-1,2-Dichloroethene | 156-59-2 | 1600 | 447 | 8.2 | 21 | 4.1 | 5 | 2.5 | 0.89 | 65 | 125 | |
| cis-1,3-Dichloropropene | 10061-01-5 | 1700 | 5000 | 0.15 | NC | 0.075 | 5 | 2.5 | 0.72 | 70 | 125 | |
| Cyclohexane | 110-82-7 | 120000 | 6000 | 13000 | NC | 3000 | 5 | 2.5 | 1.01 | 66 | 132 | |
| Dibromochloromethane | 124-48-1 | 680 | NC | 0.039 | 21 | 0.0195 | 5 | 2.5 | 0.54 | 73 | 126 | |
| Dichlorodifluoromethane (Freon-12) | 75-71-8 | 9400 | NC | 300 | NC | 150 | 5 | 2.5 | 0.65 | 35 | 135 | |
| Ethylbenzene | 100-41-4 | 5400 | 1815 | 1.5 | 780 | 0.75 | 5 | 2.5 | 0.62 | 75 | 125 | |
| Isopropylbenzene | 98-82-8 | 210000 | NC | 640 | NC | 320 | 5 | 2.5 | 0.48 | 75 | 130 | |
| m- and p-Xylene | m&pXYLENE | 59000 | 1300 | 180 | NC | 90 | 10 | 5.0 | 0.72 | 80 | 125 | |
| Methyl acetate | 79-20-9 | 7800000 | NC | 3200 | NC | 1600 | 5 | 2.5 | 1.51 | 44 | 187 | |
| Methylcyclohexane | 108-87-2 | NC | NC | NC | NC | Lab LOD | 5 | 2.5 | 1.06 | 71 | 124 | |
| Methylene chloride | 75-09-2 | 36000 | 1250 | 2.5 | 1.3 | 0.65 | 5 | 2.5 | 1.42 | 55 | 140 | |
| Methyl-tert-butyl ether (MTBE) | 1634-04-4 | 43000 | NC | 2.8 | NC | 1.4 | 5 | 2.5 | 0.96 | 76 | 123 | |
| o-Xylene | 95-47-6 | 69000 | 1300 | 190 | NC | 95 | 5 | 2.5 | 0.68 | 75 | 125 | |
| Styrene | 100-42-5 | 630000 | 64000 | 1200 | 110 | 55 | 5 | 2.5 | 0.45 | 75 | 125 | |
| Tetrachloroethene | 127-18-4 | 8600 | 179 | 4.4 | 2.3 | 1.15 | 5 | 2.5 | 1.01 | 65 | 140 | |
| Toluene | 108-88-3 | 500000 | 40000 | 590 | 690 | 295 | 5 | 2.5 | 0.64 | 70 | 125 | |
| trans-1,2-Dichloroethene | 156-60-5 | 15000 | 447 | 25 | 29 | 12.5 | 5 | 2.5 | 0.69 | 65 | 135 | |
| trans-1,3-Dichloropropene | 10061-02-6 | 1700 | 500 | 0.15 | NC | 0.075 | 5 | 2.5 | 0.79 | 65 | 125 | |
| Trichloroethene | 79-01-6 | 440 | 500 | 0.16 | 1.8 | 0.08 | 5 | 2.5 | 0.86 | 75 | 125 | |
| Trichlorofluoromethane (Freon-11) | 75-69-4 | 79000 | NC | 690 | NC | 345 | 5 | 2.5 | 1.32 | 25 | 185 | |
| Vinyl chloride | 75-01-4 | 60 | 412 | 0.0053 | 0.69 | 0.00265 | 5 | 2.5 | 1.23 | 60 | 125 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-3b—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: SVOCs

| Analyte | CAS # | Full Scan or SIM | Adjusted Residential Soil RSLs ¹ (µg/kg) | Soil ESVs ^{1,2} (µg/kg) | Risk-Based SSLs ¹ (µg/kg) | MCL-Based SSLs ¹ (µg/kg) | Project QL Goal ³ (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ⁴ (%) | | |
|------------------------------|---------------|------------------|---|----------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|---------------------------|-----|-------|---|-----|-----|
| | | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,1-Biphenyl | 92-52-4 | Full Scan | 5100 | 13600 | 8.7 | NC | 4.35 | 330 | 170 | 12.6 | 56 | 107 | 30 |
| 1,2,4,5-Tetrachlorobenzene | 95-94-3 | Full Scan | 1800 | 1000 | 5.8 | NC | 2.9 | 330 | 170 | 13.1 | 33 | 136 | |
| 2,2'-Oxybis(1-chloropropane) | 108-60-1 | Full Scan | 4600 | NC | 0.11 | NC | 0.055 | 330 | 170 | 13.8 | 52 | 104 | |
| 2,3,4,6-Tetrachlorophenol | 58-90-2 | Full Scan | 180000 | 500 | 1100 | NC | 250 | 330 | 170 | 12.07 | 47 | 120 | |
| 2,4,5-Trichlorophenol | 95-95-4 | Full Scan | 610000 | 1350 | 3300 | NC | 675 | 330 | 170 | 23.4 | 50 | 110 | |
| 2,4,6-Trichlorophenol | 88-06-2 | Full Scan | 6100 | 580 | 13 | NC | 6.5 | 330 | 170 | 10.2 | 45 | 110 | |
| 2,4-Dichlorophenol | 120-83-2 | Full Scan | 18000 | 500 | 41 | NC | 20.5 | 330 | 170 | 12.7 | 45 | 110 | |
| 2,4-Dimethylphenol | 105-67-9 | Full Scan | 120000 | 1000 | 320 | NC | 160 | 330 | 170 | 18.9 | 30 | 105 | |
| 2,4-Dinitrophenol | 51-28-5 | Full Scan | 12000 | 20000 | 34 | NC | 17 | 330 | 170 | 33.9 | 15 | 130 | |
| 2,4-Dinitrotoluene | 121-14-2 | Full Scan | 1600 | 11000 | 0.28 | NC | 0.14 | 330 | 170 | 10.1 | 50 | 115 | |
| 2,6-Dinitrotoluene | 606-20-2 | Full Scan | 6100 | 8500 | 20 | NC | 10 | 330 | 170 | 13.6 | 50 | 110 | |
| 2-Chloronaphthalene | 91-58-7 | Full Scan | 630000 | LMW PAH | 2900 | NC | 1450 | 330 | 170 | 7.6 | 45 | 105 | |
| 2-Chlorophenol | 95-57-8 | Full Scan | 39000 | 500 | 57 | NC | 28.5 | 330 | 170 | 17.6 | 45 | 105 | |
| 2-Methylnaphthalene | 91-57-6 | Full Scan | 23000 | LMW PAH | 140 | NC | 70 | 330 | 170 | 8.4 | 45 | 105 | |
| 2-Methylphenol | 95-48-7 | Full Scan | 310000 | 1000 | 580 | NC | 290 | 330 | 170 | 18.1 | 40 | 105 | |
| 2-Nitroaniline | 88-74-4 | Full Scan | 61000 | NC | 62 | NC | 31 | 330 | 170 | 14.8 | 45 | 120 | |
| 2-Nitrophenol | 88-75-5 | Full Scan | 39000 | 1000 | 57 | NC | 28.5 | 330 | 170 | 16.1 | 40 | 110 | |
| 3- and 4-Methylphenol | m- & p-CRESOL | Full Scan | 610000 | 1000 | 1100 | NC | 500 | 330 | 170 | 21.4 | 40 | 105 | |
| 3,3'-Dichlorobenzidine | 91-94-1 | Full Scan | 1100 | NC | 0.71 | NC | 0.355 | 330 | 170 | 17.3 | 10 | 92 | |
| 3-Nitroaniline | 99-09-2 | Full Scan | NC | NC | NC | NC | Lab LOD | 330 | 170 | 21.4 | 20 | 125 | |
| 4,6-Dinitro-2-methylphenol | 534-52-1 | Full Scan | 490 | 1000 | 2 | NC | 1 | 330 | 170 | 19.1 | 30 | 135 | |
| 4-Bromophenyl-phenylether | 101-55-3 | Full Scan | NC | NC | NC | NC | Lab LOD | 330 | 170 | 6.5 | 45 | 115 | |
| 4-Chloro-3-methylphenol | 59-50-7 | Full Scan | 610000 | 500 | 1300 | NC | 250 | 330 | 170 | 14.8 | 45 | 115 | |
| 4-Chloroaniline | 106-47-8 | Full Scan | 2400 | 500 | 0.13 | NC | 0.065 | 330 | 170 | 23.5 | 10 | 130 | |
| 4-Chlorophenyl-phenylether | 7005-72-3 | Full Scan | 31000 | NC | 1500 | NC | 750 | 330 | 170 | 18.1 | 45 | 110 | |
| 4-Nitroaniline | 100-01-6 | Full Scan | 24000 | NC | 1.4 | NC | 0.7 | 330 | 170 | 43.4 | 35 | 115 | |
| 4-Nitrophenol | 100-02-7 | Full Scan | 4800 | 380 | 0.079 | NC | 0.0395 | 330 | 170 | 61.9 | 15 | 140 | |
| Acenaphthene | 83-32-9 | Full Scan | 340000 | LMW PAH | 4100 | NC | 2050 | 330 | 170 | 9.4 | 45 | 110 | |
| Acenaphthylene | 208-96-8 | Full Scan | 340000 | LMW PAH | 4100 | NC | 2050 | 330 | 170 | 8.4 | 45 | 105 | |
| Acetophenone | 98-86-2 | Full Scan | 780000 | NC | 450 | NC | 225 | 330 | 170 | 10.2 | 50 | 111 | |

Worksheet #15-3b—Reference Limits and Evaluation Table (continued)

Matrix: Surface Soil, Subsurface Soil
 Analytical Group: SVOCs

| Analyte | CAS # | Full Scan or SIM | Adjusted Residential Soil RSLs ¹ (µg/kg) | Soil ESVs ^{1,2} (µg/kg) | Risk-Based SSLs ¹ (µg/kg) | MCL-Based SSLs ¹ (µg/kg) | Project QL Goal ³ (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ⁴ (%) | | |
|----------------------------|-----------|------------------|---|----------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|---------------------------|-----|------|---|-----|-----|
| | | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Anthracene | 120-12-7 | 8270 SIM | 1700000 | LMW PAH | 42000 | NC | 21000 | 3.3 | 1.7 | 0.4 | 55 | 105 | |
| Atrazine | 1912-24-9 | Full Scan | 2100 | 11.9 | 0.17 | 1.9 | 0.085 | 330 | 170 | 17.6 | 50 | 113 | |
| Benzaldehyde | 100-52-7 | Full Scan | 780000 | NC | 330 | NC | 165 | 330 | 170 | 17.4 | 10 | 95 | |
| Benzo(a)anthracene | 56-55-3 | 8270 SIM | 150 | HMW PAH | 10 | NC | 5 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Benzo(a)pyrene | 50-32-8 | 8270 SIM | 15 | HMW PAH | 3.5 | 240 | 1.75 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Benzo(b)fluoranthene | 205-99-2 | 8270 SIM | 150 | HMW PAH | 35 | NC | 17.5 | 3.3 | 1.7 | 0.4 | 45 | 115 | |
| Benzo(g,h,i)perylene | 191-24-2 | 8270 SIM | 170000 | HMW PAH | 9500 | NC | 4750 | 3.3 | 1.7 | 0.4 | 40 | 125 | |
| Benzo(k)fluoranthene | 207-08-9 | 8270 SIM | 1500 | HMW PAH | 350 | NC | 175 | 3.3 | 1.7 | 0.4 | 45 | 125 | |
| bis(2-Chloroethoxy)methane | 111-91-1 | Full Scan | 18000 | NC | 11 | NC | 5.5 | 330 | 170 | 19.2 | 45 | 110 | |
| bis(2-Chloroethyl)ether | 111-44-4 | Full Scan | 210 | NC | 0.0031 | NC | 0.00155 | 330 | 170 | 16.0 | 40 | 105 | |
| bis(2-Ethylhexyl)phthalate | 117-81-7 | Full Scan | 35000 | 30000 | 1100 | 1400 | 550 | 330 | 170 | 11.8 | 45 | 125 | |
| Butylbenzylphthalate | 85-68-7 | Full Scan | 260000 | 30000 | 200 | NC | 100 | 330 | 170 | 16.0 | 50 | 125 | |
| Caprolactam | 105-60-2 | Full Scan | 3100000 | NC | 1900 | NC | 950 | 330 | 170 | 15.5 | 49 | 106 | |
| Carbazole | 86-74-8 | Full Scan | NC | NC | NC | NC | Lab LOD | 330 | 170 | 7.3 | 45 | 115 | |
| Chrysene | 218-01-9 | Full Scan | 15000 | HMW PAH | 1100 | NC | 550 | 330 | 170 | 15.1 | 55 | 110 | |
| Dibenz(a,h)anthracene | 53-70-3 | 8270 SIM | 15 | HMW PAH | 11 | NC | 5.5 | 3.3 | 1.7 | 0.4 | 40 | 125 | |
| Dibenzofuran | 132-64-9 | Full Scan | 7800 | NC | 110 | NC | 55 | 330 | 170 | 13.0 | 50 | 105 | |
| Diethylphthalate | 84-66-2 | Full Scan | 4900000 | 26800 | 4700 | NC | 2350 | 330 | 170 | 5.2 | 50 | 115 | |
| Dimethyl phthalate | 131-11-3 | Full Scan | NC | 10640 | NC | NC | 5320 | 330 | 170 | 9.0 | 50 | 110 | |
| Di-n-butylphthalate | 84-74-2 | Full Scan | 610000 | 40000 | 1700 | NC | 850 | 330 | 170 | 26.2 | 55 | 110 | |
| Di-n-octylphthalate | 117-84-0 | Full Scan | 73000 | 30000 | 53000 | NC | 15000 | 330 | 170 | 3.8 | 40 | 130 | |
| Fluoranthene | 206-44-0 | 8270 SIM | 230000 | LMW PAH | 70000 | NC | 35000 | 3.3 | 1.7 | 0.4 | 55 | 115 | |
| Fluorene | 86-73-7 | 8270 SIM | 230000 | LMW PAH | 4000 | NC | 2000 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Hexachlorobenzene | 118-74-1 | Full Scan | 300 | 1000 | 0.53 | 13 | 0.265 | 330 | 170 | 13.6 | 45 | 120 | |
| Hexachlorobutadiene | 87-68-3 | Full Scan | 6100 | NC | 0.5 | NC | 0.25 | 330 | 170 | 12.1 | 40 | 115 | |
| Hexachlorocyclopentadiene | 77-47-4 | Full Scan | 37000 | 2000 | 70 | 160 | 35 | 330 | 170 | 8.1 | 38 | 122 | |
| Hexachloroethane | 67-72-1 | Full Scan | 4300 | NC | 0.48 | NC | 0.24 | 330 | 170 | 14.9 | 35 | 110 | |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | 8270 SIM | 150 | HMW PAH | 200 | NC | 75 | 3.3 | 1.7 | 0.4 | 40 | 120 | |
| Isophorone | 78-59-1 | Full Scan | 510000 | NC | 22 | NC | 11 | 330 | 170 | 11.0 | 45 | 110 | |
| Naphthalene | 91-20-3 | 8270 SIM | 3600 | LMW PAH | 0.47 | NC | 0.235 | 3.3 | 1.7 | 0.4 | 40 | 105 | |

Worksheet #15-3b—Reference Limits and Evaluation Table (continued)

Matrix: Surface Soil, Subsurface Soil

Analytical Group: SVOCs

| Analyte | CAS # | Full Scan or SIM | Adjusted Residential Soil RSLs ¹ (µg/kg) | Soil ESVs ^{1,2} (µg/kg) | Risk-Based SSLs ¹ (µg/kg) | MCL-Based SSLs ¹ (µg/kg) | Project QL Goal ³ (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ⁴ (%) | | |
|----------------------------|----------|------------------|---|----------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|---------------------------|-----|------|---|-----|-----|
| | | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Nitrobenzene | 98-95-3 | Full Scan | 4800 | 2260 | 0.079 | NC | 0.0395 | 330 | 170 | 12.6 | 40 | 115 | |
| n-Nitroso-di-n-propylamine | 621-64-7 | Full Scan | 69 | NC | 0.007 | NC | 0.0035 | 330 | 170 | 16.8 | 40 | 115 | |
| n-Nitrosodiphenylamine | 86-30-6 | Full Scan | 99000 | 1090 | 57 | NC | 28.5 | 330 | 170 | 8.0 | 50 | 115 | |
| Pentachlorophenol | 87-86-5 | Full Scan | 8900 | 5000 | 0.36 | 10 | 0.18 | 330 | 170 | 22.8 | 25 | 120 | |
| Phenanthrene | 85-01-8 | 8270 SIM | 1700000 | LMW PAH | 42000 | NC | 21000 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Phenol | 108-95-2 | Full Scan | 1800000 | 1880 | 2600 | NC | 940 | 330 | 170 | 7.7 | 40 | 100 | |
| Pyrene | 129-00-0 | 8270 SIM | NC | HMW PAH | 9500 | NC | 4750 | 3.3 | 1.7 | 0.4 | 45 | 125 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Site-Specific ESVs for PAHs are based on whether they are LMW or HMW. The cumulative LMW ESV is 29,000 µg/kg and the cumulative HMW ESV is 18,000 µg/kg.

³ Project QL goals are equal to half of the minimum applicable PAL.

⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

HMW = high molecular weight

LMW = low molecular weight

Worksheet #15-3c—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil ¹

Analytical Group: Total Metals

| Analyte | CAS # | Adjusted Residential Soil RSLs ¹ (mg/kg) | Soil ESVs ² (mg/kg) | Risk-Based SSLs ² (mg/kg) | MCL-Based SSLs ² (mg/kg) | 95% UTL for SS ² (mg/kg) | 95% UTL for SB ² (mg/kg) | Project QL Goal ³ (mg/kg) | Laboratory Limits (mg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ⁴ (%) | | |
|-----------|-----------|---|--------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|---------------------------|-------|-------|---|-----|-----|
| | | | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Aluminum | 7429-90-5 | 7700 | pH < 5.5 | 23000 | NC | 12200 | 13000 | 3850 | 2 | 1 | 0.677 | 80 | 120 | 20 |
| Antimony | 7440-36-0 | 3.1 | 78 | 0.27 | 0.27 | NC | NC | 0.135 | 0.2 | 0.1 | 0.026 | 80 | 120 | |
| Arsenic | 7440-38-2 | 0.39 | 18 | 0.0013 | 0.29 | 6.36 | 5.54 | 0.00065 | 0.1 | 0.05 | 0.022 | 80 | 120 | |
| Barium | 7440-39-3 | 1500 | 330 | 120 | 82 | 52.9 | 84.5 | 26.45 | 1 | 0.5 | 0.008 | 80 | 120 | |
| Beryllium | 7440-41-7 | 16 | 40 | 13 | 3.2 | 0.587 | NC | 0.2935 | 0.1 | 0.05 | 0.007 | 80 | 120 | |
| Cadmium | 7440-43-9 | 7 | 32 | 0.52 | 0.38 | NC | NC | 0.19 | 0.1 | 0.05 | 0.009 | 80 | 120 | |
| Calcium | 7440-70-2 | NC | NC | NC | NC | 2290 | 2380 | 1145 | 50 | 25 | 0.635 | 80 | 120 | |
| Chromium | 7440-47-3 | 0.29 | 64 | 0.00059 | 180000 | 18.2 | 33.7 | 0.000295 | 0.2 | 0.10 | 0.011 | 80 | 120 | |
| Cobalt | 7440-48-4 | 2.3 | 13 | 0.21 | NC | 9.93 | 5.18 | 0.105 | 0.1 | 0.05 | 0.006 | 80 | 120 | |
| Copper | 7440-50-8 | 310 | 70 | 22 | 46 | 4.25 | 3.17 | 1.585 | 0.2 | 0.10 | 0.006 | 80 | 120 | |
| Iron | 7439-89-6 | 5500 | 5 < pH > 8 | 270 | NC | 19900 | 32000 | 135 | 20 | 10 | 0.926 | 80 | 120 | |
| Lead | 7439-92-1 | 400 | 120 | NC | 14 | 17.4 | 8.79 | 4.395 | 0.1 | 0.05 | 0.004 | 80 | 120 | |
| Magnesium | 7439-95-4 | NC | NC | NC | NC | 1070 | 1120 | 535 | 50 | 25 | 0.693 | 80 | 120 | |
| Manganese | 7439-96-5 | 180 | 220 | 21 | NC | 324 | 176 | 10.5 | 0.1 | 0.05 | 0.006 | 80 | 120 | |
| Mercury | 7439-97-6 | 2.3 | 0.1 | 0.033 | 0.1 | 0.111 | NC | 0.0165 | 0.01 | 0.005 | 0.002 | 80 | 120 | |
| Nickel | 7440-02-0 | 150 | 38 | 20 | NC | 9.52 | 17.6 | 4.76 | 0.1 | 0.05 | 0.009 | 80 | 120 | |
| Potassium | 7440-09-7 | NC | NC | NC | NC | 708 | 901 | 354 | 50 | 25 | 0.901 | 80 | 120 | |
| Selenium | 7782-49-2 | 39 | 0.52 | 0.4 | 0.26 | 0.51 | NC | 0.13 | 0.5 | 0.25 | 0.056 | 80 | 120 | |
| Silver | 7440-22-4 | 39 | 560 | 0.6 | NC | NC | NC | 0.3 | 0.1 | 0.05 | 0.007 | 75 | 120 | |
| Sodium | 7440-23-5 | NC | NC | NC | NC | 521 | 811 | 260.5 | 50 | 25 | 1.225 | 80 | 120 | |
| Thallium | 7440-28-0 | 0.078 | 1 | 0.011 | 0.14 | NC | NC | 0.0055 | 0.1 | 0.05 | 0.005 | 80 | 120 | |
| Vanadium | 7440-62-2 | 39 | 130 | 78 | NC | 27.9 | 48.3 | 13.95 | 0.5 | 0.25 | 0.013 | 80 | 120 | |
| Zinc | 7440-66-6 | 2300 | 120 | 290 | NC | 26.5 | 28 | 13.25 | 0.2 | 0.10 | 0.011 | 85 | 115 | |
| Cyanide | 57-12-5 | 2.2 | 15.8 | 0.014 | 2 | NC | NC | 0.007 | 0.25 | 0.125 | 0.033 | 80 | 110 | |

Notes:

¹Select Subsurface soil samples will be analyzed for a reduced metals list (Aluminum only), as identified on Worksheet #18.

² Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

³ Project QL goals are equal to half of the minimum applicable PAL.

⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-3d—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Hexavalent Chromium

| Analyte | CAS # | Adjusted Residential Soil RSLs ¹ (mg/kg) | Soil ESVs ¹ (mg/kg) | Risk-Based SSLs ¹ (mg/kg) | MCL-Based SSLs ¹ (mg/kg) | Project QL Goal ² (mg/kg) | Laboratory Limits (mg/kg) | | | LCS Recovery Limits ³ (%) | | MS/MSD Recovery Limits and RPD ³ (%) | | |
|---------------------|------------|---|--------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|---------------------------|------|------|--------------------------------------|-----|---|-----|-----|
| | | | | | | | LOQ | LOD | DL | LCL | UCL | LCL | UCL | RPD |
| Hexavalent Chromium | 18540-29-9 | 0.29 | 0.40 | 0.00059 | NC | 0.000295 | 0.5 | 0.25 | 0.13 | 82 | 120 | 75 | 125 | 20 |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-3e—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Explosives

| Analyte | CAS # | Remedial Goal for TNT Conveyor Belt Soil (µg/kg) | Adjusted Residential Soil RSLs ¹ (µg/kg) | Soil ESVs ¹ (µg/kg) | Risk-Based SSLs ¹ (µg/kg) | MCL-Based SSLs ¹ (µg/kg) | Project QL Goal ² (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|--|------------|--|---|--------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|---------------------------|------|------|---|-----|-----|
| | | | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) | 2691-41-0 | NC | 380000 | 10000 | 990 | NC | 495 | 80 | 40 | 16 | 75 | 125 | 30 |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | 121-82-4 | NC | 5600 | 10000 | 0.23 | NC | 0.115 | 80 | 40 | 17.9 | 70 | 135 | |
| 1,3,5-Trinitrobenzene (1,3,5-TNB) | 99-35-4 | NC | 220000 | NC | 1700 | NC | 850 | 40 | 20 | 8.7 | 75 | 125 | |
| 1,3-Dinitrobenzene (1,3-DNB) | 99-65-0 | NC | 610 | NC | 1.4 | NC | 0.7 | 40 | 20 | 7.4 | 80 | 125 | |
| Methyl-2,4,6-trinitrophenylnitramine (Tetryl) | 479-45-8 | NC | 24000 | 10000 | 580 | NC | 290 | 80 | 40 | 20.5 | 10 | 150 | |
| Nitrobenzene (NB) | 98-95-3 | NC | 4800 | 2260 | 0.079 | NC | 0.0395 | 40 | 20 | 7.3 | 75 | 125 | |
| 2,4,6-Trinitrotoluene (2,4,6-TNT) | 118-96-7 | 15,000 | 3600 | 10000 | 13 | NC | 6.5 | 40 | 20 | 9 | 55 | 140 | |
| 4-Amino-2,6-dinitrotoluene (4-Am-DNT) | 19406-51-0 | NC | 15000 | 8000 | 23 | NC | 11.5 | 40 | 20 | 9.7 | 80 | 125 | |
| 2-Amino-4,6-dinitrotoluene (2-Am-DNT) | 35572-78-2 | NC | 15000 | 8000 | 23 | NC | 11.5 | 40 | 20 | 10.5 | 80 | 125 | |
| 2,4-Dinitrotoluene (2,4-DNT) | 121-14-2 | NC | 1600 | 11000 | 0.28 | NC | 0.14 | 40 | 20 | 7 | 80 | 125 | |
| 2,6-Dinitrotoluene (2,6-DNT) | 606-20-2 | NC | 6100 | 8500 | 20 | NC | 10 | 40 | 20 | 12.2 | 80 | 120 | |
| 2-Nitrotoluene (2-NT) | 88-72-2 | NC | 2900 | NC | 0.25 | NC | 0.125 | 80 | 40 | 13.6 | 80 | 125 | |
| 3-Nitrotoluene (3-NT) | 99-08-1 | NC | 610 | NC | 1.2 | NC | 0.6 | 80 | 40 | 17.1 | 75 | 120 | |
| 4-Nitrotoluene (4-NT) | 99-99-0 | NC | 24000 | NC | 3.4 | NC | 1.7 | 80 | 40 | 15.9 | 75 | 125 | |
| PETN | 78-11-5 | NC | 12000 | NC | 24 | NC | 12 | 200 | 100 | 42.2 | 48 | 117 | |
| Nitroglycerin | 55-63-0 | NC | 610 | NC | 0.66 | NC | 0.33 | 4000 | 3200 | 1230 | 61 | 146 | |
| Perchlorate | 14797-73-0 | NC | 5500 | 1000 | NC | NC | 500 | 2 | 1 | 0.32 | 80 | 120 | 15 |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-3f—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Wet Chemistry

| Analyte | CAS # | PIL ¹ (µg/kg) | Laboratory Limits (µg/kg) | | | LCS Recovery Limits ² (%) | | MS/MSD Recovery Limits and RPD ² (%) | | |
|---------|-------|-----------------------------|------------------------------|---------|--------|--------------------------------------|-----|---|-----|-----|
| | | | LOQ | LOD | DL | LCL | UCL | LCL | UCL | RPD |
| pH | PH | 5 < pH > 8 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| TOC | TOC | NC | 250.000 | 125.000 | 48.849 | 83 | 115 | 46 | 152 | 20 |

Notes:

¹ There are no action limits for wet chemistry analytes because they are screening data. PILs are approximate threshold values for results that will help support the ERA.

² DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. **Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.**

NC indicates cases where there is no criteria for an analyte.

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Worksheet #15-4a—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: VOCs including 1,4-dioxane

| Analyte | CAS # | Adjusted RSL Residential Soil x 10 for Sediment ¹ (µg/kg) | Freshwater Sediment ESV (µg/kg) | Project QL Goal ² (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|---|----------|--|---------------------------------|--------------------------------------|---------------------------|------|------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,1,1-Trichloroethane | 71-55-6 | 640000 | 170 | 320000 | 5 | 2.5 | 0.88 | 70 | 135 | 30 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 5600 | 940 | 2800 | 5 | 2.5 | 0.46 | 75 | 125 | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113) | 76-13-1 | 910000 | NC | 455000 | 5 | 2.5 | 1.33 | 60 | 138 | |
| 1,1,2-Trichloroethane | 79-00-5 | 1600 | 1200 | 800 | 5 | 2.5 | 0.90 | 60 | 125 | |
| 1,1-Dichloroethane | 75-34-3 | 33000 | 27 | 16500 | 5 | 2.5 | 0.94 | 75 | 125 | |
| 1,1-Dichloroethene | 75-35-4 | 240000 | 31 | 120000 | 5 | 2.5 | 1.47 | 65 | 135 | |
| 1,2,3-Trichlorobenzene | 87-61-6 | 49000 | 858 | 24500 | 5 | 2.5 | 0.50 | 60 | 135 | |
| 1,2,4-Trichlorobenzene | 120-82-1 | 62000 | 9200 | 31000 | 5 | 2.5 | 0.70 | 65 | 130 | |
| 1,2-Dibromo-3-chloropropane | 96-12-8 | 54 | NC | 27 | 5 | 2.5 | 0.87 | 40 | 135 | |
| 1,2-Dibromoethane | 106-93-4 | 340 | NC | 170 | 5 | 2.5 | 0.64 | 70 | 125 | |
| 1,2-Dichlorobenzene | 95-50-1 | 380000 | 340 | 190000 | 5 | 2.5 | 0.62 | 75 | 120 | |
| 1,2-Dichloroethane | 107-06-2 | 43000 | 250 | 21500 | 5 | 2.5 | 0.64 | 70 | 135 | |
| 1,2-Dichloropropane | 78-87-5 | 9400 | NC | 4700 | 5 | 2.5 | 0.26 | 70 | 120 | |
| 1,3-Dichlorobenzene | 541-73-1 | NC | 1700 | N/A | 5 | 2.5 | 0.37 | 70 | 125 | |
| 1,4-Dichlorobenzene | 106-46-7 | 24000 | 350 | 12000 | 5 | 2.5 | 0.41 | 70 | 125 | |
| 1,4-Dioxane | 123-91-1 | 49000 | NC | 24500 | 100 | 50 | 50 | 15 | 117 | |
| 2-Butanone | 78-93-3 | 28000000 | NC | 14000000 | 25 | 12.5 | 3.11 | 30 | 160 | |
| 2-Hexanone | 591-78-6 | 210000 | NC | 105000 | 25 | 12.5 | 3.92 | 45 | 145 | |
| 4-Methyl-2-pentanone | 108-10-1 | 3400000 | NC | 1700000 | 25 | 12.5 | 2.92 | 45 | 145 | |
| Acetone | 67-64-1 | 61000000 | NC | 30500000 | 25 | 12.5 | 3.02 | 20 | 160 | |
| Benzene | 71-43-2 | 11000 | 57 | 5500 | 5 | 2.5 | 0.38 | 75 | 125 | |
| Bromochloromethane | 74-97-5 | 160000 | NC | 80000 | 5 | 2.5 | 0.79 | 70 | 125 | |
| Bromodichloromethane | 75-27-4 | 2700 | NC | 1350 | 5 | 2.5 | 0.62 | 70 | 130 | |
| Bromoform | 75-25-2 | 620000 | 650 | 310000 | 5 | 2.5 | 0.74 | 55 | 135 | |
| Bromomethane | 74-83-9 | 7300 | NC | 3650 | 5 | 2.5 | 2.45 | 30 | 160 | |
| Carbon disulfide | 75-15-0 | 740000 | 0.85 | 370000 | 5 | 2.5 | 1.06 | 45 | 160 | |
| Carbon tetrachloride | 56-23-5 | 6100 | 1200 | 3050 | 5 | 2.5 | 0.99 | 65 | 135 | |
| Chlorobenzene | 108-90-7 | 290000 | 820 | 145000 | 5 | 2.5 | 0.50 | 75 | 125 | |
| Chloroethane | 75-00-3 | 2100000 | NC | 1050000 | 5 | 2.5 | 1.40 | 40 | 155 | |
| Chloroform | 67-66-3 | 2900 | 22 | 1450 | 5 | 2.5 | 0.74 | 70 | 125 | |

Worksheet #15-4a—Reference Limits and Evaluation Table (continued)

Matrix: Sediment

Analytical Group: VOCs including 1,4-dioxane

| Analyte | CAS # | Adjusted RSL Residential Soil x 10 for SD ¹ (µg/kg) | Freshwater SD ESV (µg/kg) | Project QL Goal ² (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|------------------------------------|---------------|--|---------------------------|--------------------------------------|---------------------------|-----|------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Chloromethane | 74-87-3 | 120000 | NC | 60000 | 5 | 2.5 | 0.86 | 50 | 130 | |
| cis-1,2-Dichloroethene | 156-59-2 | 160000 | 400 | 80000 | 5 | 2.5 | 0.89 | 65 | 125 | |
| cis-1,3-Dichloropropene | 10061-01-5 | 17000 | 0.051 | 8500 | 5 | 2.5 | 0.72 | 70 | 125 | |
| Cyclohexane | 110-82-7 | 120000 | NC | 60000 | 5 | 2.5 | 1.01 | 66 | 132 | |
| Dibromochloromethane | 124-48-1 | 6800 | NC | 3400 | 5 | 2.5 | 0.54 | 73 | 126 | |
| Dichlorodifluoromethane (Freon-12) | 75-71-8 | 94000 | NC | 47000 | 5 | 2.5 | 0.65 | 35 | 135 | |
| Ethylbenzene | 100-41-4 | 54000 | 3600 | 27000 | 5 | 2.5 | 0.62 | 75 | 125 | |
| Isopropylbenzene | 98-82-8 | 270000 | 86 | 135000 | 5 | 2.5 | 0.48 | 75 | 130 | |
| m- and p-Xylene | m- & p-XYLENE | 390000 | 160 | 195000 | 10 | 5.0 | 0.72 | 80 | 125 | |
| Methyl acetate | 79-20-9 | 29000000 | NC | 14500000 | 5 | 2.5 | 1.51 | 44 | 187 | |
| Methylcyclohexane | 108-87-2 | NC | NC | N/A | 5 | 2.5 | 1.06 | 71 | 124 | |
| Methylene chloride | 75-09-2 | 360000 | 370 | 180000 | 5 | 2.5 | 1.42 | 55 | 140 | |
| Methyl-tert-butyl ether (MTBE) | 1634-04-4 | 430000 | NC | 215000 | 5 | 2.5 | 0.96 | 76 | 123 | |
| o-Xylene | 95-47-6 | 430000 | 160 | 215000 | 5 | 2.5 | 0.68 | 75 | 125 | |
| Styrene | 100-42-5 | 870000 | 559 | 435000 | 5 | 2.5 | 0.45 | 75 | 125 | |
| Tetrachloroethene | 127-18-4 | 86000 | 530 | 43000 | 5 | 2.5 | 1.01 | 65 | 140 | |
| Toluene | 108-88-3 | 820000 | 670 | 410000 | 5 | 2.5 | 0.64 | 70 | 125 | |
| trans-1,2-Dichloroethene | 156-60-5 | 150000 | 400 | 75000 | 5 | 2.5 | 0.69 | 65 | 135 | |
| trans-1,3-Dichloropropene | 10061-02-6 | 17000 | 0.051 | 8500 | 5 | 2.5 | 0.79 | 65 | 125 | |
| Trichloroethene | 79-01-6 | 4400 | 1600 | 2200 | 5 | 2.5 | 0.86 | 75 | 125 | |
| Trichlorofluoromethane (Freon-11) | 75-69-4 | 790000 | NC | 395000 | 5 | 2.5 | 1.32 | 25 | 185 | |
| Vinyl chloride | 75-01-4 | 600 | NC | 300 | 5 | 2.5 | 1.23 | 60 | 125 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally the adjusted RSLs are multiplied by 10 for sediment evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-4b—Reference Limits and Evaluation Table

Matrix: Sediment
 Analytical Group: SVOCs

| Analyte | CAS # | Full Scan or SIM | Adjusted RSL Residential Soil x 10 for Sediment ¹ (µg/kg) | Freshwater Sediment ESV ² (µg/kg) | Project QL Goal ³ (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ⁴ (%) | | |
|------------------------------|---------------|------------------|--|--|--------------------------------------|---------------------------|-----|-------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| 1,1-Biphenyl | 92-52-4 | Full Scan | 51000 | 1100 | 25500 | 330 | 170 | 12.6 | 56 | 107 | 30 |
| 1,2,4,5-Tetrachlorobenzene | 95-94-3 | Full Scan | 18000 | 1092.7 | 9000 | 330 | 170 | 13.1 | 33 | 136 | |
| 2,2'-Oxybis(1-chloropropane) | 108-60-1 | Full Scan | 46000 | NC | 23000 | 330 | 170 | 13.8 | 52 | 104 | |
| 2,3,4,6-Tetrachlorophenol | 58-90-2 | Full Scan | 1800000 | 284.3 | 900000 | 330 | 170 | 12.07 | 47 | 120 | |
| 2,4,5-Trichlorophenol | 95-95-4 | Full Scan | 6100000 | NC | 3050000 | 330 | 170 | 23.4 | 50 | 110 | |
| 2,4,6-Trichlorophenol | 88-06-2 | Full Scan | 61000 | 213 | 30500 | 330 | 170 | 10.2 | 45 | 110 | |
| 2,4-Dichlorophenol | 120-83-2 | Full Scan | 180000 | 117 | 90000 | 330 | 170 | 12.7 | 45 | 110 | |
| 2,4-Dimethylphenol | 105-67-9 | Full Scan | 1200000 | NC | 600000 | 330 | 170 | 18.9 | 30 | 105 | |
| 2,4-Dinitrophenol | 51-28-5 | Full Scan | 120000 | NC | 60000 | 330 | 170 | 33.9 | 15 | 130 | |
| 2,4-Dinitrotoluene | 121-14-2 | Full Scan | 16000 | 41.645 | 8000 | 330 | 170 | 10.1 | 50 | 115 | |
| 2,6-Dinitrotoluene | 606-20-2 | Full Scan | 61000 | NC | 30500 | 330 | 170 | 13.6 | 50 | 110 | |
| 2-Chloronaphthalene | 91-58-7 | Full Scan | 6300000 | NC | 3150000 | 330 | 170 | 7.6 | 45 | 105 | |
| 2-Chlorophenol | 95-57-8 | Full Scan | 390000 | 31.2 | 195000 | 330 | 170 | 17.6 | 45 | 105 | |
| 2-Methylnaphthalene | 91-57-6 | Full Scan | 230000 | NC | 115000 | 330 | 170 | 8.4 | 45 | 105 | |
| 2-Methylphenol | 95-48-7 | Full Scan | 3100000 | NC | 1550000 | 330 | 170 | 18.1 | 40 | 105 | |
| 2-Nitroaniline | 88-74-4 | Full Scan | 610000 | NC | 305000 | 330 | 170 | 14.8 | 45 | 120 | |
| 2-Nitrophenol | 88-75-5 | Full Scan | 390000 | NC | 195000 | 330 | 170 | 16.1 | 40 | 110 | |
| 3,3'-Dichlorobenzidine | 91-94-1 | Full Scan | 11000 | 127 | 5500 | 330 | 170 | 21.4 | 10 | 92 | |
| 3- and 4-Methylphenol | m- & p-CRESOL | Full Scan | 6100000 | NC | 3050000 | 330 | 170 | 17.3 | 40 | 105 | |
| 3-Nitroaniline | 99-09-2 | Full Scan | NC | NC | N/A | 330 | 170 | 21.4 | 20 | 125 | |
| 4,6-Dinitro-2-methylphenol | 534-52-1 | Full Scan | 4900 | NC | 2450 | 330 | 170 | 19.1 | 30 | 135 | |
| 4-Bromophenyl-phenylether | 101-55-3 | Full Scan | NC | 1300 | N/A | 330 | 170 | 6.5 | 45 | 115 | |
| 4-Chloro-3-methylphenol | 59-50-7 | Full Scan | 6100000 | NC | 3050000 | 330 | 170 | 14.8 | 45 | 115 | |
| 4-Chloroaniline | 106-47-8 | Full Scan | 24000 | NC | 12000 | 330 | 170 | 23.5 | 10 | 130 | |
| 4-Chlorophenyl-phenylether | 7005-72-3 | Full Scan | 310000 | NC | 155000 | 330 | 170 | 18.1 | 45 | 110 | |
| 4-Nitroaniline | 100-01-6 | Full Scan | 240000 | NC | 120000 | 330 | 170 | 43.4 | 35 | 115 | |
| 4-Nitrophenol | 100-02-7 | Full Scan | 48000 | NC | 24000 | 330 | 170 | 61.9 | 15 | 140 | |
| Acenaphthene | 83-32-9 | Full Scan | 3400000 | 290 | 1700000 | 330 | 170 | 9.4 | 45 | 110 | |
| Acenaphthylene | 208-96-8 | Full Scan | 3400000 | 160 | 1700000 | 330 | 170 | 8.4 | 45 | 105 | |
| Acetophenone | 98-86-2 | Full Scan | 2500000 | NC | 1250000 | 330 | 170 | 10.2 | 50 | 111 | |

Worksheet #15-4b—Reference Limits and Evaluation Table (continued)

Matrix: Sediment
 Analytical Group: SVOCs

| Analyte | CAS # | Full Scan or SIM | Adjusted RSL Residential Soil x 10 for SD ¹ (µg/kg) | Freshwater SD ESV ² (µg/kg) | Project QL Goal ⁵ (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ⁴ (%) | | |
|----------------------------|-----------|------------------|--|--|--------------------------------------|---------------------------|-----|------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Anthracene | 120-12-7 | 8270 SIM | 17000000 | 57.2 | 8500000 | 3.3 | 1.7 | 0.4 | 55 | 105 | |
| Atrazine | 1912-24-9 | Full Scan | 21000 | 6.62 | 10500 | 330 | 170 | 17.6 | 50 | 113 | |
| Benzaldehyde | 100-52-7 | Full Scan | 1200000 | NC | 600000 | 330 | 170 | 17.4 | 10 | 95 | |
| Benzo(a)anthracene | 56-55-3 | 8270 SIM | 1500 | 108 | 750 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Benzo(a)pyrene | 50-32-8 | 8270 SIM | 150 | 150 | 75 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Benzo(b)fluoranthene | 205-99-2 | 8270 SIM | 1500 | 240 | 750 | 3.3 | 1.7 | 0.4 | 45 | 115 | |
| Benzo(g,h,i)perylene | 191-24-2 | 8270 SIM | 1700000 | 170 | 850000 | 3.3 | 1.7 | 0.4 | 40 | 125 | |
| Benzo(k)fluoranthene | 207-08-9 | 8270 SIM | 15000 | 240 | 7500 | 3.3 | 1.7 | 0.4 | 45 | 125 | |
| bis(2-Chloroethoxy)methane | 111-91-1 | Full Scan | 180000 | NC | 90000 | 330 | 170 | 19.2 | 45 | 110 | |
| bis(2-Chloroethyl)ether | 111-44-4 | Full Scan | 2100 | NC | 1050 | 330 | 170 | 16.0 | 40 | 105 | |
| bis(2-Ethylhexyl)phthalate | 117-81-7 | Full Scan | 350000 | 750 | 175000 | 330 | 170 | 11.8 | 45 | 125 | |
| Butylbenzylphthalate | 85-68-7 | Full Scan | 2600000 | 11000 | 1300000 | 330 | 170 | 16.0 | 50 | 125 | |
| Caprolactam | 105-60-2 | Full Scan | 31000000 | NC | 15500000 | 330 | 170 | 15.5 | 49 | 106 | |
| Carbazole | 86-74-8 | Full Scan | NC | NC | N/A | 330 | 170 | 7.3 | 45 | 115 | |
| Chrysene | 218-01-9 | Full Scan | 150000 | 166 | 75000 | 330 | 170 | 15.1 | 55 | 110 | |
| Dibenz(a,h)anthracene | 53-70-3 | 8270 SIM | 150 | 33 | 75 | 3.3 | 1.7 | 0.4 | 40 | 125 | |
| Dibenzofuran | 132-64-9 | Full Scan | 78000 | 5100 | 39000 | 330 | 170 | 13.0 | 50 | 105 | |
| Diethylphthalate | 84-66-2 | Full Scan | 49000000 | 630 | 24500000 | 330 | 170 | 5.2 | 50 | 115 | |
| Dimethyl phthalate | 131-11-3 | Full Scan | NC | NC | N/A | 330 | 170 | 9.0 | 50 | 110 | |
| Di-n-butylphthalate | 84-74-2 | Full Scan | 6100000 | 110 | 3050000 | 330 | 170 | 26.2 | 55 | 110 | |
| Di-n-octylphthalate | 117-84-0 | Full Scan | 730000 | NC | 365000 | 330 | 170 | 3.8 | 40 | 130 | |
| Fluoranthene | 206-44-0 | 8270 SIM | 2300000 | 423 | 1150000 | 3.3 | 1.7 | 0.4 | 55 | 115 | |
| Fluorene | 86-73-7 | 8270 SIM | 2300000 | 77.4 | 1150000 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Hexachlorobenzene | 118-74-1 | Full Scan | 3000 | 20 | 1500 | 330 | 170 | 13.6 | 45 | 120 | |
| Hexachlorobutadiene | 87-68-3 | Full Scan | 61000 | 550 | 30500 | 330 | 170 | 12.1 | 40 | 115 | |
| Hexachlorocyclopentadiene | 77-47-4 | Full Scan | 370000 | NC | 185000 | 330 | 170 | 8.1 | 38 | 122 | |
| Hexachloroethane | 67-72-1 | Full Scan | 43000 | 1000 | 21500 | 330 | 170 | 14.9 | 35 | 110 | |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | 8270 SIM | 1500 | 200 | 750 | 3.3 | 1.7 | 0.4 | 40 | 120 | |
| Isophorone | 78-59-1 | Full Scan | 5100000 | NC | 2550000 | 330 | 170 | 11.0 | 45 | 110 | |
| Naphthalene | 91-20-3 | 8270 SIM | 36000 | 176 | 18000 | 3.3 | 1.7 | 0.4 | 40 | 105 | |

Worksheet #15-4b—Reference Limits and Evaluation Table (continued)

Matrix: Sediment
 Analytical Group: SVOCs

| Analyte | CAS # | Full Scan or SIM | Adjusted RSL Residential Soil x 10 for SD ¹ (µg/kg) | Freshwater SD ESV ² (µg/kg) | Project QL Goal ³ (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ⁴ (%) | | |
|----------------------------|----------|------------------|--|--|--------------------------------------|---------------------------|-----|------|---|-----|-----|
| | | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Nitrobenzene | 98-95-3 | Full Scan | 48000 | 1779 | 24000 | 330 | 170 | 12.6 | 40 | 115 | |
| n-Nitroso-di-n-propylamine | 621-64-7 | Full Scan | 690 | NC | 345 | 330 | 170 | 16.8 | 40 | 115 | |
| n-Nitrosodiphenylamine | 86-30-6 | Full Scan | 990000 | 2684 | 495000 | 330 | 170 | 8.0 | 50 | 115 | |
| Pentachlorophenol | 87-86-5 | Full Scan | 8900 | 504 | 4450 | 330 | 170 | 22.8 | 25 | 120 | |
| Phenanthrene | 85-01-8 | 8270 SIM | 17000000 | 204 | 8500000 | 3.3 | 1.7 | 0.4 | 50 | 110 | |
| Phenol | 108-95-2 | Full Scan | 18000000 | 48 | 9000000 | 330 | 170 | 7.7 | 40 | 100 | |
| Pyrene | 129-00-0 | 8270 SIM | 1700000 | 195 | 850000 | 3.3 | 1.7 | 0.4 | 45 | 125 | |

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally the adjusted RSLs are multiplied by 10 for sediment evaluation. The screening values used will be the most currently published values available during data evaluation.

² Site-Specific ESVs for PAHs are based on whether they are LMW or HMW. The cumulative ESV is 3,553 µg/kg, the cumulative LMW ESV is 786 µg/kg and the cumulative HMW ESV is 2,900 µg/kg.

³ Project QL goals are equal to half of the minimum applicable PAL.

⁴ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-4c—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Total Metals

| Analyte | CAS # | Adjusted RSL Residential Soil x 10 for Sediment ¹ (mg/kg) | Freshwater Sediment ESV (mg/kg) | Project QL Goal ² (mg/kg) | Laboratory Limits (mg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|-----------|-----------|--|---------------------------------|--------------------------------------|---------------------------|-------|-------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Aluminum | 7429-90-5 | 77000 | 25500 | 12750 | 5 | 2.5 | 0.84 | 80 | 120 | 20 |
| Antimony | 7440-36-0 | 31 | 3 | 1.5 | 2.5 | 1.25 | 0.56 | 80 | 120 | |
| Arsenic | 7440-38-2 | 3.9 | 9.79 | 1.95 | 1 | 0.5 | 0.33 | 80 | 120 | |
| Barium | 7440-39-3 | 15000 | 20 | 10 | 5 | 2.5 | 0.40 | 80 | 120 | |
| Beryllium | 7440-41-7 | 160 | NC | 80 | 0.3 | 0.15 | 0.06 | 80 | 120 | |
| Cadmium | 7440-43-9 | 70 | 0.99 | 0.495 | 0.3 | 0.15 | 0.06 | 80 | 120 | |
| Calcium | 7440-70-2 | NC | NC | N/A | 100 | 50 | 1.07 | 80 | 120 | |
| Chromium | 7440-47-3 | 2.9 | 43.4 | 1.45 | 0.5 | 0.25 | 0.13 | 80 | 120 | |
| Cobalt | 7440-48-4 | 23 | 50 | 11.5 | 1.5 | 0.75 | 0.57 | 80 | 120 | |
| Copper | 7440-50-8 | 3100 | 31.6 | 15.8 | 1 | 0.5 | 0.32 | 80 | 120 | |
| Iron | 7439-89-6 | 55000 | 20000 | 10000 | 5 | 2.5 | 1.33 | 80 | 120 | |
| Lead | 7439-92-1 | 4000 | 35.8 | 17.9 | 0.6 | 0.3 | 0.12 | 80 | 120 | |
| Magnesium | 7439-95-4 | NC | NC | N/A | 100 | 50 | 4.58 | 80 | 120 | |
| Manganese | 7439-96-5 | 1800 | 460 | 230 | 1 | 0.5 | 0.19 | 80 | 120 | |
| Mercury | 7439-97-6 | 23 | 0.18 | 0.09 | 0.01 | 0.005 | 0.002 | 80 | 120 | |
| Nickel | 7440-02-0 | 1500 | 22.7 | 11.35 | 2 | 1 | 0.46 | 80 | 120 | |
| Potassium | 7440-09-7 | NC | NC | N/A | 100 | 50 | 3.50 | 80 | 120 | |
| Selenium | 7782-49-2 | 390 | 2 | 1 | 1 | 0.5 | 0.41 | 80 | 120 | |
| Silver | 7440-22-4 | 390 | 1 | 0.5 | 0.5 | 0.25 | 0.15 | 75 | 120 | |
| Sodium | 7440-23-5 | NC | NC | N/A | 100 | 50 | 2.52 | 80 | 120 | |
| Thallium | 7440-28-0 | 0.78 | NC | 0.39 | 2 | 1 | 0.27 | 80 | 120 | |
| Vanadium | 7440-62-2 | 390 | NC | 195 | 2 | 1 | 0.59 | 80 | 120 | |
| Zinc | 7440-66-6 | 23000 | 121 | 60.5 | 2 | 1 | 0.70 | 80 | 120 | |
| Cyanide | 57-12-5 | 22 | NC | 11 | 0.25 | 0.125 | 0.033 | 80 | 110 | |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally the adjusted RSLs are multiplied by 10 for sediment evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-4d—Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil

Analytical Group: Hexavalent Chromium

| Analyte | CAS # | Adjusted RSL Residential Soil x 10 for Sediment ¹ (mg/kg) | Freshwater Sediment ESV (mg/kg) | Project QL Goal ² (mg/kg) | Laboratory Limits (mg/kg) | | | LCS Recovery Limits ³ (%) | | MS/MSD Recovery Limits and RPD ³ (%) | | |
|---------------------|------------|---|---------------------------------|---|------------------------------|------|------|--------------------------------------|-----|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | LCL | UCL | RPD |
| Hexavalent Chromium | 18540-29-9 | 2.9 | NC | 1.5 | 0.5 | 0.25 | 0.13 | 82 | 120 | 75 | 125 | 20 |

Notes:

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. **Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.**

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-4e—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Explosives

| Analyte | CAS # | Adjusted RSL Residential Soil x 10 for Sediment ¹ (µg/kg) | Freshwater Sediment ESV ¹ (µg/kg) | Project QL Goal ² (µg/kg) | Laboratory Limits (µg/kg) | | | LCS and MS/MSD Recovery Limits and RPD ³ (%) | | |
|--|------------|--|---|---|------------------------------|------|------|--|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) | 2691-41-0 | 3800000 | 4.74 | 2.37 | 80 | 40 | 16 | 75 | 125 | 30 |
| Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) | 121-82-4 | 56000 | 12.7 | 6.35 | 80 | 40 | 17.9 | 70 | 135 | |
| 1,3,5-Trinitrobenzene (1,3,5-TNB) | 99-35-4 | 2200000 | 2.4 | 1.2 | 40 | 20 | 8.7 | 75 | 125 | |
| 1,3-Dinitrobenzene (1,3-DNB) | 99-65-0 | 61000 | 6.7 | 3.35 | 40 | 20 | 7.4 | 80 | 125 | |
| Methyl-2,4,6-trinitrophenylnitramine (Tetryl) | 479-45-8 | 240000 | NC | 120000 | 80 | 40 | 20.5 | 10 | 150 | |
| Nitrobenzene (NB) | 98-95-3 | 48000 | 1779 | 889.5 | 40 | 20 | 7.3 | 75 | 125 | |
| 2,4,6-Trinitrotoluene (2,4,6-TNT) | 118-96-7 | 36000 | 92 | 46 | 40 | 20 | 9 | 55 | 140 | |
| 4-Amino-2,6-dinitrotoluene (4-Am-DNT) | 19406-51-0 | 150000 | 23.2 | 11.6 | 40 | 20 | 9.7 | 80 | 125 | |
| 2-Amino-4,6-dinitrotoluene (2-Am-DNT) | 35572-78-2 | 150000 | 13.2 | 6.6 | 40 | 20 | 10.5 | 80 | 125 | |
| 2,4-Dinitrotoluene (2,4-DNT) | 121-14-2 | 16000 | 41.645 | 20.8225 | 40 | 20 | 7 | 80 | 125 | |
| 2,6-Dinitrotoluene (2,6-DNT) | 606-20-2 | 61000 | NC | 30500 | 40 | 20 | 12.2 | 80 | 120 | |
| 2-Nitrotoluene (2-NT) | 88-72-2 | 29000 | 6204 | 3102 | 80 | 40 | 13.6 | 80 | 125 | |
| 3-Nitrotoluene (3-NT) | 99-08-1 | 6100 | 1922 | 961 | 80 | 40 | 17.1 | 75 | 120 | |
| 4-Nitrotoluene (4-NT) | 99-99-0 | 240000 | 4062.034 | 2031.017 | 80 | 40 | 15.9 | 75 | 125 | |
| PETN | 78-11-5 | 120000 | NC | 60000 | 200 | 100 | 42.2 | 48 | 117 | |
| Nitroglycerin | 55-63-0 | 6100 | NC | 3050 | 4000 | 3200 | 1230 | 61 | 146 | |
| Perchlorate | 14797-73-0 | 55000 | NC | 27500 | 2 | 1 | 0.32 | 80 | 120 | 15 |

Notes:

Shading represents cases where the PAL is lower than the laboratory LOD. Non-detects will not be treated as exceedances, though they will be reported at a value greater than the PAL.

¹ Refer to Worksheet #11 for specific identification of PALs by matrix. The RSLs shown in this table are from November 2012. RSLs based on non-carcinogenic effects are adjusted by dividing by 10 to account for exposure to more than one constituent that affects the same organ; additionally the adjusted RSLs are multiplied by 10 for sediment evaluation. The screening values used will be the most currently published values available during data evaluation.

² Project QL goals are equal to half of the minimum applicable PAL.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.

NC indicates cases where there is no criteria for an analyte.

Worksheet #15-4f—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Wet Chemistry

| Analyte | CAS # ¹ | PIL ² | Laboratory Limits | | | LCS Recovery Limits ² (%) | | MS/MSD Recovery Limits and RPD ² (%) | | |
|---------------|--------------------|------------------|-------------------|-----|--------|--------------------------------------|-----|---|-----|-----|
| | | | LOQ | LOD | DL | LCL | UCL | LCL | UCL | RPD |
| pH (pH units) | PH | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| TOC (mg/kg) | TOC | 2,000 | 250 | 125 | 48.849 | 83 | 115 | 46 | 152 | 20 |

Notes:

¹ In some instances, a contractor specific identifier is used.

² There are no action limits for wet chemistry analytes because they are screening data. PILs are approximate threshold values for results that will help support the ERA.

³ DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. **Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.**

Worksheet #15-4g—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: AVS/SEM

| Analyte | CAS # ¹ | Laboratory Limits ($\mu\text{mol/g}$) | | | LCS and MS/MSD Recovery Limits and RPD ² (%) | | |
|-----------------------|--------------------|--|------|------|---|-----|-----|
| | | LOQ | LOD | DL | LCL | UCL | RPD |
| Cadmium | 7440-43-9 | 1.04 | 0.52 | 0.17 | 82 | 117 | 20 |
| Copper | 7440-50-8 | 6.18 | 3.09 | 1.24 | 80 | 115 | |
| Lead | 7439-92-1 | 1.14 | 0.57 | 0.49 | 82 | 117 | |
| Mercury | 7439-97-6 | 0.04 | 0.02 | 0.02 | 73 | 121 | |
| Nickel | 7440-02-0 | 1.38 | 0.69 | 2.81 | 85 | 118 | |
| Silver | 7440-22-4 | 1.82 | 0.91 | 0.55 | 81 | 123 | |
| Zinc | 7440-66-6 | 12.02 | 6.01 | 3.9 | 88 | 127 | |
| Acid volatile sulfide | ACIDSO2 | N/A | 5 | N/A | 75 | 125 | |

Notes:

¹ In some instances, a contractor specific identifier is used.

² DoD QSM v.4.2 is the basis for LCS and MS/MSD limits. **Bolded values represent in-house limits when DOD QSM v4.2 limits do not exist.**

$\mu\text{mol/g}$ = micromole per gram

Worksheet #15-4h—Reference Limits and Evaluation Table

Matrix: Sediment

Analytical Group: Grain Size

| Analyte ¹ | CAS # ² | Units |
|----------------------------|--------------------|-----------|
| GS03 Sieve 3" (75 mm) | SIEVE75.0 | % Passing |
| GS05 Sieve 2" (50 mm) | SIEVE50.0 | % Passing |
| GS06 Sieve 1.5" (37.5 mm) | SIEVE37.5 | % Passing |
| GS07 Sieve 1" (25.0 mm) | SIEVE25.0 | % Passing |
| GS08 Sieve 0.75" (19.0 mm) | SIEVE19.0 | % Passing |
| GS10 Sieve 0.375" (9.5 mm) | SIEVE9.5 | % Passing |
| Sieve No. 004 (4.75 mm) | SIEVE4.75 | % Passing |
| Sieve No. 010 (2.00 mm) | SIEVE2.0 | % Passing |
| Sieve No. 020 (850 µm) | SIEVE850 | % Passing |
| Sieve No. 040 (425 µm) | SIEVE425 | % Passing |
| Sieve No. 060 (250 µm) | SIEVE250 | % Passing |
| Sieve No. 080 (180 µm) | SIEVE180 | % Passing |
| Sieve No. 100 (150 µm) | SIEVE150 | % Passing |
| Sieve No. 200 (75 µm) | SIEVE75 | % Passing |
| Gravel (%) | GRAVEL | % |
| Sand (%) | 14808-60-7 | % |
| Coarse Sand (%) | COARSE SAND | % |
| Medium Sand (%) | MEDIUM SAND | % |
| Fine Sand (%) | FINE SAND | % |
| Fines (%) | FINES | % |

Notes:

¹ There are no action limits, laboratory reporting limits, or LCS recovery limits for grain size analytes.

² In some instances, a contractor-specific identifier is used.

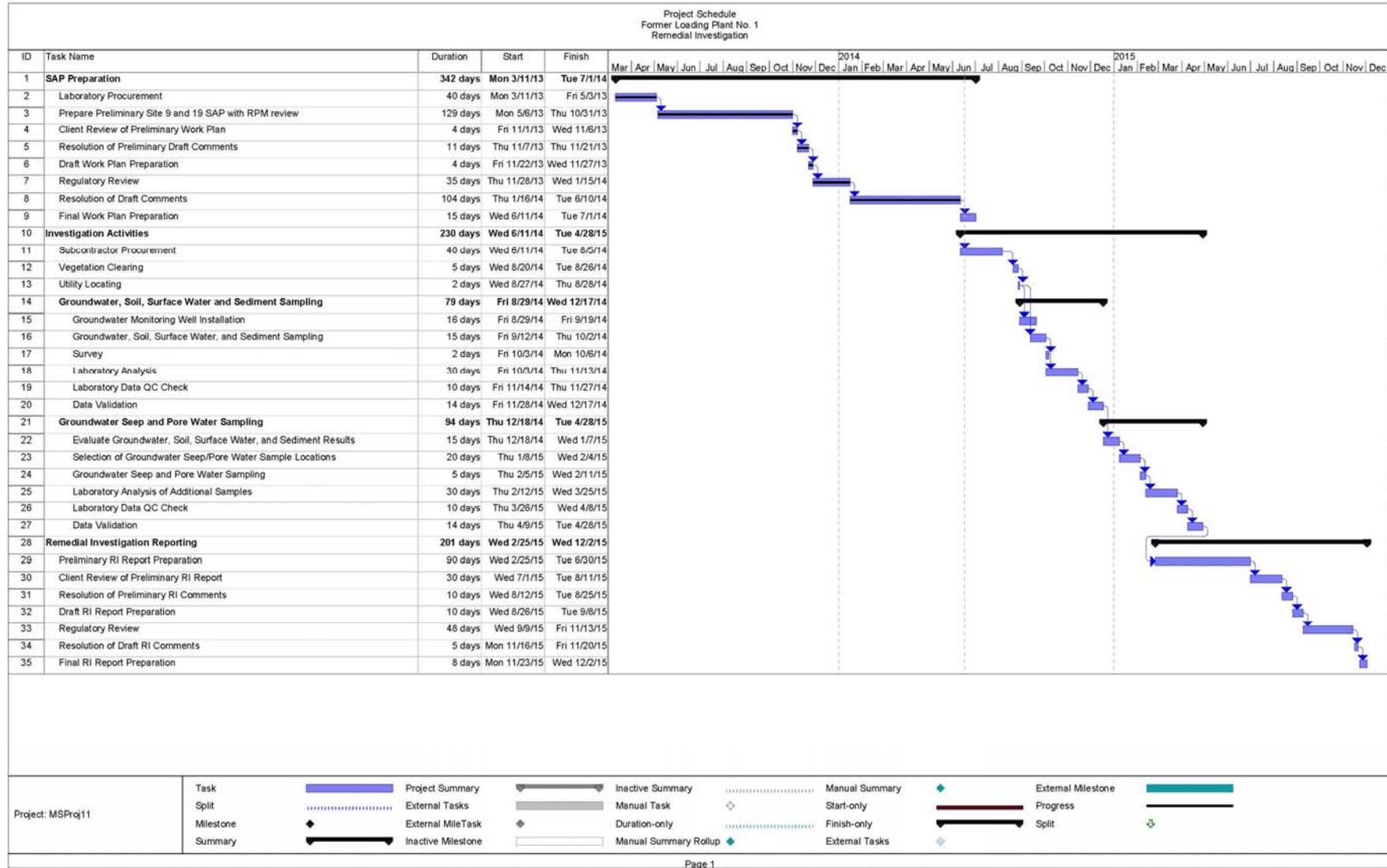
mm = millimeter

µm = micrometer

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SAP Worksheet #16—Project Schedule/Timeline Table

(UFP-QAPP Manual Section 2.8.2)



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SAP Worksheet #17—Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

| Matrix | Depths to Sample | Analysis | Approximate Number of Samples | Rationale | * Sampling Strategy |
|---|---|---------------------------------|---|--|--|
| Groundwater | Middle of well screen | Target Compound List (TCL) VOCs | 21 | <p>Sampling locations to provide sufficient spatial coverage between source and receptor (Lee Pond); sampling parameters based on historical use of VOCs, SVOCs, explosives, and metals at Loading Plant No. 1, and historical data exceeding risk-based screening levels. New groundwater monitoring well locations were selected downgradient of the Former Loading Plant No. 1 buildings to evaluate migration of contaminants from potential source areas in former building footprints.</p> <p>Groundwater samples will only be collected and analyzed for hexavalent chromium during the second mobilization if the SW-846 6020A data indicate that chromium concentrations may be of concern.</p> | <p>The 12 existing groundwater wells were installed to evaluate the historical Site 9 and 19 areas (the wastewater discharge area and the former TNT Conveyor Belt) and will be resampled to evaluate contaminant migration and concentration changes since the previous sampling event in 1995.</p> <p>One new shallow monitoring well will be installed downgradient of the former Building 98 (19GW010).</p> <p>Five new monitoring wells (four shallow and one deep) will be installed downgradient of former Building 10 to evaluate impacts from the various operational areas (mine storage, mine loading, and mine cooling) that were located in this building (19GW007, 19GW008, 19GW009, 19GW011, and 19GW012).</p> <p>One new shallow monitoring well will be installed downgradient of the former Nitrate Prep and Storage Building (19GW015).</p> <p>One new shallow monitoring well will be located downgradient of the former Building 11 (19GW014).</p> <p>One new deep monitoring well will be co-located with existing YS19-GW004 to assess deeper groundwater impacts downgradient of Site 19 (19GW013).</p> <p>See Figure 5 for proposed sampling locations.</p> |
| | | Total and Dissolved Metals | | | |
| | | Perchlorate | | | |
| | | Total Cyanide | | | |
| | | Free Cyanide | | | |
| | | SVOCs (including PAHs by SIM) | | | |
| | | Explosives | | | |
| | | 1,4-Dioxane | | | |
| | | Hexavalent Chromium | | | |
| Soil (all soil samples with the exception of the former TNT Conveyor Belt area) | 0-6 inches bgs and 6-24 inches bgs | TCL VOCs | 44 surface and 44 subsurface samples | <p>Sampling locations to provide sufficient spatial coverage in the vicinity of the former building footprints; sampling parameters based on historical use of VOCs, SVOCs, explosives, and metals at Former Loading Plant No. 1 and historical data exceeding risk-based screening levels. Soil samples were focused within the former building/structure footprints and near the loading docks/door of the former buildings.</p> <p>Soil samples will only be collected and analyzed for hexavalent chromium during the second mobilization if the SW-846 6020A data indicate that chromium concentrations may be of concern.</p> | <p>Fourteen soil locations are within the former Building 10 footprint and are distributed as follows throughout the former production areas: six locations within the Empty Mine Storage Area (19SO15 – 19SO19, 19SO21), two locations within the mine filling building (19SO13 and 19SO14), four locations within the Mine Cooling Area (19SO09 – 19SO12), and two locations within the Loaded Mine Storage Area (19SO05 and 19SO08). Ten soil locations are located within the former building loading areas (19SO01-19SO04, 19SO07-19SO08, 19SO25, 19SO27-19SO29).</p> <p>Two soil locations are within the former Building 11 footprint (19SO25 and 19SO27), and two soil locations are located within the former building loading areas (19SO26 and 19SO28).</p> <p>One soil location is within the former Building 98 footprint (19SO40), and one soil location is located within the former building loading area (19SO39).</p> <p>Two soil locations are within the former Building 527 footprint near historical floor drain locations (19SO42 and 19SO43), and two soil locations are located within the former building loading area (19SO41, 19SO44).</p> <p>Three soil locations are within the former Building 528 footprint near historical floor drain locations (19SO35, 19SO36, 19SO38), and one soil location is located within the former building loading area (19SO37).</p> <p>Six soil locations are within the former Nitrate Conveyor Belt footprint (19SO29 – 19SO34).</p> <p>See Figure 6 for proposed sampling locations.</p> |
| | | Total Metals | | | |
| | | Perchlorate | | | |
| | | Total Cyanide | | | |
| | | SVOCs (including PAHs by SIM) | | | |
| | | Explosives | | | |
| | | 1,4-Dioxane | | | |
| | | Hexavalent Chromium | | | |
| | | TOC | | | |
| | | pH | | | |
| Soil (Former TNT Conveyor Belt area) | Samples near former Building 98 (0-6 and 6-24 inches bgs) and samples beneath former conveyor belt (24-36 inches bgs) | 2,4,6-TNT | 2 surface and 8 subsurface soil samples | Sampling locations selected based on historical analytical results to confirm that 2,4,6-TNT contaminated soil exceeding site cleanup goals was removed from the site during the 1998 remedial action | <p>Two locations, to be sampled at 0-6 inches and 6-24 inches bgs are located near the former Building 98 to evaluate the 2,4,6-TNT concentrations left in place during the historical RA (19SO45 – 19SO46). Six additional sample locations to be sampled at 24-36 inches bgs are located within the former conveyor belt trench and will be used to determine whether 2,4,6-TNT concentrations exceeding the site cleanup goal were left in place during the RA (19SO47 – 19SO52).</p> <p>See Figure 8 for proposed sampling locations.</p> |
| Soil (Former TNT Conveyor Belt area) | Samples spaced along the former conveyor belt trench (12-18 inches bgs and 18-24 inches bgs) | Aluminum | 12 subsurface soil samples | Sampling locations selected along the length of the former trench to confirm that 2 feet of backfill is present above the aluminum-impacted soil at the base of the trench. | <p>Six locations to be sampled at 12-18 inches bgs and 18-24 inches bgs will be located along the length of the former conveyor belt trench to evaluate whether 2 feet of backfill are present above the aluminum-impacted soil (19SO53 – 19SO58).</p> <p>See Figure 8 for proposed sampling locations.</p> |
| | | pH | | | |

SAP Worksheet #17—Sampling Design and Rationale (continued)

| Matrix | Depths to Sample | Analysis | Approximate Number of Samples | Rationale | * Sampling Strategy |
|-------------------|---|-------------------------------|-------------------------------|--|--|
| Sediment | Grab sample at 0 to 4 inches bgs | TCL VOCs | 17 samples | <p>Samples located in the drainage ditches surrounding Former Loading Plant No. 1. Locations selected based on areas with highest potential for historical discharges.</p> <p>Sediment samples will only be collected and analyzed for hexavalent chromium during the second mobilization if the SW-846 6010B data indicate that chromium concentrations may be of concern.</p> | <p>Three sediment samples are located within the drainage ditch from the former Building 11 (19SWSD13 – 19SWSD15).</p> <p>Twelve sediment samples are located within the drainage ditch from the former Building 10 (19SWSD01 – 19SWSD12).</p> <p>Two sediment samples are located within the drainage ditch from the former Building 98 (19SWSD16 – 19SWSD17).</p> <p>See Figure 7 for proposed sampling locations.</p> |
| | | Total Metals | | | |
| | | Perchlorate | | | |
| | | Total Cyanide | | | |
| | | SVOCs (including PAHs by SIM) | | | |
| | | Explosives | | | |
| | | 1,4-Dioxane | | | |
| | | Hexavalent Chromium | | | |
| | | TOC | | | |
| | | pH | | | |
| | | AVS/SEM | | | |
| | | Grain Size | | | |
| Surface Water | Grab sample at location determined by water column monitoring | TCL VOCs | 17 samples | <p>Samples located in the drainage ditches surrounding Former Loading Plant No. 1. Locations selected based on areas with highest potential for historical discharges.</p> <p>Surface water samples will only be collected and analyzed for hexavalent chromium during the second mobilization if the SW-846 6020A data indicate that chromium concentrations may be of concern.</p> | <p>Three surface water samples are located within the drainage ditch from the former TNT Building (19SWSD13 – 19SWSD15).</p> <p>Twelve surface water samples are located within the drainage ditch from the former Building 10 (19SWSD01 – 19SWSD12).</p> <p>Two surface water samples are located within the drainage ditch from the former Building 98 (19SWSD16 – 19SWSD17).</p> <p>See Figure 7 for proposed sampling locations.</p> |
| | | Total and Dissolved Metals | | | |
| | | Perchlorate | | | |
| | | Total Cyanide | | | |
| | | Free Cyanide | | | |
| | | SVOCs (including PAHs by SIM) | | | |
| | | Explosives | | | |
| | | 1,4-Dioxane | | | |
| | | Hexavalent Chromium | | | |
| | | Hardness | | | |
| Groundwater Seeps | Grab sample directly at source | TBD | Up to 5 samples | <p>Sampling locations where contaminated groundwater may be discharging to groundwater seeps or affecting pore water</p> | <p>Sampling locations TBD based on groundwater, soil, and sediment results and site characteristics</p> |
| Pore Water | Passive diffusion sampling at 0 to 6 inches bgs | TBD | Up to 5 samples | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|--------------------------------------|---|-------------|------------------|---|---|------------------------|
| Groundwater (Mobilization #1) | | | | | | |
| YS09-GW01 | YS09-GW01-MMY | Groundwater | Middle of screen | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total and Dissolved Target Analyte List (TAL) Metals, Total and Free Cyanide, Explosives, Perchlorate | 21Field Samples Field Duplicates – YS09-GW04A, YS19-GW03, and YS19-GW12 MS/MSDs – YS09-GW02 and YS19-GW05 | Refer to Worksheet #21 |
| YS09-GW02 | YS09-GW02-MMY YS09-GW02-MMY-MS YS09-GW02-MMY-SD | | | | | |
| YS09-GW02A | YS09-GW02A-MMY | | | | | |
| YS09-GW03 | YS09-GW03-MMY | | | | | |
| YS09-GW04A | YS09-GW04A-MMY YS09-GW04AP-MMY | | | | | |
| YS19-GW01 | YS19-GW01-MMY | | | | | |
| YS19-GW02 | YS19-GW02-MMY | | | | | |
| YS19-GW03 | YS19-GW03-MMY YS19-GW03P-MMY | | | | | |
| YS19-GW03A | YS19-GW03A-MMY | | | | | |
| YS19-GW04 | YS19-GW04-MMY | | | | | |
| YS19-GW05 | YS19-GW05-MMY YS19-GW05-MMY-MS YS19-GW05-MMY-SD | | | | | |
| YS19-GW06 | YS19-GW06-MMY | | | | | |
| YS19-GW07 | YS19-GW07-MMY | | | | | |
| YS19-GW08 | YS19-GW08-MMY | | | | | |
| YS19-GW09 | YS19-GW09-MMY | | | | | |
| YS19-GW10 | YS19-GW10-MMY | | | | | |
| YS19-GW11 | YS19-GW11-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|---------------------------------------|---|--------------|------------------|---|--|------------------------|
| YS19-GW12 | YS19-GW12-MMY YS19-GW12P-MMY | | | | | |
| YS19-GW13 | YS19-GW13-MMY | | | | | |
| YS19-GW14 | YS19-GW14-MMY | | | | | |
| YS19-GW15 | YS19-GW15-MMY | | | | | |
| Surface Soil (Mobilization #1) | | | | | | |
| YS19-SO01 | YS19-SS01-MMY YS19-SS01-MMY-MS YS19-SS01-MMY-SD | Surface Soil | 0 – 6 inches bgs | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total TAL Metals, Total Cyanide, Explosives, Perchlorate, pH, TOC | 44 Field Samples Field Duplicates – SS02, SS15, SS27, SS38, and SS43 MS/MSDs – SS01, SS25, and SS39 | Refer to Worksheet #21 |
| YS19-SO02 | YS19-SS02-MMY YS19-SS02P-MMY | | | | | |
| YS19-SO03 | YS19-SS03-MMY | | | | | |
| YS19-SO04 | YS19-SS04-MMY | | | | | |
| YS19-SO05 | YS19-SS05-MMY | | | | | |
| YS19-SO06 | YS19-SS06-MMY | | | | | |
| YS19-SO07 | YS19-SS07-MMY | | | | | |
| YS19-SO08 | YS19-SS08-MMY | | | | | |
| YS19-SO09 | YS19-SS09-MMY | | | | | |
| YS19-SO10 | YS19-SS10-MMY | | | | | |
| YS19-SO11 | YS19-SS11-MMY | | | | | |
| YS19-SO12 | YS19-SS12-MMY | | | | | |
| YS19-SO13 | YS19-SS13-MMY | | | | | |
| YS19-SO14 | YS19-SS14-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|------------------|---|--------------|------------------|---|--|------------------------|
| YS19-SO15 | YS19-SS15-MMY YS19-SS15P-MMY | | | | | |
| YS19-SO16 | YS19-SS16-MMY | | | | | |
| YS19-SO17 | YS19-SS17-MMY | | | | | |
| YS19-SO18 | YS19-SS18-MMY | | | | | |
| YS19-SO19 | YS19-SS19-MMY | | | | | |
| YS19-SO20 | YS19-SS20-MMY | Surface Soil | 0 – 6 inches bgs | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total TAL Metals, Total Cyanide, Explosives, Perchlorate, pH, TOC | 44 Field Samples Field Duplicates – SS02, SS15, SS27, SS38, and SS43 MS/MSDs – SS01, SS25, and SS39 | Refer to Worksheet #21 |
| YS19-SO21 | YS19-SS21-MMY | | | | | |
| YS19-SO22 | YS19-SS22-MMY | | | | | |
| YS19-SO23 | YS19-SS23-MMY | | | | | |
| YS19-SO24 | YS19-SS24-MMY | | | | | |
| YS19-SO25 | YS19-SS25-MMY YS19-SS25-MMY-MS YS19-SS25-MMY-SD | | | | | |
| YS19-SO26 | YS19-SS26-MMY | | | | | |
| YS19-SO27 | YS19-SS27-MMY YS19-SS27P-MMY | | | | | |
| YS19-SO28 | YS19-SS28-MMY | | | | | |
| YS19-SO29 | YS19-SS29-MMY | | | | | |
| YS19-SO30 | YS19-SS30-MMY | | | | | |
| YS19-SO31 | YS19-SS31-MMY | | | | | |
| YS19-SO32 | YS19-SS32-MMY | | | | | |
| YS19-SO33 | YS19-SS33-MMY | | | | | |
| YS19-SO34 | YS19-SS34-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|--|---|-----------------|-------------------|---|--|------------------------|
| YS19-SO35 | YS19-SS35-MMY | | | | | |
| YS19-SO36 | YS19-SS36-MMY | | | | | |
| YS19-SO37 | YS19-SS37-MMY | | | | | |
| YS19-SO38 | YS19-SS38-MMY YS19-SS38P-MMY | | | | | |
| YS19-SO39 | YS19-SS39-MMY YS19-SS39-MMY-MS YS19-SS39-MMY-SD | | | | | |
| YS19-SO40 | YS19-SS40-MMY | Surface Soil | 0—6 inches bgs | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total TAL Metals, Total Cyanide, Explosives, Perchlorate, pH, TOC | 44 Field Samples Field Duplicates – SS02, SS15, SS27, SS38, and SS43 MS/MSDs – SS01, SS25, and SS39 | Refer to Worksheet #21 |
| YS19-SO41 | YS19-SS41-MMY | | | | | |
| YS19-SO42 | YS19-SS42-MMY | | | | | |
| YS19-SO43 | YS19-SS43-MMY YS19-SS43P-MMY | | | | | |
| YS19-SO44 | YS19-SS44-MMY | | | | | |
| Subsurface Soil (Mobilization #1) | | | | | | |
| YS19-SO01 | YS19-SB01-MMY | Subsurface Soil | 6 – 24 inches bgs | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total TAL Metals, Total Cyanide, Explosives, Perchlorate, pH, TOC | 44 Field Samples Field Duplicates – SB03, SB16, SB28, SB39, and SB44 MS/MSDs – SB02, SB26, and SB40 | Refer to Worksheet #21 |
| YS19-SO02 | YS19-SB02-MMY YS19-SB02-MMY-MS YS19-SB02-MMY-SD | | | | | |
| YS19-SO03 | YS19-SB03-MMY YS19-SB03P-MMY | | | | | |
| YS19-SO04 | YS19-SB04-MMY | | | | | |
| YS19-SO05 | YS19-SB05-MMY | | | | | |
| YS19-SO06 | YS19-SB06-MMY | | | | | |
| YS19-SO07 | YS19-SB07-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|------------------|---|-----------------|-------------------|--|--|------------------------|
| YS19-SO08 | YS19-SB08-MMY | | | | | |
| YS19-SO09 | YS19-SB09-MMY | | | | | |
| YS19-SO10 | YS19-SB10-MMY | | | | | |
| YS19-SO11 | YS19-SB11-MMY | | | | | |
| YS19-SO12 | YS19-SB12-MMY | | | | | |
| YS19-SO13 | YS19-SB13-MMY | | | | | |
| YS19-SO14 | YS19-SB14-MMY | Subsurface Soil | 6 – 24 inches bgs | TCL VOCs, TCL SVOCs, 1,4-dioxane Total TAL Metals, Total Cyanide, Explosives, Perchlorate, pH, TOC | 44 Field Samples Field Duplicates – SB03, SB16, SB28, SB39, and SB44 MS/MSDs – SB02, SB26, and SB40 | Refer to Worksheet #21 |
| YS19-SO15 | YS19-SB15-MMY | | | | | |
| YS19-SO16 | YS19-SB16-MMY YS19-SB16P-MMY | | | | | |
| YS19-SO17 | YS19-SB17-MMY | | | | | |
| YS19-SO18 | YS19-SB18-MMY | | | | | |
| YS19-SO19 | YS19-SB19-MMY | | | | | |
| YS19-SO20 | YS19-SB20-MMY | | | | | |
| YS19-SO21 | YS19-SB21-MMY | | | | | |
| YS19-SO22 | YS19-SB22-MMY | | | | | |
| YS19-SO23 | YS19-SB23-MMY | | | | | |
| YS19-SO24 | YS19-SB24-MMY | | | | | |
| YS19-SO25 | YS19-SB25-MMY | | | | | |
| YS19-SO26 | YS19-SB26-MMY YS19-SB26-MMY-MS YS19-SB26-MMY-SD | | | | | |
| YS19-SO27 | YS19-SB27-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|------------------|---|-----------------|-------------------|---|--|------------------------|
| YS19-SO28 | YS19-SB28-MMY YS19-SB28P-MMY | | | | | |
| YS19-SO29 | YS19-SB29-MMY | | | | | |
| YS19-SO30 | YS19-SB30-MMY | | | | | |
| YS19-SO31 | YS19-SB31-MMY | | | | | |
| YS19-SO32 | YS19-SB32-MMY | | | | | |
| YS19-SO33 | YS19-SB33-MMY | | | | | |
| YS19-SO34 | YS19-SB34-MMY | | | | | |
| YS19-SO35 | YS19-SB35-MMY | Subsurface Soil | 6 – 24 inches bgs | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total TAL Metals, Total Cyanide, Explosives, Perchlorate, pH, TOC | 44 Field Samples Field Duplicates – SB03, SB16, SB28, SB39, and SB44 MS/MSDs – SB02, SB26, and SB40 | Refer to Worksheet #21 |
| YS19-SO36 | YS19-SB36-MMY | | | | | |
| YS19-SO37 | YS19-SB37-MMY | | | | | |
| YS19-SO38 | YS19-SB38-MMY | | | | | |
| YS19-SO39 | YS19-SB39-MMY YS19-SB39P-MMY | | | | | |
| YS19-SO40 | YS19-SB40-MMY YS19-SB40-MMY-MS YS19-SB40-MMY-SD | | | | | |
| YS19-SO41 | YS19-SB41-MMY | | | | | |
| YS19-SO42 | YS19-SB42-MMY | | | | | |
| YS19-SO43 | YS19-SB43-MMY YS19-SB43P-MMY | | | | | |
| YS19-SO44 | YS19-SB44-MMY | | | | | |
| YS19-SO45 | YS19-SS45-TD-BD-MMY | Surface Soil | 0 – 6 inches bgs | 2,4,6-TNT | 2 Field Samples | Refer to Worksheet #21 |
| YS19-SO46 | YS19-SS46-TD-BD-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|------------------|------------------------|------------------|--------------------|-------------------------------|--|------------------------|
| YS19-SO45 | YS19-SB45-TD-BD-MMY | Subsurface Soil | 6-24 inches bgs | 2,4,6-TNT | 8 Field Samples | Refer to Worksheet #21 |
| YS19-SO46 | YS19-SB46-TD-BD-MMY | | | | | |
| YS19-SO47 | YS19-SB47-TB-BD-MMY | | | | | |
| YS19-SO48 | YS19-SB48-TB-BD-MMY | | | | | |
| YS19-SO49 | YS19-SB49-TB-BD-MMY | | | | | |
| YS19-SO50 | YS19-SB50-TB-BD-MMY | | | | | |
| YS19-SO51 | YS19-SB51-TB-BD-MMY | | 24 - 36 inches bgs | | | |
| YS19-SO52 | YS19-SB52-TB-BD-MMY | | | | | |
| YS19-SO53 | YS19-SB53-TB-BD-MMY | | | | | |
| YS19-SO54 | YS19-SB54-TB-BD-MMY | | | | | |
| YS19-SO55 | YS19-SB55-TB-BD-MMY | | | | | |
| YS19-SO56 | YS19-SB56-TB-BD-MMY | | | | | |
| YS19-SO57 | YS19-SB57-TB-BD-MMY | | 12-18 inches bgs | Aluminum and pH | 6 Field Samples | Refer to Worksheet #21 |
| YS19-SO58 | YS19-SB58-TB-BD-MMY | | | | | |
| YS19-SO53 | YS19-SB53-TB-BD-MMY | | | | | |
| YS19-SO54 | YS19-SB54-TB-BD-MMY | | | | | |
| YS19-SO55 | YS19-SB55-TB-BD-MMY | | | | | |
| YS19-SO56 | YS19-SB56-TB-BD-MMY | | | | | |
| YS19-SO57 | YS19-SB57-TB-BD-MMY | 18-24 inches bgs | | | | |
| YS19-SO58 | YS19-SB58-TB-BD-MMY | | | | | |
| | | | | | 6 Field Samples | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|-----------------------------------|---|----------|------------------|---|---|------------------------|
| Sediment (Mobilization #1) | | | | | | |
| YS19-SWSD01 | YS19-SD01-MMY YS19-SD01-MMY-MS YS19-SD01-MMY-SD | Sediment | 0 – 4 inches bgs | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total TAL Metals, Total Cyanide, Explosives, Perchlorate, pH, TOC, AVS/SEM, grain size | 17 Field Samples Field Duplicates – SD02, SD11 MS/MSD – SD01 | Refer to Worksheet #21 |
| YS19-SWSD02 | YS19-SD02-MMY YS19-SD02P-MMY | | | | | |
| YS19-SWSD03 | YS19-SD03-MMY | | | | | |
| YS19-SWSD04 | YS19-SD04-MMY | | | | | |
| YS19-SWSD05 | YS19-SD05-MMY | | | | | |
| YS19-SWSD06 | YS19-SD06-MMY | | | | | |
| YS19-SWSD07 | YS19-SD07-MMY | | | | | |
| YS19-SWSD08 | YS19-SD08-MMY | | | | | |
| YS19-SWSD09 | YS19-SD09-MMY | | | | | |
| YS19-SWSD10 | YS19-SD10-MMY | | | | | |
| YS19-SWSD11 | YS19-SD11-MMY YS19-SD11P-MMY | | | | | |
| YS19-SWSD12 | YS19-SD12-MMY | | | | | |
| YS19-SWSD13 | YS19-SD13-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|--|---|---------------|---------------|---|--|------------------------|
| YS19-SWSD14 | YS19-SD14-MMY | | | | | |
| YS19-SWSD15 | YS19-SD15-MMY | | | | | |
| YS19-SWSD16 | YS19-SD16-MMY | | | | | |
| YS19-SWSD17 | YS19-SD17-MMY | | | | | |
| Surface Water (Mobilization #1) | | | | | | |
| YS19-SWSD01 | YS19-SW01-MMY | Surface Water | N/A | TCL VOCs, TCL SVOCs, 1,4-dioxane, Total and Dissolved TAL Metals, Total and Free Cyanide, Explosives, Perchlorate, and Hardness | 17 Field Samples Field Duplicates – SW04, SW08 MS/MSD – SW10 | Refer to Worksheet #21 |
| YS19-SWSD02 | YS19-SW02-MMY | | | | | |
| YS19-SWSD03 | YS19-SW03-MMY | | | | | |
| YS19-SWSD04 | YS19-SW04-MMY YS19-SW04P-MMY | | | | | |
| YS19-SWSD05 | YS19-SW05-MMY | | | | | |
| YS19-SWSD06 | YS19-SW06-MMY | | | | | |
| YS19-SWSD07 | YS19-SW07-MMY | | | | | |
| YS19-SWSD08 | YS19-SW08-MMY YS19-SW08P-MMY | | | | | |
| YS19-SWSD09 | YS19-SW09-MMY | | | | | |
| YS19-SWSD10 | YS19-SW10-MMY YS19-SW10-MMY-MS YS19-SW10-MMY-SD | | | | | |
| YS19-SWSD11 | YS19-SW11-MMY | | | | | |
| YS19-SWSD12 | YS19-SW12-MMY | | | | | |
| YS19-SWSD13 | YS19-SW13-MMY | | | | | |
| YS19-SWSD14 | YS19-SW14-MMY | | | | | |
| YS19-SWSD15 | YS19-SW15-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|---|------------------------|------------------------------------|------------------|-------------------------------|--|------------------------|
| YS19-SWSD16 | YS19-SW16-MMY | | | | | |
| YS19-SWSD17 | YS19-SW17-MMY | | | | | |
| Groundwater Seeps (Mobilization #2) | | | | | | |
| YS19-SP01 | YS19-SP01-MMY | Seeps (Optional) ⁴ | N/A | TBD | Up to 5 samples Field Duplicates – SP01 MS/MSD – SP02 | Refer to Worksheet #21 |
| YS19-SP02 | YS19-SP02-MMY | | | | | |
| YS19-SP03 | YS19-SP03-MMY | | | | | |
| YS19-SP04 | YS19-SP04-MMY | | | | | |
| YS19-SP05 | YS19-SP05-MMY | | | | | |
| Pore Water (Mobilization #2) | | | | | | |
| YS19-WN01 | YS19-WN01-MMY | Pore Water (Optional) ⁴ | N/A | TBD | Up to 5 samples Field Duplicates – WN01 MS/MSD – WN-02 | Refer to Worksheet #21 |
| YS19-WN02 | YS19-WN02-MMY | | | | | |
| YS19-WN03 | YS19-WN03-MMY | | | | | |
| YS19-WN04 | YS19-WN04-MMY | | | | | |
| YS19-WN05 | YS19-WN05-MMY | | | | | |
| Various Media to be Analyzed for Hexavalent Chromium (Mobilization #2)⁵ | | | | | | |
| YS19-GWXX | YS19-GWXX-MMY | Groundwater | Middle of screen | Hexavalent chromium | SW-846 7199 | Refer to Worksheet #21 |
| YS19-SOXX | YS19-SSXX-MMY | Surface Soil | 0-6 inches | Hexavalent chromium | SW-846 7199 | Refer to Worksheet #21 |
| YS19-SOXX | YS19-SBXX-MMY | Subsurface Soil | 6-24 inches bgs | Hexavalent chromium | SW-846 7199 | Refer to Worksheet #21 |
| YS19-SWSDXX | YS19-SDXX-MMY | Sediment | 0 -4 inches bgs | Hexavalent chromium | SW-846 7199 | Refer to Worksheet #21 |
| YS19-SWSDXX | YS19-SWXX-MMY | Surface Water | N/A | Hexavalent chromium | SW-846 7199 | Refer to Worksheet #21 |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ¹ | Matrix | Depth (units) | Analytical Group ² | Number of Samples (identify field duplicates) ³ | Sampling SOP Reference |
|------------------|------------------------|------------|---------------|-------------------------------|--|------------------------|
| YS19-SPXX | YS19-SPXX-MMY | Seeps | N/A | Hexavalent chromium | SW-846 7199 | Refer to Worksheet #21 |
| YS19-WNXX | YS19-WNXX-MMY | Pore Water | N/A | Hexavalent chromium | SW-846 7199 | Refer to Worksheet #21 |

Notes:

¹ Additional nomenclature instructions are as follows.

- Duplicates will have "P" added after the station indicator; for example, YS19-SB01P-MMY.
- For all sample IDs, "MMYY" will be replaced with the two-digit month and year in which the sample was collected.
- For soil samples collected from depths other than 0-6 inches bgs (surface soil) and 6-24 inches bgs (subsurface soil), sample IDs will include the top depth and bottom depth in two-digit feet bgs; this is indicated in sample IDs by "TB-BD."
- Equipment blanks will be identified with the two-digit month, day, and year, and what matrix it is relevant to; for example, YS19-EBMMDDYY-SO.
- Trip blanks will be identified with the two-digit month, day, and year, and whether it is the first or other trip blank of the day; for example, YS19-TB01-MMDDYY.

² Additional samples may be collected and analyzed for hexavalent chromium, if the total metals analytical results indicate that chromium levels are of concern at the site during Mobilization #2.

³ Sample counts shown here do not include duplicates or MS/MSD.

⁴ Seeps and pore water will only be sampled if they are observed and if analytical results from other media indicate that site contaminants may be affecting these media.

⁵ The need for hexavalent chromium sampling during the second mobilization will be determined after review of the total chromium results. If collected, the exact number and sample locations for hexavalent chromium analysis will be determined at a later date.

ID - identification

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SAP Worksheet #19—Analytical SOP Requirements Table

| Matrix | Analytical Group ¹ | Preparation and Analytical Method / SOP Reference | Containers (Number, Size, and Type) | Minimum Sample Amount Required for Analysis | Preservation Requirements (Chemical, Temperature, Light Protected) | Maximum Holding Time |
|-------------------------------|-------------------------------------|---|---|---|--|--|
| Groundwater | VOCs | SW-846 5030B, 8260B / M8260B/C | Three 40-milliliter (mL) volatile organic analyte (VOA) vials | 40 mL | < 6 °C but not frozen; hydrochloric acid (HCl) to pH < 2 | 14 days |
| | SVOCs (including 1,4-dioxane) | SW-846 3510C, 8270D / M3510C,3580A, M8270C/D | Two 1-liter (L) glass, amber | 1 L | < 6 °C but not frozen | 7 days to extraction / 40 days to analysis |
| | | SW-846 3510C, 8270D SIM / M3510C,3580A, M8270C/D | | | | |
| | METALS | SW-846 3010A, 6020A / M3010A, M6020/6020A | One 500-mL high-density polyethylene (HDPE) | 50 mL | < 6 °C but not frozen; nitric acid (HNO ₃) to pH < 2 | 180 days 28 days (Mercury) |
| | | SW-846 7470A / M7470A | One 250-mL HDPE | 30 mL | | 28 days |
| | | SW-846 9012B / M9010C, M9012B | Two 1-L HDPE | 1 L | < 6 °C but not frozen; sodium hydroxide (NaOH) to pH > 12 | 14 days |
| | | SW-846 7199 / GEN-7199 | One 250-mL HDPE | 10 mL | < 6 °C but not frozen | 24 hours |
| | FMETALS | SW-846 3010A, 6020A / M3010A, M6020/6020A | One 500-mL HDPE | 50 mL | Field filter; < 6 °C but not frozen; HNO ₃ to pH < 2 | 180 days 28 days (Mercury) |
| | | SW-846 7470A / M7470A | One 250-mL HDPE | 30 mL | | 28 days |
| | EXPLOs | SW-846 3535A, 8330B / M3535A, M8330/A | Two 1-L glass, amber | 1 L | < 6 °C but not frozen | 7 days to extraction / 40 days to analysis |
| | | SW-846 6850 / HPLC-6850 | One 125-mL HDPE | 10 mL | < 6 °C but not frozen | 28 days |
| | Surface Water, Pore Water, or Seeps | VOCs | SW-846 5030B, 8260B / M8260B/C | Three 40-mL VOA vials | 40 mL | < 6 °C but not frozen; HCl to pH < 2 |
| SVOCs (including 1,4-dioxane) | | SW-846 3510C, 8270D / M3510C,3580A, M8270C/D | Two 1-L glass, amber | 1 L | < 6 °C but not frozen | 7 days to extraction / 40 days to analysis |
| METALS | | SW-846 3010A, 6020A / M3010A, M6020/6020A | One 500-mL HDPE | 50 mL | < 6 °C but not frozen; HNO ₃ to pH < 2 | 180 days |
| | | SW-846 7470A / M7470A | One 250-mL HDPE | 30 mL | | 28 days |
| | | SW-846 9012B / M9010C, M9012B | Two 1-L HDPE | 1 L | < 6 °C but not frozen; NaOH to pH > 12 | 14 days |
| FMETALS | | SW-846 3010A, 6020A / M3010A, M6020/6020A | One 500-mL HDPE | 50 mL | Field filter; < 6 °C but not frozen; HNO ₃ to pH < 2 | 180 days |
| | | SW-846 7470A / M7470A | One 250-mL HDPE | 30 mL | | 28 days |
| EXPLOs | | SW-846 3535A, 8330B / M3535A, M8330/A | Two 1-L glass, amber | 1 L | < 6 °C but not frozen | 7 days to extraction / 40 days to analysis |
| | | SW-846 6850 / HPLC-6850 | One 125-mL HDPE | 10 mL | | 28 days |
| Wet Chem | | EPA 200.7 (Hardness) / M200.7-2340B | N/A (calculation) | | | |

SAP Worksheet #19—Analytical SOP Requirements Table (continued)

| Matrix | Analytical Group ¹ | Preparation and Analytical Method / SOP Reference | Containers (Number, Size, and Type) | Minimum Sample Amount Required for Analysis | Preservation Requirements (Chemical, Temperature, Light Protected) | Maximum Holding Time |
|----------------------------------|-------------------------------|---|-------------------------------------|---|--|---|
| Surface Soil, or Subsurface Soil | VOCs (including 1,4-Dioxane) | SW-846 5035A, 8260B / M8260B/C | Three TerraCores | Three TerraCores - 2 with DI water, 1 with methanol | < 6 °C but not frozen | 48 hours to freeze, 14 days to analysis |
| | SVOCs | SW-846 3541, 3510C, 8270D / M3541, M3510C,3580A, M8270C/D | One 8-ounce (oz) glass wide-mouth | 30 grams (g) | | 14 days to extraction / 40 days to analysis |
| | METALS | SW-846 3050B, 6020A / M3050B, M6020/6020A | | 2 g | | 180 days |
| | | SW-846 7471A / M7471A/B | 0.6 g | 28 days | | |
| | | SW-846 9012B / M9010C, M9012B | One 4-oz glass, wide-mouth | 1 g | | 14 days |
| | EXPLOs | SW-846 3060A, 7199 / GEN-3060, GEN-7199 | One 4-oz glass, wide-mouth | 2.5 g | | 30 days to extraction / 7 days to analysis |
| | | SW-846 8330B / M8330-A-Explosives salting prep, M8330/A | One 8-oz glass wide-mouth | 10 g | | 14 days to extraction / 40 days to analysis |
| | | SW-846 6850 / HPLC-6850 | One 4-oz glass, amber wide-mouth | 1 g | | 28 days |
| | Wet Chem | SW-846 9045D / M9045C,D | One 4-oz glass, wide-mouth | 5 g | | As soon as possible (ASAP) |
| | | Lloyd Kahn / M-Lloyd Kahn | | 40 milligrams (mg) | | 14 days |
| Sediment | VOCs (including 1,4-Dioxane) | SW-846 5035A, 8260B / M8260B/C | Three TerraCores | Three TerraCores - 2 with DI water, 1 with methanol | < 6 °C but not frozen | 14 days |
| | SVOCs | SW-846 M3541, M3510C, 8270D / M3541, M3510C,3580A, M8270C/D | One 8-oz glass wide-mouth | 30 g | | 14 days to extraction / 40 days to analysis |
| | METALS | SW-846 3050B, 6010B / M3050B, M6010B/C | | 2 g | | 180 days |
| | | SW-846 7471A / M7471A/B | 0.6 g | 28 days | | |
| | | SW-846 9012B / M9010C, M9012B | One 4-oz glass, wide-mouth | 1 g | | 14 days |
| | EXPLOs | SW-846 8330B / M8330-A-Explosives salting prep, M8330/A | One 8-oz glass wide-mouth | 10 g | | 14 days to extraction / 40 days to analysis |
| | | SW-846 6850 / HPLC-6850 | One 4-oz glass, amber wide-mouth | 1 g | | 28 days |
| | Wet Chem | SW-846 9045D / M9045C,D | One 4-oz glass, wide-mouth | 5 g | | ASAP |
| | | Lloyd Kahn / M-Lloyd Kahn | | 40 mg | | 14 days |
| | | Grain Size / ASTM D422 | | One 8-oz glass wide-mouth | | 400 g |
| AVS/SEM | EPA821R91100/ M AVS-04 | One 4-oz glass, wide-mouth | 5 g | < 6 °C but not frozen | 14 days | |

Notes:

¹ Refer to Worksheet #18 for details regarding analytical groups to be tested for each media.

SAP Worksheet #20—Field Quality Control Sample Summary Table

| Matrix | Analytical Group | No. of Sampling Locations | No. of Field Duplicates ¹ | No. of MS/MSDs ¹ | No. of Equip. Blanks ¹ | No. of Trip Blanks ¹ | Total No. of Samples to Lab ¹ |
|---------------------|-----------------------------|---------------------------|--------------------------------------|-----------------------------|-----------------------------------|---------------------------------|--|
| Groundwater | VOCs | 21 | 3 | 2/2 | 6 | 6 | 40 |
| | SVOCs including 1,4-Dioxane | 21 | 3 | 2/2 | 6 | - | 34 |
| | Total Metals | 21 | 3 | 2/2 | 6 | - | 34 |
| | Dissolved Metals | 21 | 3 | 2/2 | 6 | - | 34 |
| | Cyanide | 21 | 3 | 2/2 | 6 | - | 34 |
| | Free Cyanide | 21 | 3 | 2/2 | 6 | - | 34 |
| | Explosives | 21 | 3 | 2/2 | 6 | - | 34 |
| | Explosives (Perchlorate) | 21 | 3 | 2/2 | 6 | - | 34 |
| Surface Water | VOCs | 17 | 2 | 1/1 | 2 | 2 | 25 |
| | SVOCs including 1,4-Dioxane | 17 | 2 | 1/1 | 2 | - | 23 |
| | Total Metals | 17 | 2 | 1/1 | 2 | - | 23 |
| | Dissolved Metals | 17 | 2 | 1/1 | 2 | - | 23 |
| | Cyanide | 17 | 2 | 1/1 | 2 | - | 23 |
| | Free Cyanide | 17 | 2 | 1/1 | 2 | - | 23 |
| | Explosives | 17 | 2 | 1/1 | 2 | - | 23 |
| | Explosives (Perchlorate) | 17 | 2 | 1/1 | 2 | - | 23 |
| Wet Chem (Hardness) | 17 | - | - | - | - | 17 | |

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

| Matrix | Analytical Group | No. of Sampling Locations | No. of Field Duplicates ¹ | No. of MS/MSDs ¹ | No. of Equip. Blanks ¹ | No. of Trip Blanks ¹ | Total No. of Samples to Lab ¹ |
|-----------------|------------------------------|---------------------------|--------------------------------------|-----------------------------|-----------------------------------|---------------------------------|--|
| Surface Soil | VOCs including 1,4-Dioxane | 44 | 5 | 3/3 | 3 | 3 | 61 |
| | SVOCs | 44 | 5 | 3/3 | 3 | - | 58 |
| | Metals | 44 | 5 | 3/3 | 3 | - | 58 |
| | Metals (Hexavalent Chromium) | 2 | 1 | 1/1 | 1 | - | 6 |
| | Cyanide | 44 | 5 | 3/3 | 3 | - | 58 |
| | Explosives | 44 | 5 | 3/3 | 3 | - | 58 |
| | Explosives (2,4,6-TNT only) | 2 | - | - | - | - | 2 |
| | Explosives (Perchlorate) | 44 | 5 | 3/3 | 3 | - | 58 |
| | Wet Chem (pH, TOC) | 44 | - | - | - | - | 44 |
| Subsurface Soil | VOCs including 1,4-Dioxane | 44 | 5 | 3/3 | 3 | 3 | 61 |
| | SVOCS | 44 | 5 | 3/3 | 3 | - | 58 |
| | Metals | 44 | 5 | 3/3 | 3 | - | 58 |
| | Metals (Aluminum only) | 12 | - | - | - | - | 12 |
| | Cyanide | 44 | 5 | 3/3 | 3 | - | 58 |
| | Explosives | 44 | 5 | 3/3 | 3 | - | 58 |
| | Explosives (2,4,6-TNT only) | 8 | - | - | - | - | 8 |
| | Explosives (Perchlorate) | 44 | 5 | 3/3 | 3 | - | 58 |
| | Wet Chem (pH and/or TOC) | 56 | - | - | - | - | 56 |

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

| Matrix | Analytical Group | No. of Sampling Locations | No. of Field Duplicates ¹ | No. of MS/MSDs ¹ | No. of Equip. Blanks ¹ | No. of Trip Blanks ¹ | Total No. of Samples to Lab ¹ |
|-------------------------|--|---------------------------|--------------------------------------|-----------------------------|-----------------------------------|---------------------------------|--|
| Sediment | VOCs including 1,4-Dioxane | 17 | 2 | 1/1 | 2 | 2 | 25 |
| | SVOCS | 17 | 2 | 1/1 | 2 | - | 23 |
| | Metals | 17 | 2 | 1/1 | 2 | - | 23 |
| | Cyanide | 17 | 2 | 1/1 | 2 | - | 23 |
| | Explosives | 17 | 2 | 1/1 | 2 | - | 23 |
| | Explosives (Perchlorate) | 17 | 2 | 1/1 | 2 | - | 23 |
| | Wet Chem (pH, TOC) | 17 | - | - | - | - | 17 |
| | AVS/SEM | 17 | - | - | - | - | 17 |
| | Grainsize | 17 | - | - | - | - | 17 |
| Optional Samples | | | | | | | |
| Groundwater | Total Metal (Hexavalent Chromium) ³ | - | - | - | - | - | - |
| Surface Soil | Metals (Hexavalent Chromium) ³ | - | - | - | - | - | - |
| Subsurface Soil | Metals (Hexavalent Chromium) ³ | - | - | - | - | - | - |
| Sediment | Total Metal (Hexavalent Chromium) ³ | - | - | - | - | - | - |
| Surface Water | Metals (Hexavalent Chromium) ³ | - | - | - | - | - | - |
| Pore Water | Metals (Hexavalent Chromium) ³ | - | - | - | - | - | - |
| Groundwater Seeps | Metals (Hexavalent Chromium) ³ | - | - | - | - | - | - |

SAP Worksheet #20—Field Quality Control Sample Summary Table (continued)

| Matrix | Analytical Group | No. of Sampling Locations | No. of Field Duplicates ¹ | No. of MS/MSDs ¹ | No. of Equip. Blanks ¹ | No. of Trip Blanks ¹ | Total No. of Samples to Lab ¹ |
|--------------------------------------|-----------------------------|---------------------------|--------------------------------------|-----------------------------|-----------------------------------|---------------------------------|--|
| Pore Water and/or Seeps ² | VOCs | 10 | 2 | 1/1 | 2 | 2 | 18 |
| | SVOCs including 1,4-Dioxane | 10 | 2 | 1/1 | 2 | - | 16 |
| | Total Metals | 10 | 2 | 1/1 | 2 | - | 16 |
| | Dissolved Metals | 10 | 2 | 1/1 | 2 | - | 16 |
| | Cyanide | 10 | 2 | 1/1 | 2 | - | 16 |
| | Free Cyanide | 10 | 2 | 1/1 | 2 | - | 16 |
| | Explosives | 10 | 2 | 1/1 | 2 | - | 16 |
| | Explosives (Perchlorate) | 10 | 2 | 1/1 | 2 | - | 16 |
| | Wet Chem (Hardness) | 10 | - | - | - | - | 10 |

Notes:

- ¹ The number of field QC samples to be collected is dependent on the number of parent samples and the number of days of the sampling event.
 - Field duplicates are collected at a frequency of 1 per 10 field samples per matrix.
 - MS/MSD pairs are collected at a frequency of 1 per 20 samples per matrix sent to the laboratory (including duplicates).
 - Equipment blanks for decontaminated equipment are collected once per day of sampling, per type of equipment. Equipment blanks for disposable equipment are collected once per lot.
 - Trip blanks are collected for each cooler to the laboratory containing VOC samples.
 - Field blanks will not be collected as part of this investigation.
- ² Samples from groundwater seeps will only be collected if groundwater seeps are observed at the time of sampling. No more than 10 samples will be collected.
- ³ The number of hexavalent chromium samples is dependent upon the results of the total metals analysis. Select media may be sampled for hexavalent chromium analysis.

SAP Worksheet #21—Project Sampling SOP References Table

[\(UFP-QAPP Manual Section 3.1.2\)](#)

| Reference | Title, Revision Date and/or Number | Originating Organization of Sampling SOP | Equipment Type | Modified for Project Work? (Y/N) |
|--------------------------|--|--|--|----------------------------------|
| Dispose | <i>Disposal of Waste Fluids and Solids, 8/2012</i> | CH2M HILL | Fluids – 55-gallon drum, tools to secure drum, funnel, labels, marking pen, seals for drum Solids – 55-gallon drum, tools to secure drum, plastic sheets, labels, marking pen | N |
| DrumSample | <i>Sampling Contents of Tanks and Drums, 8/2012</i> | CH2M HILL | Drum/tank, sampling instrument, gloves, plastic sheets, labels, monitoring instrument | N |
| LogBooks | <i>Preparing Field Log Books, 8/2012</i> | CH2M HILL | Logbook, Indelible pen | N |
| OVA | <i>Volatiles Monitoring with an OVA, 8/2012</i> | CH2M HILL | Operations manual, organic vapor analyzer (OVA) unit (Minirae 2000), 100 ppm isobutylene as calibration gas, T-type feeder tube with regulator | N |
| ShipLowConc | <i>Packaging and Shipping Procedures for Low-Concentration Samples, 8/2012</i> | CH2M HILL | Coolers, duct tape, ice, strapping tape, packaging material, Ziploc bags, custody seals, chain-of-custody | N |
| Utility Location_General | <i>Locating and Clearing Underground Utilities, 8/2012</i> | CH2M HILL | Subsurface locating instruments, spray paint (provided by utility locating contractor), historical documents, facility as built diagrams | N |
| Soils | <i>Soil Sampling, 8/2012</i> | CH2M HILL | Stainless steel trowel, thin-walled sampling tubes, drilling rig, stainless steel bowl, sample bottles | N |
| MWInstall | <i>General Guidance for Monitoring Well Installation, 8/2012</i> | CH2M HILL | Drilling rig, well construction materials, well development materials | N |
| LowFlow-EPA RegI&III | <i>Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III</i> | CH2M HILL | Pump, water quality meter with flow-through cell, water level indicator, power source for the pump, tubing, sample bottles, gloves | N |
| SedSamp | <i>Sediment Sampling, 8/2012</i> | CH2M HILL | Stainless steel trowel, stainless steel bowl, sample bottles, gloves | N |
| SWSamp | <i>Surface Water Sampling, 8/2012</i> | CH2M HILL | Sample containers, gloves | N |
| Seep | <i>Seep Groundwater Sample Collection, 8/2012</i> | CH2M HILL | Stainless steel or PVC drive point, hammer, peristaltic pump with tubing or small bailer, sample containers, gloves | N |
| PoreWater | <i>Groundwater-Surface Water Investigation: Well Point Method Pore Water Sampling Procedures</i> | CH2M HILL | Well point apparatus, water quality meter, hammer, sample tubing, in-line filters, pump, measuring tape | N |

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SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table

[\(UFP-QAPP Manual Section 3.1.2.4\)](#)

| Field Equipment | Activity | Frequency | Acceptance Criteria | CA | Resp. Person | SOP Reference |
|---------------------------------------|--|--|--|--|--------------|-----------------------|
| Water quality meter | Check mechanical and electronic parts, verify system continuity, check battery and clean probes. Calibration check. | Daily before use, at the end of the day, and when unstable readings occur. | Stable readings after 3 minutes. pH reads 4.0 ± 3 percent conductivity reads 4.49 ± 3 percent turbidity reads $0 \pm 3\%$ | Clean probe with DI water and calibrate again. Do not use instrument if not able to calibrate properly. | FTL | Water Qual-Horiba-YSI |
| Multi-RAE 2000 PID | Maintenance- Check mechanical and electronic parts, verify system continuity, check battery and clean filter (change if clogged or dirty). Calibration check | Daily before use, at the end of the day, and when unstable readings occur. | Fresh air calibration reads $0.0 \text{ ppm} \pm 3.0 \text{ ppm}$, span gas calibration (isobutylene) reads $100.0 \text{ ppm} \pm 3.0 \text{ ppm}$ | Replace filter, clean airway and check for obstructions. Use external filter if there is high humidity or if it is raining. Do not use instrument if not able to calibrate properly. | FTL | MiniRAE 2000 |
| Groundwater sampling pumps and tubing | Visual inspection of equipment and materials | During each use | Maintained in good working order per manufacturer's recommendations | Replace items | FTL | LowFlow |

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SAP Worksheet #23—Analytical SOP References Table

| Lab SOP Number | Title, Revision Date, and Number | Date reviewed if not revised | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis ¹ | Variance to QSM | Modified for Project Work? |
|---------------------------------|--|------------------------------|------------------------------|---|-------------------------------------|---|-----------------|----------------------------|
| 4.2 | Processing of Samples; May 1, 2013. | | N/A (Receiving) | SD / GRAINSIZE | N/A (Receiving) | Geostructures | N/A | N |
| ASTM D422 | Geostructures employs ASMT D422 for analysis of grain size. Because of copyright restrictions, this method is not available for distribution. | | Screening | SD / GRAINSIZE | Hydrometer | Geostructures | N/A | N |
| M200.7-2340B | Total Hardness by EPA Method 200.7 and Standard Method 2340B; April 22, 2002; Rev. 06. | 3/8/2013 | Screening | SW, PW, Seeps / WCHEM | N/A (Titration) | Chemtech | None | N |
| M3010A | Digestion procedure for the determination of total metals in water and wastewater that contain suspended solids by inductively coupled plasma (ICP) atomic emission spectrometry (AES) using Test Methods for Evaluating Solid Waste, SW846, 3rd Edition, Method 3010A, March 8, 2013, Rev.11. | | Definitive | GW, SW, PW, Seeps / METAL, FMETAL | N/A | Chemtech | None | N |
| M3050B | Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, Method 3050B, March 8, 2013, Rev.14 | | Definitive | SS, SB, SD / METALS | N/A | Chemtech | None | N |
| M3510C,3580A | Extractions preparation of Extractable SVOCs to be analyzed by SW846 Method 8270C/D, February 25, 2013, Rev. 13. | | Definitive | GW, SW, PW, Seeps, SS, SB, SD / SVOC | N/A | Chemtech | None | N |
| M3535A | Sample Preparation for High-performance Liquid Chromatography (HPLC) Explosives by Method SW 846 3535A, September 2009, Rev.02. | 05/29/2013 | Definitive | GW, SW, PW, Seeps / EXPLO | N/A | Chemtech | None | N |
| M3541 | Automated Soxhlet Extraction Procedure by Method SW 846 3541 modified, February 25, 2013, Rev.06. | | Definitive | SS, SB, SD / SVOC | N/A | Chemtech | None | N |
| M6010B/C | Trace Elemental Analysis by Inductively Coupled Plasma-Atomic Emission Spectrometric Method; March 8, 2013; Rev. 19. | | Definitive | SD / METAL | ICP-AES | Chemtech | None | N |
| M6020/6020A | Trace Elemental Analysis by ICP-Mass Spectrometric Method; March 8, 2013; Rev. 15. | | Definitive | GW, SW, PW, Seeps, SS, SB / METAL, FMETAL | ICP-MS | Chemtech | None | N |
| M7470A | Mercury Analysis in Liquid Waste by Cold Vapor Technique; March 8, 2013; Rev. 13. | | Definitive | GW, SW, PW, Seeps / METAL, FMETAL | Cold vapor atomic absorption (CVAA) | Chemtech | None | N |
| M7471A/B | Mercury Analysis in Soil and Sediments by Cold Vapor Technique; March 8, 2013; Rev. 12. | | Definitive | SS, SB, SD / METAL | CVAA | Chemtech | None | N |
| M8260B/C | VOCs by Gas Chromatography/Mass Spectrometry (GC/MS) - SW 846 Method 8260B/C; January 28, 2013; Rev. 19. | | Definitive | GW, SW, PW, Seeps, SS, SB, SD / VOC | GC/MS | Chemtech | None | N |
| M8270C/D | Determination of Extractable SVOCs by SW-846 Method 8270C/D; February 28, 2013; Rev. 18. | | Definitive | GW, SW, PW, Seeps, SS, SB, SD / SVOC | GC/MS | Chemtech | None | N |
| M8330/A | Determination of Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC) by using SW-846 Method 8330/A; March 29, 2013; Rev. 11. | | Definitive | GW, SW, PW, Seeps, SS, SB, SD / EXPLO | HPLC | Chemtech | None | N |
| M8330-A-Explosives salting prep | Sample preparation for explosives analysis using SW-846 Method 8330/8330A, September 2009, Rev.2. | 05/29/2013 | Definitive | SS, SB, SD / EXPLO | N/A | Chemtech | None | N |
| M9010C | Determination of Total Cyanide and Amenable Cyanide by Midi Distillation using Method SW 846 9010C, March 15, 2013, Rev.13. | | Definitive | GW, SW, PW, Seeps, SS, SB, SD / METAL | N/A | Chemtech | None | N |
| M9012A/B | Determination of Total Cyanide by Method SW-846 9012A/B; May 23, 2011; Rev. 13. | 5/23/2012 | Definitive | GW, SW, PW, Seeps, SS, SB, SD / METAL | Spectrometer | Chemtech | None | N |
| M9045C,D | Determination of pH in Soil and Waste by SW-846 Method 9045C; March 15, 2013; Rev. 09. | | Screening | SS, SB, SD / WCHEM | pH Meter | Chemtech | None | N |
| M-AVS-04 | Determination of AVSs in Sediment; March 15, 2013; Rev. 04. | | Screening | SD / WCHEM | Spectrophotometer | Chemtech | None | N |
| M-Lloyd Kahn | Determination of TOC in Sediment; March 15, 2013; Rev. 05. | | Screening | SD / WCHEM | TOC Analyzer | Chemtech | None | N |
| GEN-3060 | Alkaline Digestion for Hexavalent Chromium in Soil; March 1, 2013; Rev. 03. | | Definitive | SS, SB / METAL | N/A (Digestion) | ALS - Rochester | None | N |

SAP Worksheet #23—Analytical SOP References Table (continued)

| Lab SOP Number | Title, Revision Date, and Number | Date reviewed if not revised | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis ¹ | Variance to QSM | Modified for Project Work? |
|----------------|--|------------------------------|------------------------------|--|-----------------|---|-----------------|----------------------------|
| GEN-7199 | Hexavalent Chromium by Ion Chromatography (IC) for Water and Soil Extracts; June 7, 2012; Rev. 05. | In Review | Definitive | GW, SS, SB / METAL | IC | ALS - Rochester | None | N |
| HPLC-6850 | SOP for Perchlorate in Water, Soils, and Solid Wastes using High Performance Liquid Chromatography/Electrospray Ionization/Mass Spectrometry (HPLC/ESI/MS); October 25, 2011; Rev. 05. | 8/27/2012 | Definitive | GW, SW, PW, Seeps, SS, SB, SD / EXPLO | HPLC | ALS - Rochester | None | N |
| SMO-GEN | Sample Receiving; November 5, 2012; Rev. 08. | | N/A (Receiving) | GW, SW, PW, Seeps, SS, SB, SD / METAL, EXPLO | N/A (Receiving) | ALS - Rochester | N/A | N |
| SMO-SPLDIS | Sample Disposal; January 15, 2013; Rev. 05. | | N/A (Disposal) | GW, SW, PW, Seeps, SS, SB, SD / METAL, EXPLO | N/A (Disposal) | ALS - Rochester | N/A | N |
| P250 | Sample Receipt, Sample Acceptance Policy, Sample Login, Sample Identification & Sample Storage; June 17, 2013; Rev. 17. | | N/A (Receiving) | GW, SW, PW, Seeps, SS, SB, SD / VOC, SVOC, METAL, FMETAL, EXPLO, WCHEM | N/A (Receiving) | Chemtech | N/A | N |

Notes:

- ¹ All labs are DoD Environmental Laboratory Accreditation Program (ELAP) accredited for analysis methods they are to perform that will generate definitive data:
 Chemtech's DoD accreditation through the Laboratory Accreditation Bureau is granted through October 20, 2015.
 CAS-Rochester's DoD accreditation through Perry Johnson Laboratory Accreditation, Inc., is granted through October 2013.

SAP Worksheet #24—Analytical Instrument Calibration Table

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | CA | Person Responsible for CA | SOP Reference ¹ |
|--------------|--|--|---|--|---------------------------|----------------------------|
| GC/MS (VOC) | 4-Bromofluorobenzene (BFB) Tuning | Prior to initial calibration (ICAL) and calibration verification (CV) (every 12 hours) | Refer to criteria listed in the method | Retune instrument and verify | Analyst | M8260B/C |
| | Multipoint ICAL (minimum five points) | Prior to sample analysis, or when CV fails | Option 1: relative standard deviation (RSD) for each analyte $\leq 15\%$; Option 2: linear least squares regression correlation coefficient (r) ≥ 0.995 ; Option 3: non-linear regression—coefficient of determination (COD) $r^2 \geq 0.99$ (6 points shall be used for second order, 7 points shall be used for third order). Average response factor (RF) for system performance check compounds (SPCCs): VOCs ≤ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≤ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. | Correct the problem and repeat ICAL | | |
| | Second-source initial calibration verification (ICV) | Once for each ICAL | All analytes within $\pm 20\%$ of expected value, average RF for SPCCs VOCs ≤ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≤ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. | Correct the problem and repeat ICAL | | |
| | Continuing calibration verification (CCV) | At start of each analytical sequence and every 12 hours thereafter | All analytes within $\pm 20\%$ of expected value. Average RF for SPCCs: VOCs ≤ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≤ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. | Correct problem, then recalibrate and reanalyze all samples since the last acceptable CCV. | | |
| GC/MS (SVOC) | Decafluorotriphenylphosphine (DFTPP) Tuning | Prior to ICAL and CV (every 12 hours) | Refer to criteria listed in the method | Retune instrument and verify | Analyst | M8270C/D |
| | Multipoint ICAL (minimum five points) | Prior to sample analysis, or when CV fails | Option 1: RSD for each analyte $\leq 15\%$; Option 2: linear least squares regression $r \geq 0.995$; Option 3: non-linear regression—coefficient of determination (r^2) ≥ 0.99 (6 points shall be used for second order, 7 points shall be used for third order) Average RF for SPCCs: SVOCs ≥ 0.050 . | Correct the problem and repeat ICAL | | |
| | ICV | Once for each ICAL | All analytes within $\pm 20\%$ of expected value | Correct the problem and repeat ICAL | | |
| | CCV | At start of each analytical sequence and every 12 hours thereafter | All analytes within $\pm 20\%$ of expected value Average RF for SPCCs SVOCs ≥ 0.050 . | Correct problem, then recalibrate and reanalyze all samples since the last acceptable CCV. | | |
| ICP (Metals) | ICAL | Before sample analysis, every 24 hours, whenever modifications are made to the system, or when CCV fails | If more than one standard is used, r must be > 0.995 | Correct problem and repeat ICAL | Analyst | M6010B/C |
| | ICV | Immediately following each ICAL | All analytes within $\pm 10\%$ of expected value | Correct problem and repeat ICAL | | |
| | Calibration Blank | Before beginning a sample run, after every 10 samples, and at the end of the sequence | No analytes detected at or above $\frac{1}{2}$ LOQ | Correct problem, then reanalyze previous 10 samples. | | |
| | CCV | After every 10 samples and at the end of the sequence | All analytes within $\pm 10\%$ of expected value | Recalibrate and reanalyze all samples since the last acceptable CCV | | |

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | CA | Person Responsible for CA | SOP Reference ¹ |
|--|--|---|--|---|---------------------------|----------------------------|
| CVAA (Mercury) | ICAL | Before sample analysis, every 24 hours, whenever modifications are made to the system, or when CCV fails | r must be > 0.995 | Correct problem and repeat ICAL | Analyst | M7470A |
| | ICV | Immediately following each ICAL | All analytes within $\pm 10\%$ of expected value | Correct problem and repeat ICAL | | |
| | Calibration Blank | Before any sequence, after every 10 samples, and at the end of the sequence | No analytes detected at or above $\frac{1}{2}$ LOQ | Correct problem, then reanalyze previous 10 samples | | |
| | CCV | After every 10 samples and at the end of the sequence | All analytes within $\pm 20\%$ of expected value | Recalibrate and reanalyze all samples since last acceptable CCV | | |
| Spectrometer (Cyanide) | ICAL (minimum six standards and a calibration blank) | Initial daily calibration before sample analysis | $r \geq 0.995$ for linear regression | Correct problem and repeat ICAL | Analyst | M9012A/B |
| | ICV | Second source standard immediately following the ICAL | 90-110% recovery | Stop analysis. Correct the problem and rerun the ICAL. | | |
| | CCV | At beginning and end of the run, and every 10 samples | 90-110% recovery | Rerun all samples associated with the failing CCV | | |
| | Distilled standards (one high and one low) | Once per ICAL | Value within $\pm 15\%$ of true value | Correct problem, then repeat distilled standards | | |
| IC / ultraviolet visible spectrum (UV-VIS) 23(HexCr) | ICAL | Prior to sample analysis | $CC > 0.999$ | Correct problem, then repeat ICAL | Analyst/Supervisor | GEN-7199 |
| | ICV | After each ICAL | 90-110% Recovery | Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. | | |
| | CCV | At the beginning of the analytical sequence, after each 10 field samples, at the end of the analytical sequence | 90-110% Recovery | Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV. | | |
| pH meter | ICAL | Every day before sample | Calibrate each instrument/electrode system each day of use at pH 4.0, 7.0, and 10.0. Repeat adjustments on successive portions of the two buffer solutions until readings are within 0.05 pH units of the buffer solution value. Note the passing slope and temperature on the batch document. | Correct problem and repeat ICAL | Analyst | M9045C,D |
| | ICV | Once after ICAL | Result should be within ± 0.1 pH unit of the known value. | Correct problem and repeat ICAL | | |
| | CCV | After every 10 samples and at the end of the sequence | Results should be within ± 0.1 unit of the known value. | Correct problem and repeat ICAL | | |
| TOC Analyzer | ICAL – multipoint calibration | Prior to sample analysis, or when CV fails | For multipoint calibration curve, $r > 0.995$ must be met prior to sample analysis. | Correct problem, then repeat ICAL | Analyst | MLloyd Kahn |
| | ICV | Once per calibration. After ICAL and before sample analysis. | Analyzed result within 10% of the true value concentration. For single point calibration, ICV standards are at half the concentration of the ICAL standard. | Correct problem, then repeat ICAL | | |

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | CA | Person Responsible for CA | SOP Reference ¹ |
|-------------------------------|-----------------------|---|--|---|---------------------------|----------------------------|
| HPLC-8330A | ICAL | A minimum 5-point calibration curve is analyzed at least annually. Calibration is performed prior to 1 year if continuing verifications fail, or if a change is made to major instrument parts or operating parameters. | If RSD exceeds 20%, linear calibration may be used with $r \geq 0.995$ with a minimum of 5 points; or second order curve may be used with $r^2 \geq 0.990$ with a minimum of 6 points. | Check standards and instrument for error, and re-analyze calibration curve. | Analyst/Supervisor | M8330/A |
| | ICV | Second source standard run at or below the mid-point of the calibration range, run after the ICAL and before any samples are analyzed using the curve. | If percent relative standard deviation (%RSD) is used for calibration, percent difference or drift (%D) for ICV, compared to that level standard response in the ICAL must be $\leq 15\%$. If linear or second order calibration is used, %recovery must be within $\pm 15\%$ of true value. | Check standard preparation and re-analyze. If failure repeats, re-analyze the calibration curve and ICV. | | |
| | CCV | Prior to beginning daily sample analysis, after every 10 samples, and at the end of the analytical sequence. | If %RSD is used for calibration, %D for ICV, compared to that level standard response in the ICAL must be $< 15\%$. If linear or second order calibration is used, %recovery must be within $\pm 15\%$ of true value. | If response is higher than expected, and the affected compound is not detected above the reporting limit (RL) in client sample, no CA is required. Otherwise, investigate the cause and correct, up to and including recalibrating, and re-inject all samples not bracketed by acceptable CCVs. | | |
| HPLC / ESI / MS (Perchlorate) | ICAL | A minimum 5-point calibration upon instrument receipt, column change, or when the CCV does not meet criteria. | $\%RSD \leq 20\%$. If RSD exceeds 20%, linear calibration may be used with r value > 0.995 with a minimum of 5 points. | Check standards and instrument for error, and re-analyze calibration curve. Re-analyze any affected sample data. | Analyst/Supervisor | HPLC-6850 |
| | ICV | Second source standard run at or below the mid-point of the calibration range, run after the ICAL and before any samples are analyzed using the curve. | Within $\pm 15\%$ of true value. | Check standard preparation and re-analyze. If failure repeats, re-analyze the calibration curve and ICV. | | |
| | CCV | Prior to beginning daily sample analysis, after every 10 samples, and at the end of the analytical sequence | Within $\pm 15\%$ of true value. | If response is higher than expected, and the affected compound is not detected above the RL in client sample, no CA is required. Otherwise, investigate the cause and correct, up to and including recalibrating, and re-inject all samples not bracketed by acceptable CCVs. | | |

Notes:

¹ Refer to Worksheet #23 for a complete reference to relevant analytical SOPs.

² The specifications in this table meet the requirements of DoD QSM 4.2.

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SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

| Instrument/ Equipment | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | CA | Responsible Person | SOP Reference |
|-----------------------------|---|-----------------------|--|-----------------------------------|--|--|---------------------|---------------------|
| GC/MS | Injection port maintenance | VOC/SVOC/1,4-dioxane | Change septum, clean injection port, clip column | Daily | Tune and CCV pass criteria | Inspect injector port, cut column, retune instrument, run calibration | Analyst/Supervisor | P255-Maintenance-02 |
| | Detector maintenance | | Clean detector, change pump oil | When tune fails or responses drop | Tune and calibration pass criteria, no air or water in tune scan | Disassemble detector, check parts, check heating element, rerun tune | | |
| ICP/AES | Tubing | Metals | Check tubing | Daily | Calibration passes criteria | Replace tubing | Analyst/Supervisor | P255-Maintenance-02 |
| | Nebulizer | | Check nebulizer | Monthly | | Clean nebulizer | | |
| | Torch | | Check torch | Annual | | Replace torch | | |
| ICP/MS | Tubing | Metals | Check tubing | Daily | Calibration passes criteria | Replace tubing | Analyst/Supervisor | P255-Maintenance-02 |
| | Nebulizer | | Check nebulizer | Monthly | | Clean nebulizer | | |
| | Torch | | Check torch | Annual | | Replace torch | | |
| | ETP Electron Multiplier | | Check Multiplier | Annual | | Replace Multiplier | | |
| CV | Tubing | Mercury | Check tubing | Daily | Calibration passes criteria | Replace tubing | Analyst/Supervisor | P255-Maintenance-02 |
| | Lamp, optic cell | | Check lamp and optic cell | Monthly | | Clean lamp and optic cell | | |
| | Mercury lamp | | Check mercury lamp | Annual | | Replace mercury lamp | | |
| Spectrophotometer (Konelab) | Reagent, Incubator alignment, rinse reservoir, rRinse cycle | Cyanide, Free Cyanide | Check reagent & replace if necessary, run rinse cycle, fill rinse reservoir, check incubator alignment | Daily | Calibration passes criteria | Check reagent & replace if necessary, run rinse cycle, fill rinse reservoir, check incubator alignment | Analyst/Supervisor | P255-Maintenance-02 |
| | Incubator and syringe | | Calibrate incubator & replace syringe | Annual | | Calibrate incubator & replace syringe | | |
| HPLC | Pump pressure | Explosives | Check pump pressure. Replace tubings and fittings. | Daily | Calibration passes criteria | Check pump pressure. Replace tubings and fittings. | Analyst/Supervisor | P255-Maintenance-02 |
| | Inspect tubing and fittings | | Change pre-column filter, replace pump seal | Monthly | | Change pre-column filter, replace pump seal | | |
| | Pre-column filter | | | | | | | |
| | Check pump seal | | Replace column, replace ultraviolet (UV) lamp, change pump valve frit | Semi-annually | | Replace column, replace ultraviolet (UV) lamp, change pump valve frit | | |
| | Wash system with MeOH/CAN | | | | | | | |
| | Check column | | | | | | | |
| | Check UV lamp | | | | | | | |
| Change pump valve frit | | | | | | | | |
| HPLC / ESI / MS | Change gas supply, analytical column, mobile phase, inlet filters | Perchlorate | Gas supply, column, mobile phase, inlet filters | As needed | Must meet initial and/or continuing calibration criteria | Repeat maintenance activity or remove from service | Analyst/ Supervisor | HPLC-6850 |
| IC/UV-VIS | Change column bed supports | Hexavalent Chromium | Change column bed supports | Monthly or as needed | Must meet initial and/or continuing calibration criteria | Repeat maintenance activity or remove from service | Analyst/Supervisor | GEN-7199 |
| | Clean column | | Clean column | | | | | |
| | Change column | | Change column | Every 6 months or as needed | | | | |
| | Change tubing | | Change tubing | Annually or as needed | | | | |

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

| Instrument/ Equipment | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | CA | Responsible Person | SOP Reference |
|-----------------------|---|------------------|--|-----------|-----------------------------|--|--------------------|---------------------|
| TOC Analyzer | Water reservoir, level of acid reservoir | TOC | Check pump pressure. Replace tubings and fittings. Clean water trap, check level water & acid reservoir. | Daily | Calibration passes criteria | Check pump pressure. Replace tubings and fittings, Clean water trap, check level water & acid reservoir. | Analyst/Supervisor | P255-Maintenance-02 |
| | Gas pressure, tube connection, water trap | | | | | | | |
| | Copper/tin | | Change copper/tin & mist trap and clean sparge tube | Monthly | | Change copper/tin & mist trap and clean sparge tube | | |
| | Mist trap | | | | | | | |
| | Sparge tube | | | | | | | |
| | Combustion tube | | Replace combustion tube & catalyst | Annually | | Replace combustion tube & catalyst | | |
| Catalyst | | | | | | | | |

SAP Worksheet #26—Sample Handling System

| |
|---|
| SAMPLE COLLECTION, PACKAGING, AND SHIPMENT |
| Sample Collection (Personnel/Organization): Field Team/CH2M HILL Sample Packaging (Personnel/Organization): FTL/ CH2M HILL Coordination of Shipment (Personnel/Organization): FTL/ CH2M HILL Type of Shipment/Carrier: Overnight Carrier/ Fed Ex |
| SAMPLE RECEIPT AND ANALYSIS |
| Sample Receipt (Personnel/Organization): Logins/Chemtech, ALS- Rochester, Geostructures Sample Custody and Storage (Personnel/Organization): Logins/Chemtech, ALS - Rochester, Geostructures Sample Preparation (Personnel/Organization): Inorganic Prep and Organic Prep/Chemtech, ALS - Rochester, Geostructures Sample Determinative Analysis (Personnel/Organization): Analysts/Chemtech, ALS - Rochester, Geostructures |
| SAMPLE ARCHIVING |
| Field Sample Storage (number of days from sample collection): 45 Sample Extract/Digestate Storage (number of days from extraction/digestion): 45 |
| SAMPLE DISPOSAL |
| Personnel/Organization: Sample Custody Personnel/Chemtech, ALS - Rochester, Geostructures Number of Days from Analysis: 45 |

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SAP Worksheet #27—Sample Custody Requirements Table

| |
|--|
| Field Sample Custody Procedures (sample collection, packaging, shipment and delivery to laboratory): |
| <p>Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled. Labels will be taped to the containers to be sure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples <6°C until they are received by the laboratory.</p> <p>The chain-of-custody will be placed into the cooler in a Ziploc bag. Coolers will be taped up and shipped to the laboratories via Fed Ex overnight, with the air bill number indicated on the chain-of-custody (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M HILL.</p> <p>See Worksheet #21 for SOPs containing sample custody guidance.</p> <p>All hexavalent chromium fractions will be shipped to ALS in Rochester, NY.</p> <p>All other samples will be shipped to Chemtech in Mountainside, NJ. Chemtech will send grain size samples to Geostructures in King of Prussia, PA.</p> |
| Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): |
| <p>Laboratory custody procedures can be found in the laboratory SOPs, which are referenced in Worksheet #23. Laboratory SOPs will be provided upon request.</p> |
| Sample ID Procedures: |
| <p>Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservation, and sampler's initials. The field logbook will identify the sample ID with the location and time collected and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain-of-custody and Worksheet #18. The laboratory will send sample log-in forms to the PC to check that sample IDs and parameters are correct.</p> |
| Chain-of-custody Procedures: |
| <p>Chains-of-custody will include, at a minimum, laboratory contact information, client contact information, sample information and relinquished by/received by information. Sample information will include sample ID, date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain-of-custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the Laboratory Information Management Systems database for each sample.</p> |

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SAP Worksheet #28-1a—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: VOCs

Analytical Method/SOP Reference: SW-846 8260B / M8260B/C

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|---|--|------------------------------|--------------------|---|
| Method Blank | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | No analytes detected >1/2 LOQ and 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common lab contaminants, no analytes detected >LOQ. Surrogate and internal standard (IS) recoveries must meet criteria. | Investigate source of contamination. Rerun all associated samples. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | See Worksheet #15 | Correct problem, then reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes. | | Accuracy/Bias | |
| MS/MSD | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | See Worksheet #15 | Narrate | | Accuracy | |
| IS | Each field and QC sample | IS area -50% to +100% compared to IS from CV; IS RT window \pm 0.5 minutes compared to CV RT | Re-analyze affected samples. | | Accuracy/Bias | |
| Surrogates | Each field and QC sample | 1,2-Dichloroethane-d4: R) = 70-120% Dibromofluoromethane: R = 85-115% Toluene-d8: R = 85-120% 4-Bromofluorobenzene: R = 75-120% | If sample volume is available and within holding time, re-analyze affected samples. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

RT - retention time

SAP Worksheet #28-1b—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: SVOCs including 1,4-Dioxane

Analytical Method/SOP Reference: SW-846 8270D / M8270C/D

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|---|--|------------------------------|--------------------|---|
| Method Blank | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | No target compounds should be \geq RL except common lab contaminants, which should be $<2X$ RL | Investigate source of contamination. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| | | Surrogates and IS recoveries must meet criteria | Re-extract and rerun all associated samples | | | |
| LCS | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Evaluate and reanalyze if possible. If an MS/MSD was extracted in the same extraction batch and acceptable, narrate. If the LCS recoveries are high but the sample results are $<RL$, narrate. Otherwise, re-prepare and reanalyze. | | Accuracy/Bias | |
| MS/MSD | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Narrate | | Accuracy | |
| IS | Each field and QC sample | IS area -50% to +100% compared to IS from CCV; IS RT window \pm 0.5 minutes compared to CCV RT | Reanalyze affected samples. | | Accuracy/Bias | |
| Surrogates | Each field and QC sample | 2-Fluorophenol: R = 20-110% Phenol-d6: R = 10-160% Nitrobenzene-d5: R = 40-110% 2-Fluorobiphenyl: R = 50-110% 2,4,6-Tribromophenol: R = 40-125% Terphenyl-d14: R = 50-135% | If sample volume is available and within holding time, re-analyze affected samples. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-1c—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: Total and Dissolved Metals

Analytical Method/SOP Reference: SW-846 6010B, 7470A / M6010B/C, M7470A

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|-----------------|--|---|--|------------------------------|--------------------|---|
| Method Blank | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | No target compounds should be \geq RL. | Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Redigest associated samples. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Redigest and reanalyze. | | Accuracy/Bias | |
| MS/MSD | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Flag results for affected analytes for all associated samples with "N." | | | |
| Serial Dilution | One per prep batch of 20 or fewer samples of similar matrix | 1:5 dilution must agree within $\pm 10\%$ of the original sample result if result is $> 10x$ RL | Perform post-spike addition. | | | |
| Post-spike | One per prep batch of 20 or fewer samples of similar matrix | Recovery within 85-115% | Flag results for affected analytes for all associated samples with "N". Reported with each batch. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-1d—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: Total Metals (Hexavalent Chromium)

Analytical Method/SOP Reference: SW-846 7199 / GEN-7199

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|-------------------------------|------------------------------------|---------------------------------------|--|------------------------------|--------------------|---|
| Method Blank | 1 per batch of 20 or fewer samples | No target compounds should be >1/2 QL | Reclean, reanalyze and/or qualify the data. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| MS | | 70-130% of True Value | If LCS acceptable, may report with qualifier and note outliers in the case narrative. | | Accuracy/Bias | |
| LCS | | 70-130% of True Value | Evaluate, reanalyze batch if possible. If the LCS recoveries are high and the sample results are <QL, narrate. | | Precision | |
| Laboratory Replicate (or MSD) | | RPD < 20%; +/- RL if <4xLOQ | Repeat sample and replicate unless obvious or historical interferences or lack of volume. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-1e—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water

Analytical Group: Cyanide and Free Cyanide

Analytical Method/SOP Reference: SW-846 9012B / M9012B

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|------------------------------------|--|---|------------------------------|--------------------|---|
| Method Blank | 1 per batch of 20 or fewer samples | No analytes detected >1/2LOQ | Redistill and rerun the entire batch | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| MS/MSD | | 85-115% or True Value | Perform a post-digestion (distillation) spike for CN when predigestion/predistillation spike recovery falls outside control limits and the sample does not exceed 4x the spike added. | | Accuracy/Bias | |
| LCS | | 85-115% or True Value | Redistill and reanalyze samples associated with the LCS. | | Precision | |
| Duplicate | | The control limits for duplicate analysis are +20% for samples with value > 5x LOQ | If duplicate sample is outside control limits, check technique (especially homogeneity of sample). Rerun duplicate. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-1f—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: Explosives

Analytical Method/SOP Reference: SW-846 8330B / M8330/A

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|---|--|------------------------------|--------------------|---|
| Method Blank | One per every 20 samples of the same matrix per extraction day | No target compounds detected above ½ laboratory quantitation limit | If affected compound is not detected above the laboratory quantitation limit in any associated samples, or if sample concentrations are >10X the blank level, no CA is required. Otherwise, re-extract the sample batch. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | One every 20 samples of the same matrix per extraction day | See Worksheet #15 | If recovery is above QC limits and affected compound is not detected above the laboratory quantitation limit in any associated samples, no CA is required. Data may be reported with qualifier with client permission. Otherwise, re-extract the sample batch. | | Accuracy/Bias | |
| MS/MSD | One per every 20 samples of the same matrix per extraction day | See Worksheet #15 | If LCS recoveries are acceptable, no CA is required. Investigate cause and include in case narrative. | | | |
| Surrogates | Each field and QC sample | 1,2-Dinitrobenzene: R = 30-150% 4-Nitroaniline: R = 30-150% 3,4-Dinitrotoluene: R 37-149% | If any surrogates are outside control limits and sample volume is available, re-extract affected samples & re-analyze. | Accuracy/Bias | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-1g—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Pore Water, Seeps

Analytical Group: Perchlorate

Analytical Method/SOP Reference: SW-846 6850 / HPLC-6850

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|---------------------------------|---|------------------------------|--------------------|---|
| Method Blank | One per prep batch or 20 or fewer samples | No detects > ½ RL | Investigate source of contamination. Reprep and rerun associated samples. | Analyst/Supervisor | Bias/Contamination | No detects > ½ RL |
| LCS | One per prep batch or 20 or fewer samples of the same matrix | See Worksheet #15 | Reprep and reanalyze the sample batch. | | Accuracy/Bias | Same as Method/SOP QC Acceptance Limits |
| MS / MSD | One per prep batch or 20 or fewer samples of the same matrix | See Worksheet #15 | If recovery of MS fails on a sample batch, the samples are acceptable only if the LCS meets acceptance criteria. If the LCS passes but the MS fails, report the MS recoveries and note outliers in the case narrative. Examine the chromatograms and bench sheets for potential matrix interferences. Reanalyze the pair if deemed appropriate. MSD: The outlying RPD should be mentioned in the case narrative so that data can be flagged appropriately. | | | |
| IS | Each field and QC sample | IS RRT must be within 0.98-1.02 | Document in the case narrative. | | Accuracy | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

RRT – relative retention time

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SAP Worksheet #28-2a—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: VOCs including 1,4-Dioxane

Analytical Method/SOP Reference: SW-846 8260B / M8260B/C

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|---|--|------------------------------|--------------------|---|
| Method Blank | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | No analytes detected >1/2 LOQ and 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common lab contaminants, no analytes detected >LOQ | Investigate source of contamination. Rerun all associated samples. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | See Worksheet #15 | Correct problem, then reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes. | | Accuracy/Bias | |
| MS/MSD | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | See Worksheet #15 | Narrate | | Accuracy | |
| IS | Each field and QC sample | IS area -50% to +100% compared to IS from CV; IS RT window \pm 0.5 minutes compared to CV RT | Reanalyze affected samples. | | Accuracy/Bias | |
| Surrogates | Each field and QC sample | 1,2-Dichloroethane-d4: R = 55-158% Dibromofluoromethane: R = 53-156% Toluene-d8: R = 85-115% 4-Bromofluorobenzene: R = 85-120% | If sample volume is available and within holding time, reanalyze affected samples. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2b—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: SVOCs

Analytical Method/SOP Reference: SW-846 8270D / M8270C/D

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|---|--|------------------------------|--------------------|---|
| Method Blank | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | No target compounds should be > LOQ except common lab contaminants, which should be <2X LOQ | Investigate source of contamination. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| | | Surrogates and IS recoveries must meet criteria | Re-extract and rerun all associated samples | | | |
| LCS | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Evaluate and reanalyze if possible. If an MS/MSD was extracted in the same extraction batch and acceptable, narrate. If the LCS recoveries are high but the sample results are <LOQ, narrate. Otherwise, reprep and reanalyze. | | Accuracy/Bias | |
| MS/MSD | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Narrate | | Accuracy | |
| IS | Each field and QC sample | IS area -50% to +100% compared to IS from CCV; IS RT window ± 0.5 minutes compared to CCV RT | Reanalyze affected samples. | | Accuracy/Bias | |
| Surrogates | Each field and QC sample | 2-Fluorophenol: R = 35-105% Phenol-d6: R = 40-100% Nitrobenzene-d5: R = 35-100% 2-Fluorobiphenyl: R = 45-105% 2,4,6-Tribromophenol: R = 35-125% Terphenyl-d14: R = 30-125% | If sample volume available and within holding time, re-extract and reanalyze affected samples. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2c—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Total Metals

Analytical Method/SOP Reference: SW-846 6010B, 7471A / M6010B/C, M7471A/B

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|-----------------|--|--|--|------------------------------|--------------------|---|
| Method Blank | One per prep batch of 20 or fewer samples of similar matrix, or one per day, whichever comes first | No target compounds should be > LOQ. | Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Redigest associated samples. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Redigest and reanalyze. | | Accuracy/Bias | |
| MS/MSD | One per prep batch of 20 or fewer samples of similar matrix | See Worksheet #15 | Flag results for affected analytes for all associated samples with "N." | | | |
| Serial Dilution | One per prep batch of 20 or fewer samples of similar matrix | 1:5 dilution must agree within $\pm 10\%$ of the original sample result if result is > 10x LOQ | Perform post-spike addition. | | | |
| Post-spike | One per prep batch of 20 or fewer samples of similar matrix | Recovery within 85 – 115% | Flag results for affected analytes for all associated samples with "N." Reported with each batch. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2d—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Total Metals (Hexavalent Chromium)

Analytical Method/SOP Reference: SW-846 7199 / GEN-7199

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|-------------------------------|------------------------------------|--|---|------------------------------|--------------------|--|
| Method Blank | 1 per batch of 20 or fewer samples | No target compounds should be >1/2 LOQ | Reclean, reanalyze, and/or qualify the data | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits. |
| MS-soluble | | 75-125% of True Value | Redigest entire batch unless spike is diluted out (sample result > 4x spike concentration). If redigest fails, contact client about possible matrix investigations. If samples are out of holding time, redigest and report both sets of data. If insufficient sample is available to redigest, flag. Flag results associated with out of control MS. | | Accuracy/Bias | |
| MS-insoluble | | | | | | |
| LCS-insoluble | | 82-120% of True Value | Redigest if possible. If samples are out of holding time, redigest and report both sets of data. If insufficient sample is available to redigest, flag. If the LCS recoveries are high and the sample results are <QL, narrate. | | | |
| Laboratory Replicate (or MSD) | | RPD<20%; +/- LOQ if <4xLOQ | Repeat sample and duplicate unless obvious or historical interferences or lack of volume. | | Precision | |
| Post-digestion MS | | 85-115% of True Value | If MS also failed, no action beyond CA for MS. | | Bias | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2e—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Cyanide

Analytical Method/SOP Reference: SW-846 9012B / M9012B

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|------------------------------------|--|--|------------------------------|--------------------|--|
| Method Blank | 1 per batch of 20 or fewer samples | No analytes detected >1/2 LOQ | redistill and rerun the entire batch | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits. |
| MS/MSD | | 85-115% or True Value | Perform a post digestion (distillation) spike for CN when predigestion/pre-distillation spike recovery falls outside control limits and the sample does not exceed 4x the spike added. | | Accuracy/Bias | |
| LCS | | 85-115% or True Value | Redistill and reanalyze samples associated with the LCS. | | Precision | |
| Duplicate | | The control limits for duplicate analysis are +20% for samples with value > 5x LOQ | If duplicate sample is outside control limits, check technique (especially homogeneity of sample). Rerun duplicate. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2f—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Explosives

Analytical Method/SOP Reference: SW-846 8330B / M8330/A

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|--|--|------------------------------|--------------------|---|
| Method Blank | One per every 20 samples of the same matrix per extraction day | No target compounds detected above ½ laboratory quantitation limit | If affected compound is not detected above the laboratory quantitation limit in any associated samples, or if sample concentrations are >10X the blank level, no CA is required. Otherwise, reextract the sample batch. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | One every 20 samples of the same matrix per extraction day | See Worksheet #15 | If recovery is above QC limits and affected compound is not detected above the laboratory quantitation limit in any associated samples, no CA is required. Data may be reported with qualifier with client permission. Otherwise, re-extract the sample batch. | | Accuracy/Bias | |
| MS/MSD | One per every 20 samples of the same matrix per extraction day | See Worksheet #15 | If any surrogates are outside control limits and sample volume is available, re-extract affected samples and re-analyze. | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2g—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: Perchlorate

Analytical Method/SOP Reference: SW-846 6850 / HPLC-6850

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|--------------|--|---------------------------------|--|------------------------------|--------------------|---|
| Method Blank | One per prep batch or 20 or fewer samples | No detects > ½ LOQ | Investigate source of contamination. Reprep and rerun associated samples. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | One per prep batch or 20 or fewer samples of the same matrix | See Worksheet #15 | Reprep and reanalyze the sample batch. | | Accuracy/Bias | |
| MS / MSD | One per prep batch or 20 or fewer samples of the same matrix | See Worksheet #15 | <p>If recovery of MS fails on a sample batch, the samples are acceptable only if the LCS meets acceptance criteria. If the LCS passes but the MS fails, report the MS recoveries and note outliers in the case narrative. Examine the chromatograms and bench sheets for potential matrix interferences. Reanalyze the pair if deemed appropriate.</p> <p>MSD: The outlying RPD should be mentioned in the case narrative so that data can be flagged appropriately.</p> | | | |

Notes:

The specifications in this table meet the requirements of DoD QSM 4.2.

SAP Worksheet #28-2h—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: TOC

Analytical Method/SOP Reference: Lloyd Kahn / M-Lloyd Kahn

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|----------------------|---|---------------------------------|---------------------------------------|------------------------------|--------------------|---|
| Method Blank | One per prep batch of 20 or fewer samples of similar matrix | Value less than LOQ | Reprepare and rerun entire batch. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| Laboratory Replicate | Every 10 samples | +20% RPD | Rerun Duplicate. | | Precision | |
| LCS | One per prep batch of 20 or fewer samples of similar matrix | 90-110% recovery | Reprepare and reanalyze entire batch. | | Accuracy/Bias | |
| MS/MSD | One per prep batch of 20 or fewer samples of similar matrix | 75-125% recovery | Note in case narrative. | | | |

SAP Worksheet #28-2i—Laboratory QC Samples Table

Matrix: Surface Soil, Subsurface Soil, Sediment

Analytical Group: pH

Analytical Method/SOP Reference: SW-846 9045D / M9045C, D

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|----------------------|------------------|---------------------------------|---------|------------------------------|-----------|---|
| Laboratory Replicate | One per batch | ±0.1 pH units | Narrate | Analyst/Supervisor | Precision | Same as Method/SOP QC Acceptance Limits |

SAP Worksheet #28-2j—Laboratory QC Samples Table

Matrix: Sediment

Analytical Group: AVS/SEM

Analytical Method/SOP Reference: EPA 821_R-91-100 / M-AVS-04

| QC Sample | Frequency/Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | DQI | MPC |
|-----------------|------------------|---------------------------------|---|------------------------------|--------------------|---|
| Method Blank | One per batch | □ Method detection limit (MDL) | Redigest and re-analyze samples. | Analyst/Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| LCS | | 75-125% recovery | Analyze a dilution, check calculation, check technique, contact supervisor or technical director. | | Accuracy/Bias | |
| MS or Duplicate | | 75-125% recovery | Check calculation, check technique, contact supervisor or technical director. | | Accuracy/Bias | |

SAP Worksheet #29—Project Documents and Records Table

[\(UFP-QAPP Manual Section 3.5.1\)](#)

| Sample Collection Documents and Records | Onsite Analysis Documents and Records | Offsite Analysis Documents and Records ¹ | Data Assessment Documents and Records | Other |
|---|--|--|--|-------|
| <ul style="list-style-type: none"> • Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables • ID of QC Samples • Meteorological Data from Field (logging daily weather) • Sampling Instrument Calibration Logs • Sampling Locations and Sampling Plan • Sampling Notes and Drilling Logs | <ul style="list-style-type: none"> • No onsite analysis will take place other than collecting water quality parameters. These readings will be recorded in field logbooks as they are collected | <ul style="list-style-type: none"> • Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (stored on disk) | <ul style="list-style-type: none"> • Fixed Laboratory Audit Checklists • DV Reports • CA Forms • Laboratory QA Plan • MDL Study Information | |

Notes:

¹ Offsite documents except for analytical laboratory data are archived with Iron Mountain, Inc., which is headquartered at 745 Atlantic Avenue, Boston, MA 02111. Analytical laboratory data are archived with the Federal Records Center.

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SAP Worksheet #30—Analytical Services Table

| Matrix | Analytical Group | Sample Locations/ID Number | Analytical Method | Data Package Turnaround Time | Laboratory / Organization | Backup Laboratory / Organization ¹ |
|-------------------------------|-----------------------------|--------------------------------|--------------------------------|------------------------------|---|---|
| Groundwater | VOCs | Refer to Worksheet #18 | SW-846 8260B | 28 calendar days | Chemtech Consulting Group 284 Sheffield Street Mountainside, NJ 07092 Kurt Hummler, (908) 728-3150 | TBD |
| | SVOCs including 1,4-dioxane | | SW-846 8270D, with PAHs by SIM | | | |
| | Total and Dissolved Metals | | SW-846 6020A and 7470A | | | |
| | Cyanide | | SW-846 9012B | | | |
| | Explosives | | SW-846 8330B | | | |
| | Explosives (Perchlorate) | | SW-846 6850 | | | |
| Surface Water | VOCs | | SW-846 8260B | | | |
| | SVOCs including 1,4-dioxane | | SW-846 8270D, with PAHs by SIM | | | |
| | Total and Dissolved Metals | | SW-846 6020A and 7470A | | | |
| | Cyanide | | SW-846 9012B | | | |
| | Explosives | | SW-846 8330B | | | |
| | Explosives (Perchlorate) | | SW-846 6850 | | | |
| | Hardness | | EPA 130.2 | | | |
| Surface Soil, Subsurface Soil | VOCs including 1,4-dioxane | SW-846 8260B | | | | |
| | SVOCs | SW-846 8270D, with PAHs by SIM | | | | |
| | Metals | SW-846 6020A and 7471A | | | | |
| | Cyanide | SW-846 9012B | | | | |
| | Explosives | SW-846 8330B (no MIS prep) | | | | |
| | Explosives (Perchlorate) | SW-846 6850 | | | | |
| | pH | SW-846 9045D | | | | |
| | TOC | SW-846 9060 | | | | |

SAP Worksheet #30—Analytical Services Table (continued)

| Matrix | Analytical Group | Sample Locations/ID Number | Analytical Method | Data Package Turnaround Time | Laboratory / Organization | Backup Laboratory / Organization ¹ |
|----------|----------------------------|----------------------------|--------------------------------|------------------------------|--|---|
| Sediment | VOCs including 1,4-dioxane | | SW-846 8260B | | | |
| | SVOCs | | SW-846 8270D, with PAHs by SIM | | | |
| | Metals | | SW-846 6010C and 7471A | | | |
| | Cyanide | | SW-846 9012B | | | |
| | Explosives | | SW-846 8330B (no MIS prep) | | | |
| | Explosives (Perchlorate) | | SW-846 6850 | | ALS - Rochester | |
| | pH | | SW-846 9045D | | Chemtech | |
| | TOC | | SW-846 9060 | | | |
| | AVS/SEM | | EPA 821_R-91-100 | | | |
| | Grain Size | | ASTM D422 | | GeoStructures, Inc. 1000 West 9th Avenue King of Prussia, PA 19406 Tami Chicarielli, (610) 265-1818 | |

SAP Worksheet #30—Analytical Services Table (continued)

| Matrix | Analytical Group | Sample Locations/ID Number | Analytical Method | Data Package Turnaround Time | Laboratory / Organization | Backup Laboratory / Organization ¹ |
|---|------------------------------------|----------------------------|--------------------------------|------------------------------|---------------------------|---|
| Optional Additional Sampling | | | | | | |
| Groundwater, Surface Water, Pore Water, Seeps | Total Metals (Hexavalent Chromium) | Refer to Worksheet #18 | SW-846 7199 | 28 calendar days | ALS - Rochester | TBD |
| Pore Water and/or Seeps | VOCs | | SW-846 8260B | | Chemtech | |
| | SVOCs including 1,4-dioxane | | SW-846 8270D, with PAHs by SIM | | | |
| | Total and Dissolved Metals | | SW-846 6020A and 7470A | | | |
| | Cyanide | | SW-846 9012B | | | |
| | Explosives | | SW-846 8330B (no MIS prep) | | | |
| | Explosives (Perchlorate) | | SW-846 6850 | | | |
| | Hardness | | EPA 130.2 | | | |
| Surface Soil, Subsurface Soil, Sediment | Metals (Hexavalent chromium) | | SW-846 7199 | | ALS - Rochester | |

Notes:

¹ A backup laboratory has not been identified. If circumstances render the subcontracted laboratory unable to perform analytical services, another laboratory will be determined at that time.

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SAP Worksheet #31—Planned Project Assessments Table

[\(UFP-QAPP Manual Section 4.1.1\)](#)

| Assessment Type | Frequency | Internal or External | Organization Performing Assessment | Person(s) Responsible for Performing Assessment (title and organizational affiliation) | Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation) | Person(s) Responsible for Identifying and Implementing CA (title and organizational affiliation) | Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation) |
|---|---|----------------------|------------------------------------|--|--|--|---|
| Field QA and H&S Audit | Once | Internal | CH2M HILL | Stephen Brand | TBD, FTL, and Field Staff | Stephen Brand | Brett Doerr Rick Cavil |
| Onsite Laboratory Technical Systems Audit (applies to definitive data only) | Laboratory must have a current accreditation from the DoD ELAP, which will identify the period of performance and scope of analytical methods. The laboratory must be re-evaluated prior to expiration of period of performance | External | Third-Party Accrediting Body | Third Party Accrediting Body (TBD) | Respective Laboratory QAO | Respective Laboratory QAO | Anita Dodson, Program Chemist, CH2M HILL |

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses Table

[\(UFP-QAPP Manual Section 4.1.2\)](#)

| Assessment Type | Nature of Deficiencies Documentation | Individual(s) Notified of Findings (name, title, organization) | Timeframe of Notification | Nature of CA Response Documentation | Individual(s) Receiving CA Response (name, title, organization) | Timeframe for Response |
|---|---|--|---------------------------|-------------------------------------|---|--|
| Field QA and H&S Audit | Checklist and Written Audit Report | Kristin Brickman/CH2M HILL, PM | Within 1 week of audit | Memorandum | TBD FTL CH2M HILL Doug Bitterman AQM CH2M HILL | Within 1 week of receipt of CA Form |
| Onsite Laboratory Technical Systems Audit | Written audit report from DoD Laboratory Accrediting Body | Respective Laboratory QAO | Within 2 months of audit | Memorandum | DoD Laboratory Accrediting Body (TBD) | Within 2 months of receipt of initial notification |

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SAP Worksheet #33—Quality Assurance Management Reports Table

[\(UFP QAPP Manual Section 4.2\)](#)

| Type of Report | Frequency (daily, weekly monthly, quarterly, annually, and so forth) | Projected Delivery Date(s) | Person(s) Responsible for Report Preparation (title and organizational affiliation) | Report Recipient(s) (title and organizational affiliation) |
|----------------|--|-------------------------------|---|---|
| RI Report | Post-field event | TBD | Kristin Brickman/CH2M HILL PM | Stakeholders, See Worksheet #3 |

Notes:

The RI Report will address the following:

- Summary of project QA/QC requirements/procedures
- Conformance of project to UFP-SAP requirements/procedures
- Deviations from the UFP-SAP and approved amendments that were made
- Results of data review activities (how much usable data were generated)
- CAs if needed, and their effectiveness
- Data usability with regards to: precision, accuracy, representativeness, completeness, comparability, and sensitivity
- Limitations on data use

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SAP Worksheets #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table¹

| Data Review Input | Description | Responsible for Verification/Validation ² | Internal/External ³ |
|---|--|--|--------------------------------|
| Field Notebooks | Field notebooks will be reviewed internally and placed into the project file for archiving at project closeout. | FTL/CH2M HILL | Internal |
| Chains-of-custody and Shipping Forms | Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chains-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chains-of-custody will also be reviewed for adherence to the SAP by the PC. | FTL/CH2M HILL PC/CH2M HILL | Internal & External |
| Sample Condition upon Receipt | Any discrepancies, missing, or broken containers will be communicated to the PC in the form of laboratory logins. | PC/CH2M HILL | External |
| Documentation of Laboratory Method Deviations | Laboratory method deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative, which becomes part of the final hard copy data package. | PC/CH2M HILL | External |
| Electronic Data Deliverables | Electronic data deliverables will be compared against hard copy laboratory results (10 percent check). | PC/CH2M HILL | External |
| Case Narrative | Case narratives will be reviewed by the data validator during the DV process. This is verification that they were generated and applicable to the data packages. | Data Validator/CH2M HILL | External |
| Laboratory Data | All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. | Respective Laboratory QAO | Internal |
| Laboratory Data | The data will be verified for completeness by the PC. | PC/CH2M HILL | External |
| Audit Reports | Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to make sure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to make sure action is taken. | PM/CH2M HILL PC/CH2M HILL | Internal |
| CA Reports | CA reports will be reviewed by the PC or PM and placed into the project file for archiving at project closeout. | PM/CH2M HILL PC/CH2M HILL | External |
| Laboratory Methods | Make sure the laboratory analyzed samples using the correct methods. | PC/CH2M HILL | External |
| TCL and TAL | Make sure the laboratory reported all analytes from each analysis group. | PC/CH2M HILL | External |

SAP Worksheets #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table¹ (continued)

| Data Review Input | Description | Responsible for Verification /Validation ² | Internal/External ³ |
|---|---|---|--------------------------------|
| RLs | Make sure the laboratory met the project-designated QLs. If QLs were not met, the reason will be determined and documented. | PC/CH2M HILL | External |
| Laboratory SOPs | Make sure that approved analytical laboratory SOPs were followed. | Respective Laboratory QAO | Internal |
| Raw Data | 10 percent review of raw data to confirm laboratory calculations. | Data Validator/CH2M HILL | External |
| Onsite Screening | All nonanalytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records. | FTL/CH2M HILL | Internal |
| Documentation of Method QC Results | Establish that all required QC samples were run. | Data Validator/CH2M HILL | External |
| Documentation of Field QC Sample Results | Establish that all required QC samples were run. | PC/CH2M HILL | Internal |
| DoD ELAP Evaluation | Make sure that each laboratory is DoD ELAP-certified for the analyses they are to perform. Be sure evaluation timeframe does not expire. | PC/CH2M HILL | External |
| Analytical data for VOCs, SVOCs, Metals (total and dissolved), Cyanide (total and free), Explosives, Perchlorate, and 1,4-dioxane, in all media; for example, groundwater, surface water, surface soil, subsurface soil, sediment, seeps, or pore water | Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. If adherence to QA/QC criteria yields deficiencies, data may be qualified. The data qualifiers used are those presented in <i>Region III Modifications to the National Functional Guidelines for Organic Data Review</i> (USEPA, 1994) and in <i>Region III Modifications to the Laboratory Data Validation Guidelines for Inorganic Data Review</i> (USEPA, 1993). National Functional Guidelines may be used for DV and the specific qualifiers listed therein may be applied to data if nonconformances against the QA/QC criteria as presented in this SAP is identified. | Data Validator/CH2M HILL | External |
| Analytical data for wet chemistry (TOC, pH, Hardness), AVS/SEM, or grain size, in all matrixes analyzed; for example, surface water, surface soil, subsurface soil, sediment, seeps, or porewater | Wet chemistry, AVS/SEM, grain size, and microbial analytical data will not undergo third-party DV, but are subject to all other data review protocols detailed above. | N/A | N/A |

Notes:

- ¹ Verification (Step I) is a completeness check that is performed before the data review process continues in order to determine whether the required information (complete data package) is available for further review. Validation (Step IIa) is a review that the data generated is in compliance with analytical methods, procedures, and contracts. Validation (Step IIb) is a comparison of generated data against MPC in the SAP (both sampling and analytical).
- ² If CH2M HILL finds discrepancies during the verification or validation procedures above, an e-mail documenting the issue will be circulated to the internal project team, and a Corrections to File Memo will be prepared identifying the issues and the CA needed. This memo will be sent to the laboratory, or applicable party, and maintained in the project file.
- ³ Internal or external is in relation to the data generator.

SAP Worksheet #37—Usability Assessment

[\(UFP-QAPP Manual Section 5.2.3\)](#)

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

Nondetected site contaminants will be evaluated to make sure that project-required QLs in **Worksheet #15** were achieved. If project QLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable. If project QLs were not achieved, then the reason will be investigated and documented, and the effect on data usability will be discussed.

During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases are not considered usable for project decisions.

| | |
|----|---|
| J | Analyte present. Reported value is estimated and may or may not be accurate or precise |
| UJ | Analyte not detected. QL may be inaccurate or imprecise |
| K | Analyte present. Reported value is estimated and may be biased high. Actual value is expected to be lower |
| L | Analyte present. Reported value is estimated and may be biased low. Actual value is expected to be higher |
| UL | Analyte not detected. QL is probably higher |
| R | Rejected result. Result is not usable |

Additional qualifiers that may be given by the validator include B, N, NJ, and U:

| | |
|----|---|
| B | Not detected more than 5 times than that in an associated blank (10 times for common laboratory contaminants in VOCs) |
| N | Tentative ID. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts |
| NJ | Qualitative ID questionable because of poor resolution. Presumptively present at approximate quantity. |
| U | Not Detected |

- For statistical comparison, nondetect values will be represented by a concentration equal to one-half the sample RL. For duplicate sample results, the greater of the values will be used for project decisions.
- Analytical data will be checked to be sure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hard copy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to be sure all results were loaded accurately.
- Field and laboratory precision will be assessed as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.
- To assess whether a sufficient quantity of acceptable data are available for decision making, the data will be compared to a 95 percent completeness goal following validation. Completeness will be calculated for the entire dataset as a percentage of available results (i.e. results which are not R-qualified) relative to the total number of results; results for field blanks and laboratory QC samples will not be considered in this calculation.

SAP Worksheet #37—Usability Assessment (continued)

Identify the personnel responsible for performing the usability assessment:

- The PM, PC, and other team members will be responsible for compiling the data. The data will then be presented to the Partnering Team which, as a whole, will evaluate the data usability according to project objectives.

References

- Baker Environmental, Inc. (Baker). 1993. *Final Round One Remedial Investigation Report, Site 1-9, 11, 12, 16-19, and 21, Naval Weapons Station, Yorktown, Virginia*. July.
- Baker. 1997. *Final Round Two Remedial Investigation Report for Sites 9 and 19, Naval Weapons Station Yorktown, Yorktown, Virginia*. January.
- C.C. Johnson & Associates, Inc., and CH2M HILL. 1984. *Initial Assessment Study of Naval Weapons Station Yorktown, Virginia*. July.
- CH2M HILL. 2011. *Background Study Report, Naval Weapons Station Yorktown, Yorktown, Virginia and Cheatham Annex, Williamsburg, Virginia*. May.
- Department of the Navy (Navy). 1998. *Final Record of Decision, Operable Unit Nos. VI and VII, Site 9 – Plant 1 Explosives-Contaminated Wastewater Discharge Area and Site 19 – Conveyor Belt Soil at Building 10, Naval Weapons Station Yorktown, Yorktown, Virginia*. March.
- IT Corporation. 1995. *Closeout Report, Sites 2 and 9, Site Screening Area 4, Mine Casing and Debris Removal Action, Naval Weapons Station, Yorktown, Virginia*. October.
- Meng, A. A., III and J. F. Harsh. 1988. *Hydrogeologic Framework of the Virginia Coastal Plain*. U.S. Geological Survey Professional Paper. 1404-C. 82 p.
- OHM Remediation (OHM). 2000. *Draft Contractor Closeout Report for Site 19 Bioremediation, Naval Weapons Station Yorktown, Yorktown, Virginia*. April.
- United States Environmental Protection Agency (USEPA). 1993. *Region III Modifications to the Laboratory Data Validation Guidelines for Inorganic Data Review*. April.
- USEPA. 1994. *Region III Modifications to the National Functional Guidelines for Organic Data Review*. September.
- USEPA. 2002. *Guidance for Quality Assurance Project Plans, EPA QA/G-5*.
- USEPA. 2005. *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)*.
- United States Geological Survey (USGS). 1997. *Geohydrology of the Shallow Aquifer System, Naval Weapons Station Yorktown, Yorktown, Virginia*. Water-Resources Investigations Report 97-4188.

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Figures



Legend

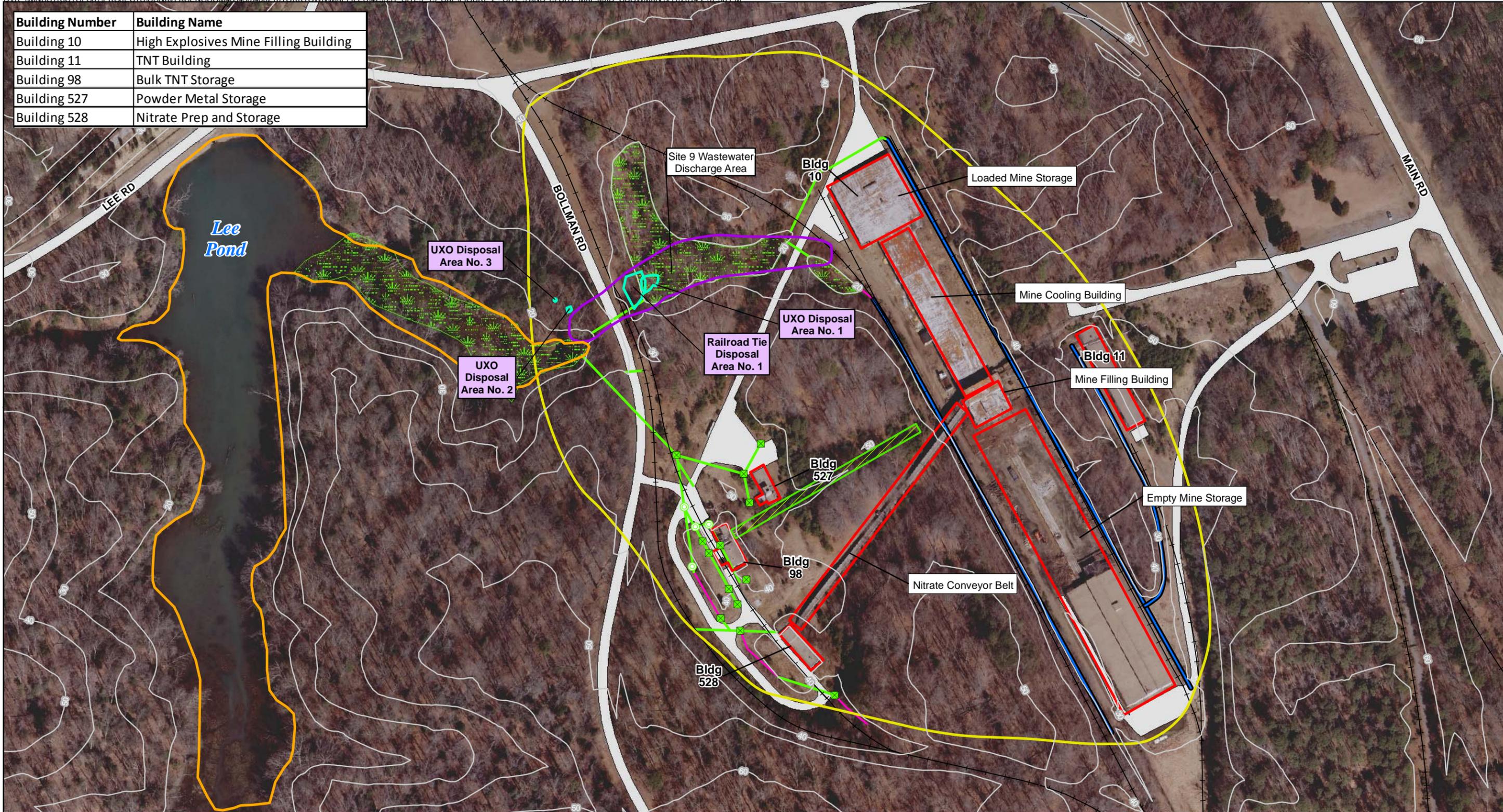
- Site Boundary
- Camp Peary Scarp
- Magazines
- Naval Weapons Station Yorktown Boundary
- Buildings and Structures
- County Boundary



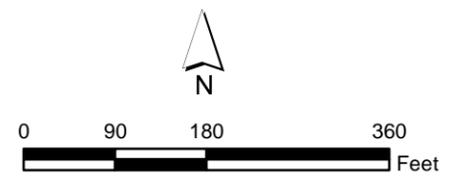
Figure 1
 WPNSTA Yorktown Location Map
 Former Loading Plant No. 1 Sampling and Analysis Plan
 Naval Weapons Station Yorktown
 Yorktown, Virginia



| Building Number | Building Name |
|-----------------|---------------------------------------|
| Building 10 | High Explosives Mine Filling Building |
| Building 11 | TNT Building |
| Building 98 | Bulk TNT Storage |
| Building 527 | Powder Metal Storage |
| Building 528 | Nitrate Prep and Storage |

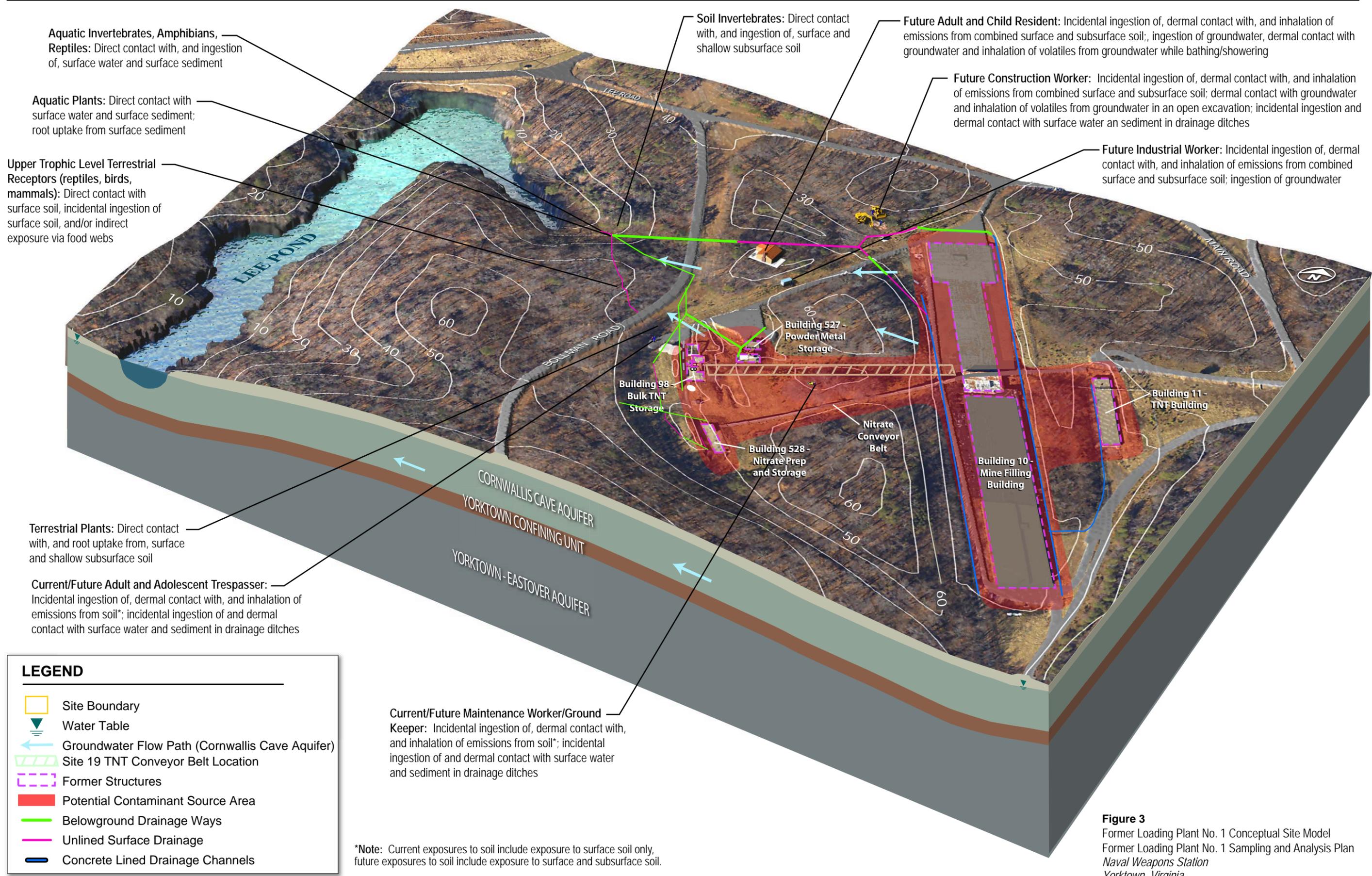


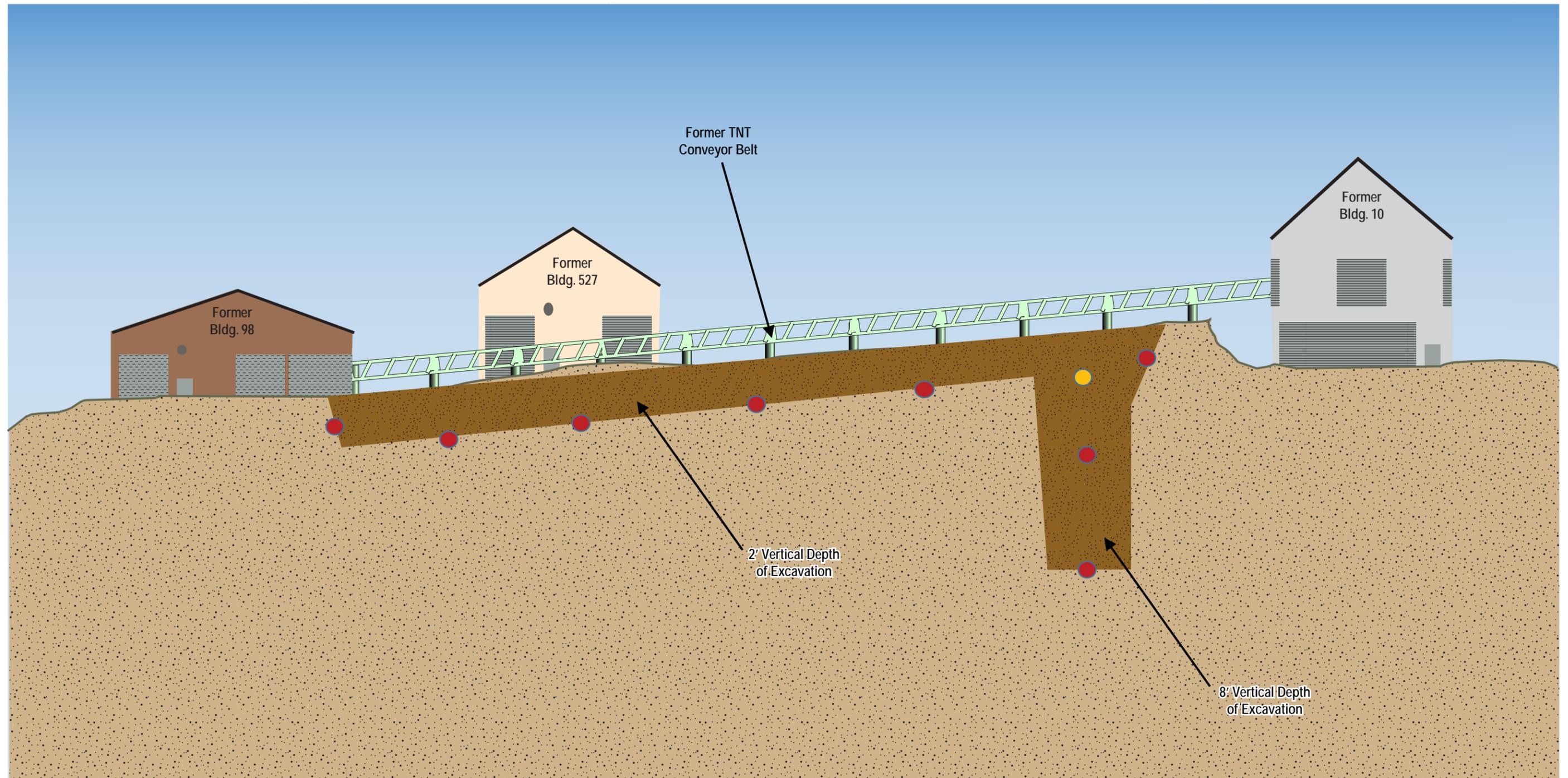
| Legend | |
|------------------------------------|---|
| Drop Inlet | Concrete Lined Drainage Channels |
| Manhole | Unlined Surface Drainage |
| Railroad | Site 19 Removal |
| Elevation Contour (10 ft interval) | Site 9 Removal Areas |
| Belowground Drainage Ways | Former Site Structures (demolished 2010-2012) |
| Study Area Boundary | Impervious Surfaces |
| | Wetland Area |
| | Site 9 |
| | Site 29 |



1 inch = 180 feet

Figure 2
Former Loading Plant No. 1 Site Map
Former Loading Plant No. 1 Sampling and Analysis Plan
Naval Weapons Station Yorktown
Yorktown, Virginia



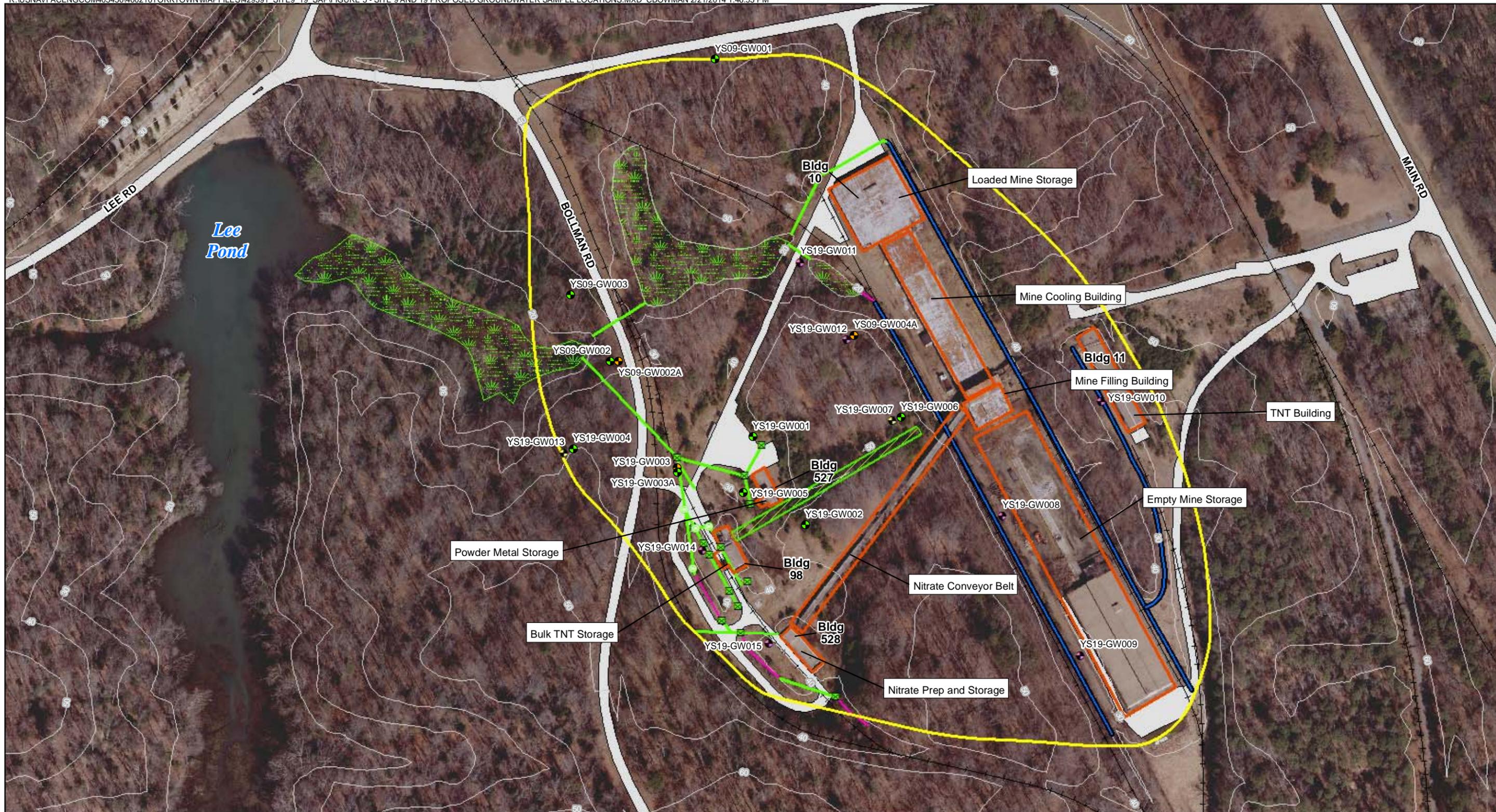


LEGEND

- Site 19 TNT Conveyor Belt Location
- 1998 Soil Removal Area Beneath Former TNT Conveyor Belt
- Excavation Floor Samples <15mg/kg TNT Cleanup Goal
- Excavation Floor Samples >15mg/kg TNT Cleanup Goal
- Ground Surface

Note: Not to Scale

Figure 4
 Site 19 Conceptual Site Model
 Former Loading Plant No. 1 Sampling and Analysis Plan
 Naval Weapons Station
 Yorktown, Virginia



- Legend**
- Drop Inlet
 - Manhole
 - Cornwallis Cave Aquifer Monitoring Wells
 - Yorktown-Eastover Aquifer Monitoring Wells
 - Proposed Cornwallis Cave Monitoring Wells
 - Proposed Yorktown-Eastover Monitoring Wells
 - Railroad
 - Elevation Contour (10 ft interval)
 - Belowground Drainage Ways
 - Concrete Lined Drainage Channels
 - Unlined Surface Drainage
 - Site Boundary
 - ▨ 1998 Estimated Conveyor Belt Soil Remedial Area
 - ▨ Former Site Structures (demolished 2010-2012)
 - ▨ Impervious Surfaces
 - ▨ Wetland Area

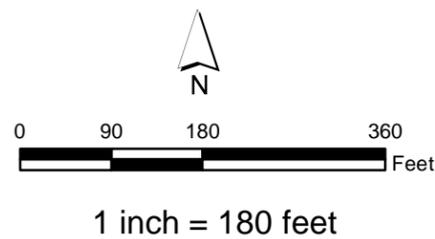
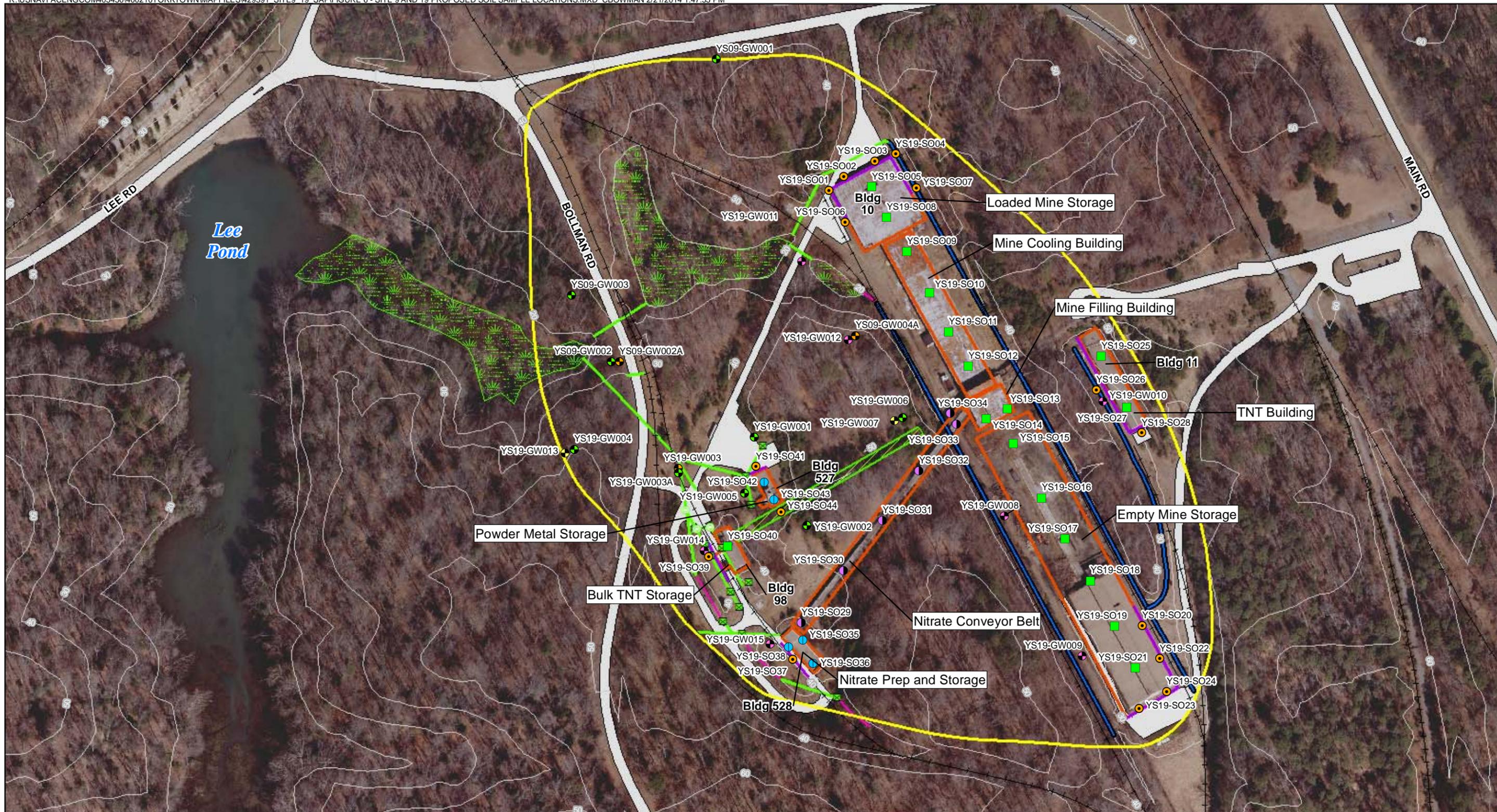


Figure 5
 Proposed Groundwater Sample Locations
 Former Loading Plant No. 1 Sampling and Analysis Plan
 Naval Weapons Station Yorktown
 Yorktown, Virginia



Legend

- Yorktown-Eastover Aquifer Monitoring Wells
- Cornwallis Cave Aquifer Monitoring Wells
- Proposed Cornwallis Cave Monitoring Wells
- Proposed Yorktown-Eastover Monitoring Wells

Proposed Surface and Subsurface Soil Sample Locations

- Floor Drain Sample
- Loading Area Sample
- Sub-Slab Sample
- Under Conveyor Belt Sample

- Drop Inlet
- Manhole
- Belowground Drainage Ways
- Concrete Lined Drainage Channels
- Unlined Surface Drainage
- Railroad
- Loading Door
- Elevation Contour (10 ft interval)

- Site Boundary
- ▨ 1998 Estimated Conveyor Belt Soil Remedial Area
- ▨ Former Site Structures (demolished 2010-2012)
- ▨ Impervious Surfaces
- ▨ Wetland Area

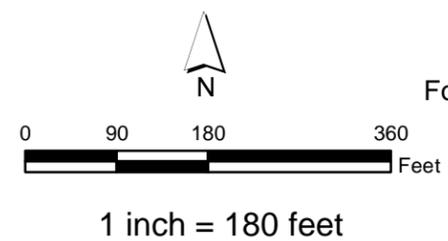
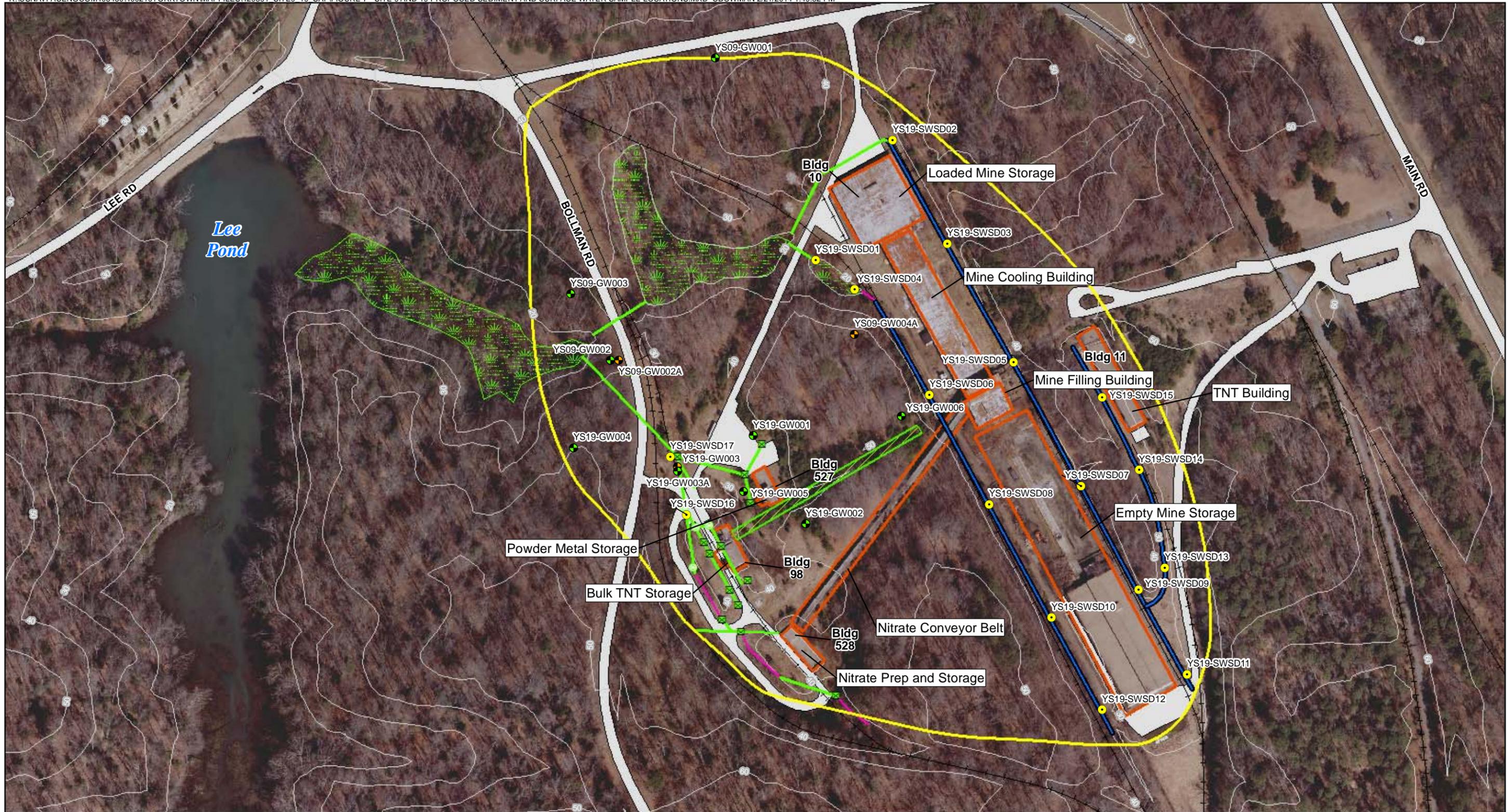


Figure 6
 Proposed Soil Sample Locations
 Former Loading Plant No. 1 Sampling and Analysis Plan
 Naval Weapons Station Yorktown
 Yorktown, Virginia



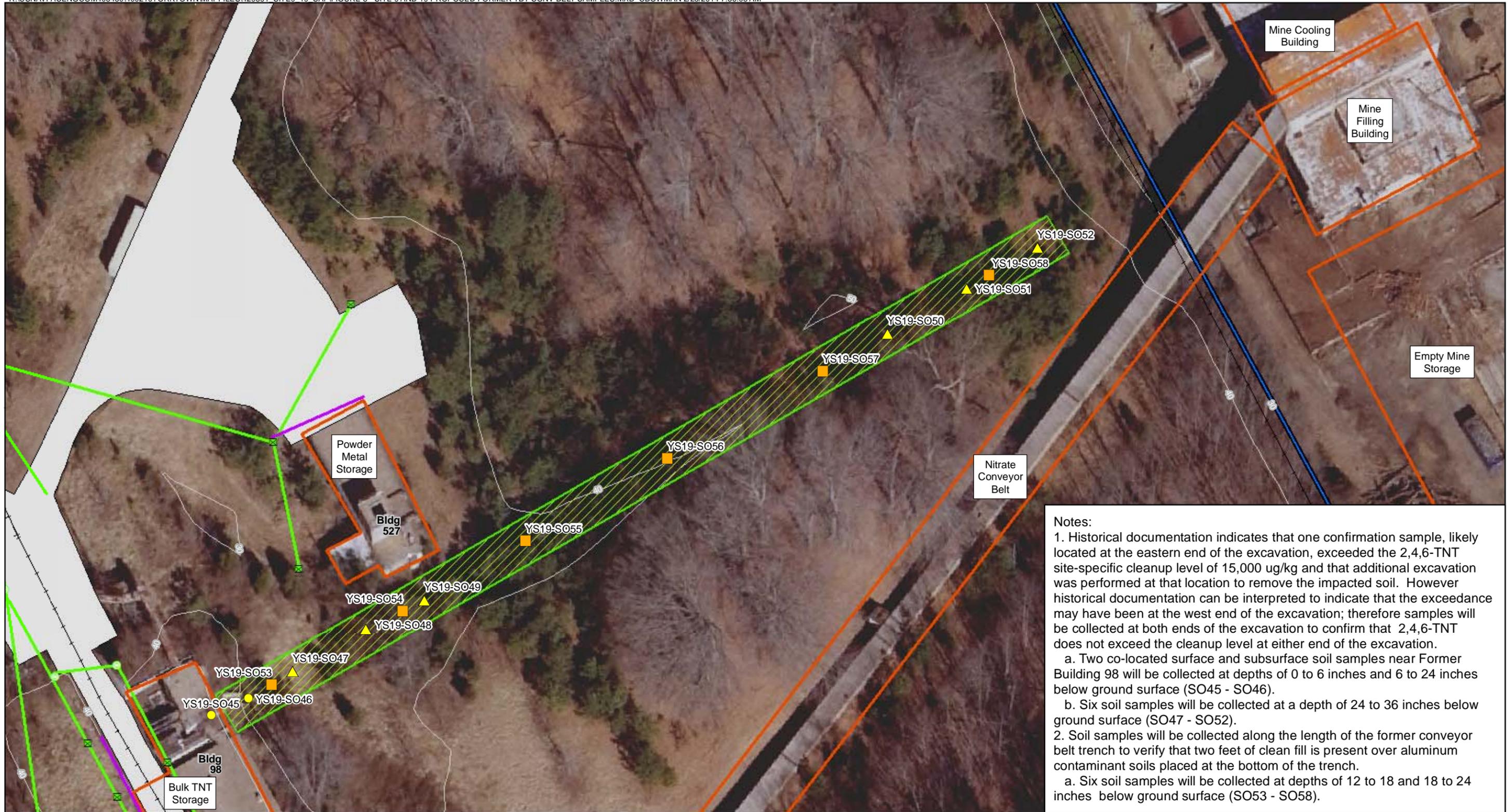
- Legend**
- Yorktown-Eastover Aquifer Monitoring Wells
 - Cornwallis Cave Aquifer Monitoring Wells
 - Proposed Sediment and Surface Water Sample Locations
 - Drop Inlet
 - Manhole
 - + Railroad
 - Elevation Contour (10 ft interval)
 - Belowground Drainage Ways
 - Concrete Lined Drainage Channels
 - Unlined Surface Drainage
 - Site Boundary
 - ▨ 1998 Estimated Conveyor Belt Soil Remedial Area
 - Former Site Structures (demolished 2010-2012)
 - Impervious Surfaces
 - ▨ Wetland Area

Note:
Surface water samples will be co-located with sediment sample if surface water is present at these locations



1 inch = 180 feet

Figure 7
Proposed Sediment and Surface Water Sample Locations
Former Loading Plant No. 1 Sampling and Analysis Plan
Naval Weapons Station Yorktown
Yorktown, Virginia



Notes:

- Historical documentation indicates that one confirmation sample, likely located at the eastern end of the excavation, exceeded the 2,4,6-TNT site-specific cleanup level of 15,000 ug/kg and that additional excavation was performed at that location to remove the impacted soil. However historical documentation can be interpreted to indicate that the exceedance may have been at the west end of the excavation; therefore samples will be collected at both ends of the excavation to confirm that 2,4,6-TNT does not exceed the cleanup level at either end of the excavation.
 - Two co-located surface and subsurface soil samples near Former Building 98 will be collected at depths of 0 to 6 inches and 6 to 24 inches below ground surface (SO45 - SO46).
 - Six soil samples will be collected at a depth of 24 to 36 inches below ground surface (SO47 - SO52).
- Soil samples will be collected along the length of the former conveyor belt trench to verify that two feet of clean fill is present over aluminum contaminant soils placed at the bottom of the trench.
 - Six soil samples will be collected at depths of 12 to 18 and 18 to 24 inches below ground surface (SO53 - SO58).

- Legend**
- ▲ TNT Subsurface Samples
 - TNT Surface and Subsurface Samples
 - Aluminum Subsurface Samples
 - ⊗ Drop Inlet
 - Manhole
 - Railroad
 - Belowground Drainage Ways
 - Concrete Lined Drainage Channels
 - Unlined Surface Drainage
 - Loading Door
 - Elevation Contour (10 ft interval)
 - ▨ 1998 Estimated Conveyor Belt Soil Remedial Area
 - ▭ Former Site Structures (demolished 2010-2012)
 - ▭ Impervious Surfaces

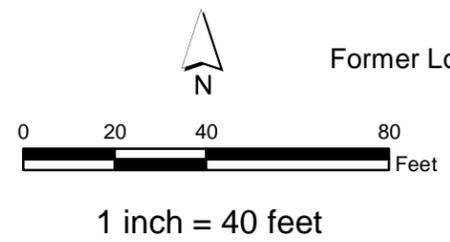
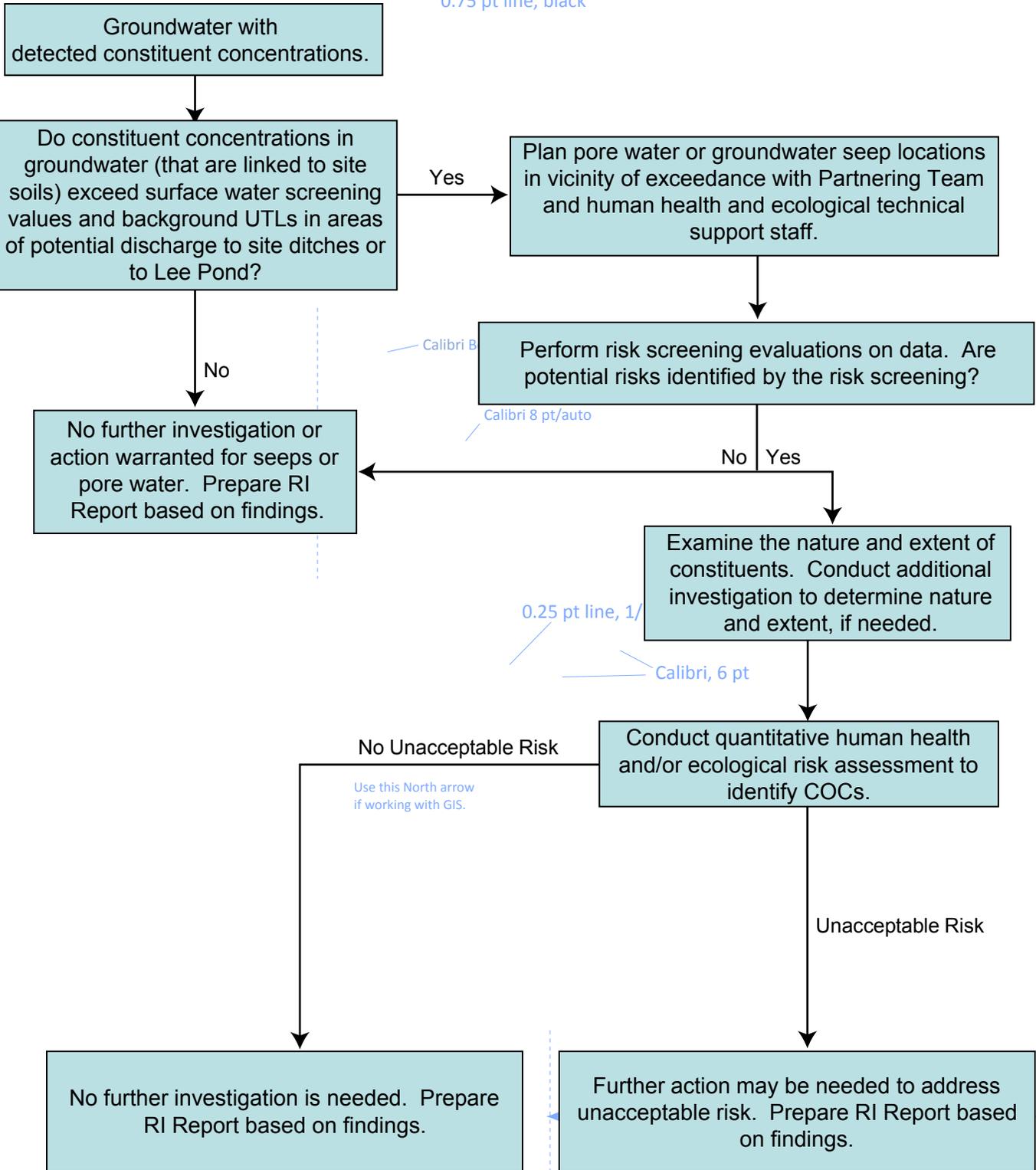


Figure 8
 Proposed TNT Conveyor Belt Samples
 Former Loading Plant No. 1 Sampling and Analysis Plan
 Naval Weapons Station Yorktown
 Yorktown, Virginia

0.75 pt line, black



.7" Left Margin

0.7" Right Margin

No Unacceptable Risk

Use this North arrow if working with GIS.

0.25 pt line, 1/

Calibri, 6 pt

Calibri B

Calibri 8 pt/auto

Examine the nature and extent of constituents. Conduct additional investigation to determine nature and extent, if needed.

Conduct quantitative human health and/or ecological risk assessment to identify COCs.

Unacceptable Risk

No further investigation is needed. Prepare RI Report based on findings.

Further action may be needed to address unacceptable risk. Prepare RI Report based on findings.

FIGURE NUMBER - Calibri, all caps, 10/11
Figure Title - Calibri, initial caps, bold, 10/11
Figure Caption or Project Name - Calibri, initial caps, italics, 10/11

Footer, or Slugline:
Arial Narrow, 6 pt, all caps.
Will ALWAYS include the JETT number, Project Acronym and FileName.

Figure 9
Pore Water and Groundwater Seep Sampling Decision Tree
Former Loading Plant No. 1 Sampling and Analysis Plan
Naval Weapons Station Yorktown
Yorktown, Virginia

space = height of logo

0.75 pt line, black

Appendix A
Field Standard Operating Procedures

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
- Paint Pens
- 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
- Paint Pens
- 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 pending analysis 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 (check with disposal facility to determine sample frequency) 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
- Generator Contact Information
- 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 if the results indicate hazardous waste or labeled as non-hazardous if applicable.

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 drum storage area by the drilling services subcontractor. Drums should be stored on pallets on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills.

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. However, prior to disposal to the sanitary sewer system, approval and 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.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

Sampling Contents of Tanks and Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in Attachment D.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature, and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device. Should a drum contain bottom sludge, a glass tube will be used to retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices that can be lowered from the top, filled at a particular depth, then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a Bacon Bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

III. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with an

explosimeter and an organic vapor analyzer may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

IV. Required Equipment and Apparatus

- A. **Health and safety equipment/materials:** As listed in the site safety plan.
- B. **Sampling equipment:** COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon Bomb, gravity corer.
- C. **Tools:** Rubber mallet, bung wrench, speed wrench with socket, etc., (all non-sparking), paint marker.
- D. **Heavy equipment:** Backhoe equipped with explosion shield, drum grappler, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).
- E. **Sample Containers:** As specified in the field sampling plan.

V. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.
2. Record, in logbook, all pertinent information from visual inspection of drum (e.g., physical condition, leaks, bulges, and labels). Label each drum with a unique identifying number.
3. If possible, stage drums for easy access.
4. If necessary, attach ground strap to drums and grounding point.
5. Remove any standing material (water, etc.) from container top.
6. Using non-sparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the non-sparking spike affixed to the backhoe can also be used to puncture the drum for sampling. See Attachment D for method of drum opening. Record air-quality monitoring results.

7. When sampling a previously sealed vessel, a check should be made for the presence of bottom sludge. This is accomplished by measuring the depth to apparent bottom, then comparing it to the known interior depth.
8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type, may be required.
9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See Attachments). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, three to four takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be recorded in logbook, including number and thickness of the layers and a conceptualized sketch.
10. Record a visual description of the sample (e.g., liquid, solid, color, viscosity, and percent layers).
11. When possible, sampling equipment (like glass tubes) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.
12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.
13. Wipe up spilled material with lab wipes. Wipe off sample containers.
14. Mark the drum with a unique sample identification number and date using a paint marker.
15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean, and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling – one will collect samples, the other will relay required equipment and implements.

2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.
3. Do not attempt to climb down into tank. Sampling MUST BE accomplished from the top.
4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.
5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.
2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.
3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.
4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)
5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.
6. Sample each trailer compartment.
7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. Refer to Attachment B for procedures for sampling with appropriate devices as follows:

Drum

Glass tube – Procedure 1

COLIWASA – Procedure 2

Storage Tank and Tank Trailer

COLIWASA – Procedure 2

Bacon Bomb – Procedure 3

Gravity Corer – Procedure 4
(for bottom sludge)

VI. Contamination Control

Sampling tools, instruments, and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP *Decontamination of Personnel and Equipment*. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

- A. Collection of Liquid-Containerized Wastes Using Glass Tubes
- B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)
- C. Sampling Containerized Wastes Using the Bacon Bomb Sampler
- D. Gravity Corer for sampling Sludges in Large Containers
- E. Construction of a Typical COLIWASA
- F. Drum Opening Techniques and Equipment

IX. References

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X. Field Checklist

| | |
|--------------------------------------|--|
| _____ Sampling Instruments | _____ Labels |
| _____ Tools | _____ Sampling and Analysis Plan |
| _____ Rubber Mallet | _____ Health and Safety Plan |
| _____ Logbook | _____ Decontamination Equipment |
| _____ Safety Glasses or Monogoggles | _____ Lab Wipes |
| _____ Safety Shoes | _____ Lab Spatulas or Stainless Steel Spoons |
| _____ Ice/Cooler, as required | _____ Chemical Preservatives, as required |
| _____ Custody Seals, as required | _____ Appropriate Containers for Waste and Equipment |
| _____ Chain-of-Custody Forms | _____ Duct Tape |
| _____ Drum Labels, as required | _____ Plastic Sheeting |
| _____ Paint Marker, if drum sampling | |
| _____ Black Indelible Pen | |
| _____ Monitoring Instruments | |

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss that is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube, and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom, uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for "waste," so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.

9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safety-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end into the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smoky after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sampler (COLIWASA)

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylformamide, mesityloxide, and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized wastes, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.
2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
3. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.
4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.
6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.
7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger-sealing surface. Stainless steel versions are also available. The volumetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

Uses

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

Procedures for Use

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained. Exercise care when using gravity corers in vessels or lagoons that have liners because penetration depths could exceed those of the substrate; this could result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is sufficient; however, 20-mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.
2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
3. Allow corer to free fall through the liquid to the bottom.
4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer because this may result in some sample loss.
5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).
6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52-m (5-ft) by 4.13-cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of the sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95-cm (3/8-in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic-products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

- a. Attach the swivel to the T-handle with the 3.18-cm (1-1/4 in) long bolt and secure with the 0.48-cm (3/16-in) National Coarse (NC) washer and lock nut.
- b. Attach the PFTE stopper to one end of the stopper rod and secure with the 0.95-cm (3/8-in) washer and lock nut.
- c. Install the stopper and stopper rod assembly in the sampling tube.
- d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.
- e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips through the center hole of the block.
- f. Attach the upper end of the stopper rod to the swivel of the T-handle.
- g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment ¹

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely; for this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water-reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked "NON SPARKING" is encouraged. However, the use of a "NON SPARKING" wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is

¹ Taken from EPA Training Course: "Sampling for Hazardous Materials," U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available, whereas the spikes are generally uniquely fabricated 4-foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, "sprayers" may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be "staged," or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the normal sampling safety gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place, if desired, and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time-consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation 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 for 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, hard-cover 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 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 Meetings: 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 chronologically 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. Health 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
 - Draw a box around the sample ID so that it stands out in the field notes
 - 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.

Volatiles Monitoring with an OVA

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for the calibration and use of an OVA Organic Vapor Analyzer.

II. Equipment and Materials

- Operations manual
- An OVA hand readout unit and side pack assembly
- 100 ppm methane 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.

OVA, Organic Vapor Analyzer

1. Introduction

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

2. Operational Checks

- See OVA Operators Manual included with instrument.

3. Calibration

- See OVA Operators Manual included with instrument.

IV. Key Checks and Preventative Maintenance

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

A complete preventative maintenance program is beyond the scope of this document. For specific instructions, refer to the operations manual.

- 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.

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped accordingly.

If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

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 or absorbent pads.
- 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 or absorbent pads.
- 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.
- 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. Cover custody seals with tape to avoid seals being able to be peeled from the cooler.
- 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.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with potential additional restrictions. If applicable, the sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier. If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by 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 prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

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

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided

by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from \$500 to several \$1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section 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 require from our utility location subs.

Services

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

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B 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 C 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 PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities / clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in **Appendix C**.

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These “dig permit” requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR)**, which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF)**, involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers**, are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. *The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.*
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. *This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.*

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. *Any particular marking requirements need to be provided in the subcontractor SOW.*
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

- A- Example SOW for Utility Location Subcontractor Procurement
- B - Services Available for Identifying and Marking Underground Utilities
- C - Equipment Used for Identifying Underground Utilities
- D - Utility Clearance Documentation Form
- E - Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-**XXX**

Scope of Work

Subsurface Utility Locating

Site **XX**

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site **XX** of **<<insert name of base, city, and state>>**. The subcontractor will need to be available beginning at **<<insert time>>** on **<<insert date>>**. It is estimated that the work can be completed within **XX** days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities **(CHOOSE 1)** that lie within a radius of 20 feet of each of **XX** sampling locations at Site **XX** shown on the attached Figure 1; **(OR)** that lie within the bounds of Site **XX** as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) **(CHOOSE 1)** can be found at **<<insert specific department and address or phone number on the base>>** and should be reviewed by the subcontractor and referenced as part of the utility locating. **(OR)**, will be provided to the subcontractor by **CH2M HILL** upon the award of the subcontract. **(OR)**, are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1) a 20-ft radius of the XX proposed soil boring locations (OR) within the boundary of the site(s)** as identified on the attached figure(s) will be marked using **paint (some Bases such as the WNY may have restrictions on the use of permanent paint)** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the **Buried Utility Location Tracking Form** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA **and any required mapping**. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - 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 CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD 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 PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD 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 PWD 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 PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington 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. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. 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.

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 | not available | 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.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 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.

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.

¹Equipment 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

²Other 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 C – 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 proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

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 new 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 D – Utility Clearance Documentation Form

Attachment E – 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

PMS 219

PMS 1795*

PMS 108

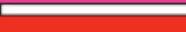
PMS 144*

13.5 parts process
2.5 parts reflex

PMS 253

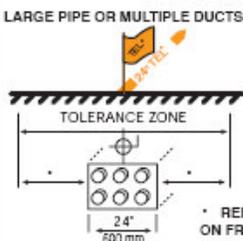
PMS 3415

 **UNIFORM COLOR CODE**

| | |
|--|---|
|  | WHITE - Proposed Excavation |
|  | PINK - Temporary Survey Markings |
|  | RED - Electric Power Lines, Cables, Conduit and Lighting Cables |
|  | YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials |
|  | ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit |
|  | BLUE - Potable Water |
|  | PURPLE - Reclaimed Water, Irrigation and Slurry Lines |
|  | GREEN - Sewers and Drain Lines |

TYPICAL MARKING

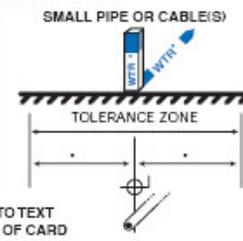
LARGE PIPE OR MULTIPLE DUCTS



TOLERANCE ZONE

2.4'
600 mm

SMALL PIPE OR CABLE(S)



TOLERANCE ZONE

* REFER TO TEXT ON FRONT OF CARD

Customize with your center's phone and address information

GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS

The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/09

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, scoop, coring device, 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/bowl or disposable sealable bags
- 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 or disposable sealable bag. 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 fine grained 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 geochemical analysis normally are not collected from thin-walled tube samples.

IV. Attachments

ASTM D 1586 Standard Penetration Test Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586.pdf)

ASTM D 1587 Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587.pdf)

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.

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. Stick-up wells will be surrounded by four concrete-filled guard posts at least 2 inches in diameter.

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

- 2" 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 (or stainless steel) screen with threaded bottom plug and riser.
- Screens will be filter packed with a properly 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 #00 or DSI #1 for a 10-slot screen) 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 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 a fine sand seal) 1-foot thick may be placed above the primary sand pack.
- Annular well seals will consist of 2 feet of pelletized, chip, 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 using powdered bentonite 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 bentonite seal has been allowed to hydrate and before the grout is applied. The seal 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 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.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the top of the bentonite seal to ground 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 either abruptly stopping flow and allowing water in the well column to fall back into the well or through the use of a surge block that is slightly smaller in diameter than the well casing inner diameter.
- 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. A Horiba-U22 meter, YSI meter with separate Hanna turbidity meter, or equivalent should be used to determine when the turbidity is low and parameters have stabilized.
- 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 as pending analysis, 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.

Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III

I. Purpose and Scope

This SOP 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

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable Teflon, Teflon-lined polyethylene tubing or polyethylene tubing for metals and other inorganics
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Sample containers
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.
2. Calibrate instruments 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 the *Water Level Measurements SOP*. **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 construction log.
7. Attach and secure the 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 in the middle of the saturated screen length and should be at least two feet above the bottom of the well to avoid mobilization of any sediment present in the bottom.
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. If using a generator, locate it 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.
10. 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-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.
11. 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 0.3-foot). 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-liter per minute) to avoid affecting well drawdown.
12. During purging, the field parameters are measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable 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 for values greater than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
- ORP: within 10 mV
- Temperature: within 3 percent

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample 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 sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

VOC samples are normally collected first and directly into pre-preserved sample containers.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that ¼ or 3/8 inch inside diameter tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, collect non-VOC dissolved gasses samples first, then increase flow rate slightly until water completely fills the tubing and collect the VOC/dissolved gases samples. Record new flow rate and drawdown depth.

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.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.

4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment SOP*.

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 (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

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. Disposable 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-foot 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.

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. Operator's 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 or plastic disposable scoop 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. In surface water bodies that are tidally influenced, sampling will be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants. Sediment sampling activities will not occur immediately after periods of heavy rainfall.
2. Make a sketch of the sample area that shows 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. Note in the field book any possible outside sources of contamination; for example, the outlet to a drainage culvert in the water body near your sampling location.
4. Transfer sample into appropriate sample jars with a stainless steel utensil or plastic disposable scoop. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.
5. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.
6. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.
7. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.
8. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.
9. 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.

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. Typical equipment required includes:

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Peristaltic pump
- 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*. Surface water samples collected from water bodies tidally influenced should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants. 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, peristaltic pumps, 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 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. If using a Peristaltic pump, lower the tubing into the water to the desired depth.
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.

IV. Attachments

None.

V. Key Checks and Items

- Start downstream, work upstream
- Log exact locations using permanent features
- Beware of hidden hazards

Seep Groundwater Sample Collection

I. Purpose

To provide a general guideline for the collection of groundwater samples from seeps, which have either limited flow or are manifested simply by damp areas on the surface of the ground.

II. Scope

The SOP covers sampling seeps with drive points, similar to the equipment used in direct-push groundwater sampling. The assumption is that, even if there is a small amount of flow at the surface, a representative sample of the groundwater discharging at the seep must be taken from below the ground surface with a drive point rather than from the water at the surface. This avoids chemical changes to the groundwater, such as volatilization of organic compounds that may occur when the groundwater comes in contact with the atmosphere.

III. Equipment and Materials

- Stainless steel or PVC drive points and extra drive rods (if needed)
- Side hammer or sledge hammer
- Peristaltic pump with dedicated polyethylene sampling tubing or small bailer
- Pre-cleaned sample containers
- Personal Protective Equipment as specified by the Health and Safety Plan.

IV. Procedures and Guidelines

1. Decontaminate the drive point and any other non-dedicated downhole equipment (e.g., extra drive rods) in accordance with the *Decontamination of Personnel and Equipment* SOP.
2. Drive the slotted interval of the drive point to the desired sampling depth using the drive hammer or sledge hammer. The desired depth is that at which there is sufficient groundwater in the drive point to obtain a sample. It should be recognized that the recharge to the small-diameter (1 to 1.25 inch ID) drive point may be slow.
3. In cases where the drive point must be pumped, insert the polyethylene sampling tubing into the drive point. Alternatively, a small-diameter bailer may be used.

4. In cases where the drive point is emplaced in a near-horizontal orientation, such as it may have when it is driven into a seepage area in the bank of a stream, be prepared for groundwater to flow from the drive point under the force of gravity. In this situation, the screen interval of the drive point must be fully embedded in the ground for groundwater to flow from the top of the drive point.
5. Fill all sample containers, beginning with the containers for VOC analysis.
6. Remove polyethylene sampling tubing, if used, from the drive point.
7. Decontaminate all non-dedicated downhole equipment in accordance with the *Decontamination of Personnel and Equipment SOP*.
8. Abandon drive point hole (as necessary) per project specifications.

V. Key Checks and Items

1. Verify that the drive points and any extra drive rods are clean.
2. When the drive point is emplaced in a near-horizontal orientation, be sure that the screen interval is completely embedded in the ground so that groundwater will flow through the embedded screen instead of through the exposed upper screen interval.

STANDARD OPERATING PROCEDURE

Groundwater-Surface Water Investigation: Well Point Method Pore Water Sampling Procedures

The groundwater-to-surface water interface (GSI) zone is an area where there is a potential link between site-related groundwater and receiving water bodies (e.g., drainages, streams, rivers, lakes, ponds). Pore water sampling at the GSI can be used to determine if venting of groundwater-associated contaminants is occurring and is often used to supplement groundwater, sediment and/or surface water sampling and analysis. These data can also help evaluate potential exposures to aquatic receptors in receiving water bodies and/or evaluate the migration of contamination from a groundwater source to other media. This standard operating procedure (SOP) describes the steps for collecting a pore water sample using the “well point” method.

Materials

- Well point apparatus (**Figure 1**)
- Water quality meter (Myron L Ultrameter or similar)
- Sledge hammer, rubber mallet, poste driver or sledge hammer
- Sample tubing (¼-inch-outer- diameter polyethylene tubing connected to ¼-inch-inner- diameter silicone peristaltic tubing)
- 45 µm cellulose acetate disposable in-line filters (dissolved metals filtering)
- Pump (portable battery powered peristaltic, hand pump or syringe assembly)
- Field notebook
- Water level meter and/or measuring tape

Construction

The well point method incorporates an outer and inner screen and riser apparatus. All well point components are built or supplied by ECT Manufacturing (Hamilton, NJ; www.ectmfg.com). **Attachment A** consists of the well point materials/components and ECT pricing as of date specified. The following describes the details of the outer and inner well point components.

Outer Well Point

Outer screens are constructed using 12-inch segments of 2-inch diameter PVC piping (**Figure 1**). Each screen has a 12-inch machine slotted screen¹ (0.010 inch slot size). A pointed well cap is attached (affixed with stainless steel screw) to the bottom of the outer screened segment, and the top end of this segment is threaded (female) to accept a 2-inch-diameter male end of a threaded PVC riser segment. The threaded area of each riser segment is sealed with an internal O-ring to prevent surface water leakage at the threaded zones. The risers are attached to the screen segment in 5-foot segments to achieve enough overall well point length so the top riser segment extends above the surface water line when the top of the slotted screen area is driven to depth matching the top of the sample interval².

Inner Well Point

Inner screens (known as a Prepack well screen) are constructed using 15-inch segments of 1-inch diameter PVC piping and are capped at the bottom (**Figure 1**). Each screen has a 12-inch machine slotted area (0.010-inch slot size) and is covered by a pre-packed filter that consists of a metal mesh covering filled with coarse well-drillers sand. This filter reduces intake of particulates and facilitates collection of a pore water sample more representative of *in situ* conditions. The top end of the inner screen segment is threaded to accept 1-inch-diameter PVC riser segments. The inner screen and riser are inserted into the outer well point, and additional 1-inch-diameter risers are attached in 5-foot segments to achieve enough overall length so the top inner riser segment extends to as close as possible to match the top of the outer riser segment (**Figure 2**). The inner risers are cut so that top of the inner and outer risers are within a 1-2 inches of each other.

Installation and Sampling

1. Measure water column depth.
2. Install outer well point (screens + risers) as follows:
 - a. Attach risers to screen segment so top riser segment extends above the surface water line when top of slotted screen area is driven to depth matching the top of the sample interval;
 - b. Place solid screw plug into top of the riser segment;
 - c. Insert apparatus to position screen at study-specified depth interval by hammering into place, striking the screw plug only (**Note: For samples collected from the top of the sediment profile, well points will be deployed such that the top of the outer well point sample screen will be at least 1-2 inch below the sediment surface. This position will better ensure there is no surface water**

¹ Depending on study objectives, screen length can be adjusted to any lengths up to several feet (most common intervals for pore water sampling application are within the 6 to 24 inch interval). Additionally, multiple depths/well points might be deployed simultaneously for profile sampling (e.g., shallow [2 to 14 inches], intermediate [14-26 inches], deep [26 to 38 inches]).

² In tidally influenced areas, make sure that the high water mark at high tide does not overtop the top end of the riser segment

draw down into the well point sampler; Additionally, depending on site-specific substrate the force needed to install will dictate the tools needed. Sometimes a hand power or a rubber mallet might suffice, but often a small sledge hammer or post driver might be necessary); and

- d. Remove solid screw plug.
3. Purge initial volume of water that enters the outer well point during installation to “reset” well point and clear it of debris that entered during installation actions; Use a pump and tubing that extends to the bottom of the screen segment (move tubing vigorously at the bottom to agitate debris/ particulate for removal).
4. Allow outer well point to charge with site pore water (water from discrete screen interval only) (*Note: for slow charging well points, or for initial gauging, a water level meter might be needed to monitor depth*).
5. Purge outer well point of one to two complete volumes of water using a pump and tubing that extends to the bottom of the screen segment (move tubing vigorously at the bottom to agitate debris/ particulate for removal).
6. For delayed sampling:
 - a. cover/ cap (do not seal) well point with 2-inch diameter lockable style well plugs or a screw cap, and let stand (equilibrate) for as long as necessary to recharge before sampling (**Figure 2**).
 - b. After equilibration, proceed to Step 7.
7. For immediate sampling, or when returning to sample after equilibration, insert inner screen/ pre-pack sand filter such that the top inner riser segment will extend to as close as possible to match the top of the outer riser segment.
8. Measure surface water quality parameters³ at pore water sampling location (directly adjacent to well point).
9. Draw pore water samples from within the inner screen using a slow-flow pump and tubing method (**Figure 3**); Slowly lower tubing until the bottom end is positioned at the bottom on the inner screen segment.
10. Collect initial (pre-sampling) water quality parameter measurements (*see footnote 3; Note: Because water quality parameters are expected to differ in the pore water and the surface water environments, compare during sampling activities onsite. This comparison will also be used to verify that pore water samples do not consist of surface water drawn down through the shallow sediment during pumping*).
11. Fill sample bottles for chemical analytical parameters; Pump pore water sample directly into the appropriate sample bottle(s) according to study plans (water for dissolved metals analysis can be collected using in-line filters [45 µm cellulose

³ Parameters will include at a minimum pH, specific conductance, temperature, oxidation-reduction potential and total dissolved solids, but depending on study objectives might also include turbidity and/or dissolved oxygen.

acetate disposable in-line filters], before the total metals sample is collected [unfiltered]).

12. Collect post-sampling water quality parameter measurements (*see footnote 3; Note: Because water quality parameters are expected to differ in the pore water and the surface water environments, compare during sampling activities onsite. This comparison will also be used to verify that pore water samples do not consist of surface water drawn down through the shallow sediment during pumping.*
13. Proceed to the next sampling location (*Note: New disposable PVC screens [outer and inner], PVC risers, sample tubing, and filters [when needed] will be used for each well. After the samples have been collected, the well point will be removed from the sediment and disposed of following investigation-derived waste procedures or left in place for a future round of sampling.*

Point of Contact

Contact **Dan Lavoie/WDC** for questions, project examples and/or native files (field forms) for adjusting to specific project needs.

Well Point – Components

- Pore water samples collected using well point method (dual PVC piezometer construction)

Inner Screen

- 1" diameter
- 12" prepack (sand) screen



inner riser
(outer riser
not shown)



Well points
nesting
(threads)

Outer Screen

- 2" diameter
- 15", 0.010" slot



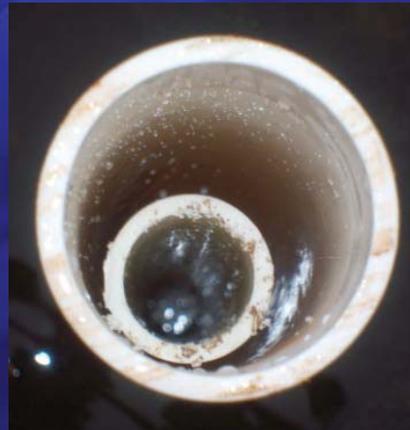
Well Point – Components

- Installation of outer piezometer with sledge/post/slide hammer
- Inner piezometer inserted after purging

Screw plug (for hammering)



Outer/inner well point nesting (non-threaded riser version)



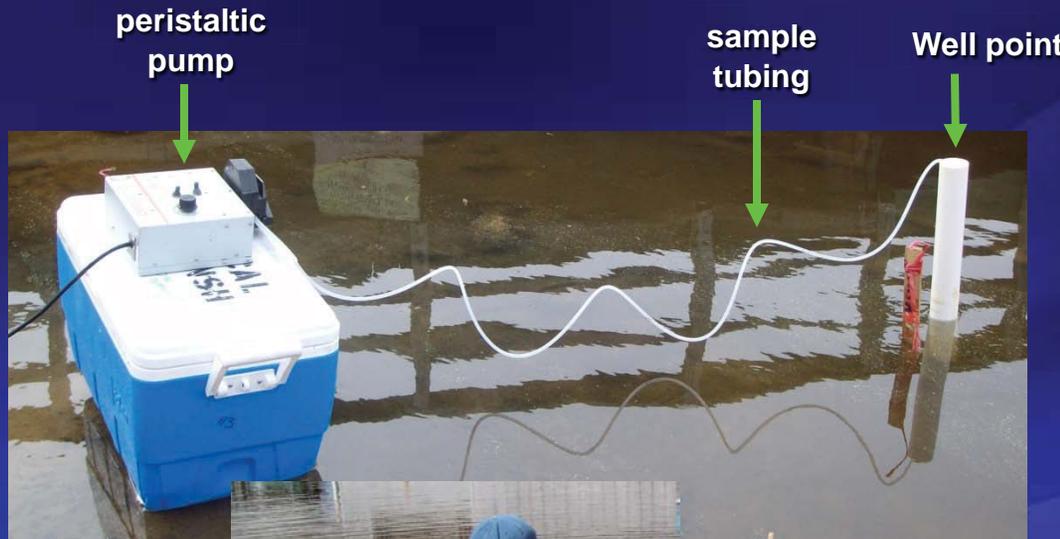
Screw cap



Well plug



Well Point – Sampling



- Slow flow
- Water quality + sample collection
- in-line filter (45 μm) for dissolved metals, as necessary



ECT Manufacturing Costing

Date: August 2012

| Item | Description | Details | Qty | Cost | Total |
|--------------|--------------------|--|------------|-------------|--------------|
| 10-020-050A | Riser | 2' x 5' S40 PVC RISER ASTM | 1 | \$13.19 | \$13.19 |
| 11-020-050E1 | Screen | 2' x 12" S40 PVC SCREEN .010 ASTM Male x Point (Pinned in using Stainless Steel pins) | 1 | \$17.25 | \$17.25 |
| 14-020-CAP | Cap | 2" S40 PVC THR FEM CAP ASTM | 1 | \$6.00 | \$6.00 |
| 14-020-PLUGJ | Plug | 2" S40 SOLID GREY THR MALE PLUG ASTM, JOHNSON | 1 | \$14.00 | \$14.00 |
| 10-010-050F | Riser | 1" x 5' S40 PVC RISER 8P | 1 | \$7.75 | \$7.75 |
| 15-010-05SS | PrePack | 1" ID x 1.7" OD x 12" x S40 .010 8M, Stainless Steel Mesh PrePacked PVC Well Screen Male x Point | 1 | \$57.25 | \$57.25 |
| T2 | Plug | 2-inch Gripper Plug Orange Torquer, S40 | 1 | \$5.75 | \$5.75 |
| -- | Frieght | Project Dependant | 1 | \$0.00 | \$0.00 |
| TOTAL | | | | | \$121.19 |

Pore Water Sampling Field Form

Sample Location: _____

Project Name: _____ Project Number: _____
 Location: _____ Date: _____
 Weather: _____
 Site Condition: _____
 Field Team: _____

Sample Method: _____
 Comments: _____

| Observation (relative to PW sampling) | Water Column Depth (inches) | pH | Conductivity (mS/cm) | Temperature (°C) | ORP (mV) | TDS (g/L) | DO (mg/L) | Turbidity (NTU) | Comments |
|--|--------------------------------|----|-------------------------|---------------------|----------|-----------|-----------|-----------------|----------|
| <i>Surface Water Conditions</i> | | | | | | | | | |
| Before | | | | | | | | | |
| <i>Pore Water Conditions</i> | | | | | | | | | |
| <i>Sample Interval 1 (_____ feet); Sample ID:</i> | | | | | | | | | |
| Before | | | | | | | | | |
| During | | | | | | | | | |
| After | | | | | | | | | |
| <i>Sample Interval 2 (_____ feet); Sample ID:</i> | | | | | | | | | |
| Before | | | | | | | | | |
| During | | | | | | | | | |
| After | | | | | | | | | |
| <i>Sample Interval 3 (_____ feet); Sample ID:</i> | | | | | | | | | |
| Before | | | | | | | | | |
| During | | | | | | | | | |
| After | | | | | | | | | |

Signature/Date: _____



Appendix B
Ecological Screening Values

Appendix B-1

Ecological Screening Values (ESVs) for Soil

| Analytical Group | Chemical | ESV | Units | Reference | Comments |
|------------------|----------------------------|------------|-------|----------------------------|--|
| Explosives | 1,3,5-Trinitrobenzene | NSV | -- | -- | |
| Explosives | 1,3-Dinitrobenzene | NSV | -- | -- | |
| Explosives | 2,4,6-Trinitrotoluene | 10,000 | ug/kg | Talmage et al. 1999 | Plant |
| Explosives | 2,4-Dinitrotoluene | 11,000 | ug/kg | NRCC 2006 | Plant/Invertebrate |
| Explosives | 2,6-Dinitrotoluene | 8,500 | ug/kg | NRCC 2006 | Plant/Invertebrate |
| Explosives | 2-Amino-4,6-dinitrotoluene | 80,000 | ug/kg | Talmage et al. 1999 | Plant |
| Explosives | 2-Nitrotoluene | NSV | -- | -- | |
| Explosives | 3,5-Dinitroaniline | NSV | -- | -- | |
| Explosives | 3-Nitrotoluene | NSV | -- | -- | |
| Explosives | 4-Amino-2,6-dinitrotoluene | 80,000 | ug/kg | 2-Amino-4,6-dinitrotoluene | Plant |
| Explosives | 4-Nitrotoluene | NSV | -- | -- | |
| Explosives | HMX | 10,000 | ug/kg | Talmage et al. 1999 | Invertebrate |
| Explosives | Nitrobenzene | 2,260 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 226,000; UF of 100 |
| Explosives | Nitroglycerine | NSV | -- | -- | |
| Explosives | Nitroguanidine | NSV | -- | -- | |
| Explosives | Perchlorate | 1,000 | ug/kg | USEPA 2002 | Invertebrate |
| Explosives | PETN | NSV | -- | -- | |
| Explosives | RDX | 10,000 | ug/kg | Talmage et al. 1999 | Invertebrate |
| Explosives | Tetryl | 10,000 | ug/kg | Talmage et al. 1999 | Plant |
| Inorganics | Aluminum | pH < 5.5 | -- | USEPA 2003a | Eco-SSL |
| Inorganics | Antimony | 78.0 | mg/kg | USEPA 2005a | Eco-SSL - Invertebrate |
| Inorganics | Arsenic | 18.0 | mg/kg | USEPA 2005b | Eco-SSL - Plant |
| Inorganics | Barium | 330 | mg/kg | USEPA 2005c | Eco-SSL - Invertebrate |
| Inorganics | Beryllium | 40.0 | mg/kg | USEPA 2005d | Eco-SSL - Invertebrate |
| Inorganics | Cadmium | 32.0 | mg/kg | USEPA 2005e | Eco-SSL - Plant |
| Inorganics | Calcium | NSV | -- | -- | |
| Inorganics | Chromium | 64.0 | mg/kg | CCME 2007 | Soil Quality Guideline |
| Inorganics | Cobalt | 13.0 | mg/kg | USEPA 2005f | Eco-SSL - Plant |
| Inorganics | Copper | 70.0 | mg/kg | USEPA 2007a | Eco-SSL - Plant |
| Inorganics | Cyanide | 15.8 | mg/kg | MHSPE 2000 | Geomean of target/intervention - complex |
| Inorganics | Iron | 5 < pH > 8 | -- | USEPA 2003b | Eco-SSL |
| Inorganics | Lead | 120 | mg/kg | USEPA 2005g | Eco-SSL - Plant |
| Inorganics | Magnesium | NSV | -- | -- | |

Appendix B-1

Ecological Screening Values (ESVs) for Soil

| Analytical Group | Chemical | ESV | Units | Reference | Comments |
|------------------|------------------------------|---------|-------|------------------------|---|
| Inorganics | Manganese | 220 | mg/kg | USEPA 2007b | Eco-SSL - Plant |
| Inorganics | Mercury | 0.10 | mg/kg | Efroymsen et al. 1997b | Invertebrate |
| Inorganics | Nickel | 38.0 | mg/kg | USEPA 2007c | Eco-SSL - Plant |
| Inorganics | Potassium | NSV | -- | -- | |
| Inorganics | Selenium | 0.52 | mg/kg | USEPA 2007d | Eco-SSL - Plant |
| Inorganics | Silver | 560 | mg/kg | USEPA 2006a | Eco-SSL - Plant |
| Inorganics | Sodium | NSV | -- | -- | |
| Inorganics | Thallium | 1.00 | mg/kg | Efroymsen et al. 1997a | Plant |
| Inorganics | Vanadium | 130 | mg/kg | CCME 2007 | Soil Quality Guideline |
| Inorganics | Zinc | 120 | mg/kg | USEPA 2007e | Eco-SSL - Invertebrate |
| SVOCs | 1,1-Biphenyl | 13,600 | ug/kg | Efroymsen et al. 1997a | Plant EC50 (68,000); UF of 5 |
| SVOCs | 1,2,3-Trichlorobenzene | 1,150 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 115,000; UF of 100 |
| SVOCs | 1,2,4-Trichlorobenzene | 1,270 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 127,000; UF of 100 |
| SVOCs | 1,2,4,5-Tetrachlorobenzene | 1,000 | ug/kg | Beyer 1990 | B value |
| SVOCs | 1,2-Dichlorobenzene | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 1,3-Dichlorobenzene | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 1,4-Dichlorobenzene | 1,280 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 128,000; UF of 100 |
| SVOCs | 2,2'-Oxybis(1-chloropropane) | NSV | -- | -- | |
| SVOCs | 2,3,4,6-Tetrachlorophenol | 500 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 2,4,5-Trichlorophenol | 1,350 | ug/kg | Efroymsen et al. 1997a | Plant NOEC |
| SVOCs | 2,4,6-Trichlorophenol | 580 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 58,000; UF of 100 |
| SVOCs | 2,4-Dichlorophenol | 500 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 2,4-Dimethylphenol | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 2,4-Dinitrophenol | 20,000 | ug/kg | Efroymsen et al. 1997a | Plant NOEC |
| SVOCs | 2,4-Dinitrotoluene | 11,000 | ug/kg | NRCC 2006 | Plant/Invertebrate |
| SVOCs | 2,6-Dinitrotoluene | 8,500 | ug/kg | NRCC 2006 | Plant/Invertebrate |
| SVOCs | 2-Chloronaphthalene | LMW PAH | -- | -- | |
| SVOCs | 2-Chlorophenol | 500 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 2-Methylnaphthalene | LMW PAH | -- | -- | |
| SVOCs | 2-Methylphenol | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 2-Nitroaniline | NSV | -- | -- | |
| SVOCs | 2-Nitrophenol | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 3- and 4-Methylphenol | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |

Appendix B-1

Ecological Screening Values (ESVs) for Soil

| Analytical Group | Chemical | ESV | Units | Reference | Comments |
|------------------|-----------------------------|---------|-------|------------------------|--|
| SVOCs | 3,3'-Dichlorobenzidine | NSV | -- | -- | |
| SVOCs | 3-Nitroaniline | NSV | -- | -- | |
| SVOCs | 4,6-Dinitro-2-methylphenol | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 4-Bromophenyl-phenylether | NSV | -- | -- | |
| SVOCs | 4-Chloro-3-methylphenol | 500 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 4-Chloroaniline | 500 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| SVOCs | 4-Chlorophenyl-phenylether | NSV | -- | -- | |
| SVOCs | 4-Methylphenol | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| SVOCs | 4-Nitroaniline | NSV | -- | -- | |
| SVOCs | 4-Nitrophenol | 380 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 38,000; UF of 100 |
| SVOCs | Acenaphthene | LMW PAH | -- | -- | |
| SVOCs | Acenaphthylene | LMW PAH | -- | -- | |
| SVOCs | Acetophenone | NSV | -- | -- | |
| SVOCs | Anthracene | LMW PAH | -- | -- | |
| SVOCs | Atrazine | 11.9 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| SVOCs | Benzaldehyde | NSV | -- | -- | |
| SVOCs | Benzo(a)anthracene | HMW PAH | -- | -- | |
| SVOCs | Benzo(a)pyrene | HMW PAH | -- | -- | |
| SVOCs | Benzo(b)fluoranthene | HMW PAH | -- | -- | |
| SVOCs | Benzo(g,h,i)perylene | HMW PAH | -- | -- | |
| SVOCs | Benzo(k)fluoranthene | HMW PAH | -- | -- | |
| SVOCs | Benzoic acid | NSV | -- | -- | |
| SVOCs | Benzyl alcohol | NSV | -- | -- | |
| SVOCs | bis(2-Chloroethoxy)methane | NSV | -- | -- | |
| SVOCs | bis(2-Chloroethyl)ether | NSV | -- | -- | |
| SVOCs | bis(2-Chloroisopropyl)ether | NSV | -- | -- | |
| SVOCs | bis(2-Ethylhexyl)phthalate | 30,000 | ug/kg | CCME 2007 | Plant; IRC |
| SVOCs | Butylbenzylphthalate | 30,000 | ug/kg | CCME 2007 | Plant; IRC |
| SVOCs | Caprolactam | NSV | -- | -- | |
| SVOCs | Carbazole | NSV | -- | -- | |
| SVOCs | Chrysene | HMW PAH | -- | -- | |
| SVOCs | Dibenz(a,h)anthracene | HMW PAH | -- | -- | |
| SVOCs | Dibenzofuran | NSV | -- | -- | |

Appendix B-1

Ecological Screening Values (ESVs) for Soil

| Analytical Group | Chemical | ESV | Units | Reference | Comments |
|------------------|--|---------|-------|------------------------|---|
| SVOCs | Diethylphthalate | 26,800 | ug/kg | Efroymsen et al. 1997a | Plant EC50 (134,000); UF of 5 |
| SVOCs | Dimethyl phthalate | 10,640 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 1,064,000; UF of 100 |
| SVOCs | Di-n-butylphthalate | 40,000 | ug/kg | Efroymsen et al. 1997a | Plant LOEC (200,000); UF of 5 |
| SVOCs | Di-n-octylphthalate | 30,000 | ug/kg | CCME 2007 | Plant; IRC |
| SVOCs | Fluoranthene | LMW PAH | -- | -- | |
| SVOCs | Fluorene | LMW PAH | -- | -- | |
| SVOCs | Hexachlorobenzene | 1,000 | ug/kg | Beyer 1990 | B value |
| SVOCs | Hexachlorobutadiene | NSV | -- | -- | |
| SVOCs | Hexachlorocyclopentadiene | 2,000 | ug/kg | Efroymsen et al. 1997a | Plant LOEC (10,000); UF of 5 |
| SVOCs | Hexachloroethane | NSV | -- | -- | |
| SVOCs | Indeno(1,2,3-cd)pyrene | HMW PAH | -- | -- | |
| SVOCs | Isophorone | NSV | -- | -- | |
| SVOCs | Naphthalene | LMW PAH | -- | -- | |
| SVOCs | Nitrobenzene | 2,260 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 226,000; UF of 100 |
| SVOCs | n-Nitroso-di-n-propylamine | NSV | -- | -- | |
| SVOCs | n-Nitrosodiphenylamine | 1,090 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 109,000; UF of 100 |
| SVOCs | PAH (HMW) | 18,000 | ug/kg | USEPA 2007f | Eco-SSL - Invertebrate |
| SVOCs | PAH (LMW) | 29,000 | ug/kg | USEPA 2007f | Eco-SSL - Invertebrate |
| SVOCs | Pentachlorophenol | 5,000 | ug/kg | USEPA 2007g | Eco-SSL - Plant |
| SVOCs | Phenanthrene | LMW PAH | -- | -- | |
| SVOCs | Phenol | 1,880 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 188,000; UF of 100 |
| SVOCs | Pyrene | HMW PAH | -- | -- | |
| VOCs | 1,1,1-Trichloroethane | 1,025 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| VOCs | 1,1,2,2-Tetrachloroethane | 5,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| VOCs | 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | NSV | -- | -- | |
| VOCs | 1,1,2-Trichloroethane | 2,000 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| VOCs | 1,1-Dichloroethane | 548 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| VOCs | 1,1-Dichloroethene | 173 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| VOCs | 1,2,3-Trichlorobenzene | 1,150 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 115,000; UF of 100 |
| VOCs | 1,2,4-Trichlorobenzene | 1,270 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 127,000; UF of 100 |
| VOCs | 1,2-Dibromo-3-chloropropane | NSV | -- | -- | |
| VOCs | 1,2-Dibromoethane | 300 | ug/kg | CCME 2007 | IRC |
| VOCs | 1,2-Dichlorobenzene | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |

Appendix B-1

Ecological Screening Values (ESVs) for Soil

| Analytical Group | Chemical | ESV | Units | Reference | Comments |
|------------------|-----------------------------------|--------|-------|------------------------|---|
| VOCs | 1,2-Dichloroethane | 2,190 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | 1,2-Dichloroethene (total) | 447 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| VOCs | 1,2-Dichloropropane | 38,800 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 3,880,000; UF of 100 |
| VOCs | 1,3-Dichlorobenzene | 1,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| VOCs | 1,4-Dichlorobenzene | 1,280 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 128,000; UF of 100 |
| VOCs | 1,4-Dioxane | NSV | -- | -- | |
| VOCs | 2-Butanone | NSV | -- | -- | |
| VOCs | 2-Hexanone | NSV | -- | -- | |
| VOCs | 4-Methyl-2-pentanone | NSV | -- | -- | |
| VOCs | Acetone | NSV | -- | -- | |
| VOCs | Benzene | 1,140 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Bromochloromethane | NSV | -- | -- | |
| VOCs | Bromodichloromethane | NSV | -- | -- | |
| VOCs | Bromoform | 300 | ug/kg | CCME 2007 | Plant; IRC |
| VOCs | Bromomethane | NSV | -- | -- | |
| VOCs | Carbon disulfide | NSV | -- | -- | |
| VOCs | Carbon tetrachloride | 3,400 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Chlorobenzene | 2,400 | ug/kg | Efroymsen et al. 1997b | Invertebrate LC50 of 240,000; UF of 100 |
| VOCs | Chloroethane | 5,000 | ug/kg | CCME 2007 | IRC |
| VOCs | Chloroform | 1,844 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Chloromethane | 5,000 | ug/kg | CCME 2007 | IRC |
| VOCs | cis-1,2-Dichloroethene | 447 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| VOCs | cis-1,3-Dichloropropene | 5,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| VOCs | Cyclohexane | 6,000 | ug/kg | Beyer 1990 | B value |
| VOCs | Dibromochloromethane | NSV | -- | -- | |
| VOCs | Dichlorodifluoromethane(Freon-12) | NSV | -- | -- | |
| VOCs | Ethylbenzene | 1,815 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Isopropylbenzene | NSV | -- | -- | |
| VOCs | m- and p-Xylene | 1,300 | ug/kg | Total xylenes | |
| VOCs | Methyl acetate | NSV | -- | -- | |
| VOCs | Methylcyclohexane | NSV | -- | -- | |
| VOCs | Methylene chloride | 1,250 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Methyl-tert-butyl ether (MTBE) | NSV | -- | -- | |

Appendix B-1

Ecological Screening Values (ESVs) for Soil

| Analytical Group | Chemical | ESV | Units | Reference | Comments |
|------------------|----------------------------------|--------|-------|------------------------|--------------------------------|
| VOCs | o-Xylene | 1,300 | ug/kg | Total xylenes | |
| VOCs | Styrene | 64,000 | ug/kg | Efroymsen et al. 1997a | Plant EC50 (320,000); UF of 5 |
| VOCs | Tetrachloroethene | 179 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Toluene | 40,000 | ug/kg | Efroymsen et al. 1997a | Plant EC50 (200,000); UF of 5 |
| VOCs | trans-1,2-Dichloroethene | 447 | ug/kg | MHSPE 2000 | Geomean of target/intervention |
| VOCs | trans-1,3-Dichloropropene | 5,000 | ug/kg | Beyer 1990; CCME 2007 | B value; IRC |
| VOCs | Trichloroethene | 500 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Trichlorofluoromethane(Freon-11) | NSV | -- | -- | |
| VOCs | Vinyl chloride | 412 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| VOCs | Xylene, total | 1,300 | ug/kg | MHSPE 2000; 2001 | Geomean of target/SRC |
| Other | Chromium (hexavalent) | 0.40 | mg/kg | CCME 2007 | Soil Quality Guideline |

NSV - No Screening Value

| Appendix B-2 Ecological Screening Values (ESVs) for Freshwater (Surface Water, Pore Water, Seeps, Groundwater) | | | | | | | | |
|---|----------------------------|------------|--------|-------|-----------------|----|----------------------------|----------|
| Analytical Group | Chemical | Type | ESV | Units | Hardness (mg/L) | pH | Reference | Comments |
| Explosives | 1,3,5-Trinitrobenzene | Freshwater | 11.0 | ug/L | | | Talmage et al. 1999 | SCV |
| Explosives | 1,3-Dinitrobenzene | Freshwater | 17.0 | ug/L | | | Talmage et al. 1999 | SCV |
| Explosives | 2,4,6-Trinitrotoluene | Freshwater | 93.0 | ug/L | | | Talmage et al. 1999 | SCV |
| Explosives | 2,4-Dinitrotoluene | Freshwater | 44.0 | ug/L | | | USEPA 2006b | SCV |
| Explosives | 2,6-Dinitrotoluene | Freshwater | 81.0 | ug/L | | | USEPA 2006b | SCV |
| Explosives | 2-Amino-4,6-dinitrotoluene | Freshwater | 19.0 | ug/L | | | Talmage et al. 1999 | SCV |
| Explosives | 2-Nitrotoluene | Freshwater | 3,400 | ug/L | | | NAVFAC 2007 | |
| Explosives | 3,5-Dinitroaniline | Freshwater | 59.0 | ug/L | | | Talmage et al. 1999 | SCV |
| Explosives | 3-Nitrotoluene | Freshwater | 750 | ug/L | | | USEPA 2006b | |
| Explosives | 4-Amino-2,6-dinitrotoluene | Freshwater | 19.0 | ug/L | | | 2-Amino-4,6-dinitrotoluene | |
| Explosives | 4-Nitrotoluene | Freshwater | 1,900 | ug/L | | | USEPA 2006b | |
| Explosives | HMX | Freshwater | 330 | ug/L | | | Talmage et al. 1999 | SCV |
| Explosives | Nitrobenzene | Freshwater | 270 | ug/L | | | USEPA 2001 | Acute/10 |
| Explosives | Nitroglycerine | Freshwater | 138 | ug/L | | | USEPA 2006b | |
| Explosives | Nitroguanidine | Freshwater | 220 | ug/L | | | NAVFAC 2007 | NOEC |
| Explosives | Perchlorate | Freshwater | 9,300 | ug/L | | | Dean et al. 1994 | CCC |
| Explosives | PETN | Freshwater | 85,000 | ug/L | | | USEPA 2006b | |
| Explosives | RDX | Freshwater | 186 | ug/L | | | Talmage et al. 1999 | SCV |
| Explosives | Tetryl | Freshwater | NSV | -- | | | -- | |
| Filtered Metals | Aluminum | Freshwater | 87.0 | ug/L | | | USEPA 2009 | AWQC |
| Filtered Metals | Antimony | Freshwater | 30.0 | ug/L | | | Suter and Tsao 1996 | FCV |
| Filtered Metals | Arsenic | Freshwater | 150 | ug/L | | | USEPA 2009 | AWQC |
| Filtered Metals | Barium | Freshwater | 4.00 | ug/L | | | Suter and Tsao 1996 | SCV |
| Filtered Metals | Beryllium | Freshwater | 0.66 | ug/L | | | Suter and Tsao 1996 | SCV |
| Filtered Metals | Cadmium | Freshwater | 0.25 | ug/L | 100 | | USEPA 2009 | AWQC |
| Filtered Metals | Calcium | Freshwater | NSV | -- | | | -- | |
| Filtered Metals | Chromium | Freshwater | 11.0 | ug/L | | | USEPA 2009 | AWQC |
| Filtered Metals | Cobalt | Freshwater | 23.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| Filtered Metals | Copper | Freshwater | 8.96 | ug/L | 100 | | USEPA 2006c | AWQC |
| Filtered Metals | Iron | Freshwater | 1,000 | ug/L | | | USEPA 2009 | AWQC |
| Filtered Metals | Lead | Freshwater | 2.52 | ug/L | 100 | | USEPA 2009 | AWQC |
| Filtered Metals | Magnesium | Freshwater | NSV | -- | | | -- | |

| Appendix B-2 Ecological Screening Values (ESVs) for Freshwater (Surface Water, Pore Water, Seeps, Groundwater) | | | | | | | | |
|---|----------------|------------|-------|-------|-----------------|----|---------------------|----------|
| Analytical Group | Chemical | Type | ESV | Units | Hardness (mg/L) | pH | Reference | Comments |
| Filtered Metals | Manganese | Freshwater | 120 | ug/L | | | Suter and Tsao 1996 | SCV |
| Filtered Metals | Mercury | Freshwater | 0.77 | ug/L | | | USEPA 2009 | AWQC |
| Filtered Metals | Nickel | Freshwater | 52.0 | ug/L | 100 | | USEPA 2009 | AWQC |
| Filtered Metals | Potassium | Freshwater | NSV | -- | | | -- | |
| Filtered Metals | Selenium | Freshwater | 4.61 | ug/L | | | USEPA 2009 | AWQC |
| Filtered Metals | Silver | Freshwater | 0.36 | ug/L | | | Suter and Tsao 1996 | SCV |
| Filtered Metals | Sodium | Freshwater | NSV | -- | | | -- | |
| Filtered Metals | Thallium | Freshwater | 12.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| Filtered Metals | Vanadium | Freshwater | 20.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| Filtered Metals | Zinc | Freshwater | 118 | ug/L | 100 | | USEPA 2009 | AWQC |
| Inorganics | Aluminum | Freshwater | 87.0 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Antimony | Freshwater | 30.0 | ug/L | | | Suter and Tsao 1996 | FCV |
| Inorganics | Arsenic | Freshwater | 150 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Barium | Freshwater | 4.00 | ug/L | | | Suter and Tsao 1996 | SCV |
| Inorganics | Beryllium | Freshwater | 0.66 | ug/L | | | Suter and Tsao 1996 | SCV |
| Inorganics | Cadmium | Freshwater | 0.27 | ug/L | 100 | | USEPA 2009 | AWQC |
| Inorganics | Calcium | Freshwater | NSV | -- | | | -- | |
| Inorganics | Chromium | Freshwater | 11.4 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Cobalt | Freshwater | 23.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| Inorganics | Copper | Freshwater | 9.33 | ug/L | 100 | | USEPA 2006c | AWQC |
| Inorganics | Cyanide, total | Freshwater | 5.20 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Cyanide, free | Freshwater | 5.20 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Iron | Freshwater | 1,000 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Lead | Freshwater | 3.18 | ug/L | 100 | | USEPA 2009 | AWQC |
| Inorganics | Magnesium | Freshwater | NSV | -- | | | -- | |
| Inorganics | Manganese | Freshwater | 120 | ug/L | | | Suter and Tsao 1996 | SCV |
| Inorganics | Mercury | Freshwater | 0.91 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Nickel | Freshwater | 52.2 | ug/L | 100 | | USEPA 2009 | AWQC |
| Inorganics | Potassium | Freshwater | NSV | -- | | | -- | |
| Inorganics | Selenium | Freshwater | 5.00 | ug/L | | | USEPA 2009 | AWQC |
| Inorganics | Silver | Freshwater | 0.36 | ug/L | | | Suter and Tsao 1996 | SCV |
| Inorganics | Sodium | Freshwater | NSV | -- | | | -- | |

| Appendix B-2 Ecological Screening Values (ESVs) for Freshwater (Surface Water, Pore Water, Seeps, Groundwater) | | | | | | | | |
|---|------------------------------|------------|-------|-------|-----------------|----|---------------------|----------------|
| Analytical Group | Chemical | Type | ESV | Units | Hardness (mg/L) | pH | Reference | Comments |
| Inorganics | Thallium | Freshwater | 12.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| Inorganics | Vanadium | Freshwater | 20.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| Inorganics | Zinc | Freshwater | 120 | ug/L | 100 | | USEPA 2009 | AWQC |
| SVOCs | 1,1-Biphenyl | Freshwater | 14.0 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | 1,2,3-Trichlorobenzene | Freshwater | 8.00 | ug/L | | | USEPA 2006b | |
| SVOCs | 1,2,4-Trichlorobenzene | Freshwater | 110 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | 1,2,4,5-Tetrachlorobenzene | Freshwater | 3.00 | ug/L | | | USEPA 2003c | Tier II SCV |
| SVOCs | 1,2-Dichlorobenzene | Freshwater | 14.0 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | 1,3-Dichlorobenzene | Freshwater | 71.0 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | 1,4-Dichlorobenzene | Freshwater | 15.0 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | 2,2'-Oxybis(1-chloropropane) | Freshwater | NSV | -- | | | -- | |
| SVOCs | 2,3,4,6-Tetrachlorophenol | Freshwater | 1.20 | ug/L | | | USEPA 2003c | Tier II SCV |
| SVOCs | 2,4,5-Trichlorophenol | Freshwater | 63.0 | ug/L | | | Buchman 2008 | |
| SVOCs | 2,4,6-Trichlorophenol | Freshwater | 4.90 | ug/L | | | Buchman 2008 | |
| SVOCs | 2,4-Dichlorophenol | Freshwater | 11.0 | ug/L | | | USEPA 2006b | SCV |
| SVOCs | 2,4-Dimethylphenol | Freshwater | 100 | ug/L | | | Buchman 2008 | |
| SVOCs | 2,4-Dinitrophenol | Freshwater | 19.0 | ug/L | | | Buchman 2008 | |
| SVOCs | 2,4-Dinitrotoluene | Freshwater | 44.0 | ug/L | | | USEPA 2006b | SCV |
| SVOCs | 2,6-Dinitrotoluene | Freshwater | 81.0 | ug/L | | | USEPA 2006b | SCV |
| SVOCs | 2-Chloronaphthalene | Freshwater | 0.40 | ug/L | | | Buchman 2008 | |
| SVOCs | 2-Chlorophenol | Freshwater | 24.0 | ug/L | | | USEPA 2006b | FCV |
| SVOCs | 2-Methylnaphthalene | Freshwater | 330 | ug/L | | | Buchman 2008 | |
| SVOCs | 2-Methylphenol | Freshwater | 13.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | 2-Nitroaniline | Freshwater | NSV | -- | | | -- | |
| SVOCs | 2-Nitrophenol | Freshwater | 1,920 | ug/L | | | USEPA 2006b | |
| SVOCs | 3- and 4-Methylphenol | Freshwater | 543 | ug/L | | | USEPA 2006b | 4-Methylphenol |
| SVOCs | 3,3'-Dichlorobenzidine | Freshwater | 4.50 | ug/L | | | USEPA 2006b | FCV |
| SVOCs | 3-Nitroaniline | Freshwater | NSV | -- | | | -- | |
| SVOCs | 4,6-Dinitro-2-methylphenol | Freshwater | 2.30 | ug/L | | | USEPA 2001 | |
| SVOCs | 4-Bromophenyl-phenylether | Freshwater | 1.50 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | 4-Chloro-3-methylphenol | Freshwater | 0.30 | ug/L | | | USEPA 2001 | |
| SVOCs | 4-Chloroaniline | Freshwater | 232 | ug/L | | | USEPA 2006b | |

| Appendix B-2 Ecological Screening Values (ESVs) for Freshwater (Surface Water, Pore Water, Seeps, Groundwater) | | | | | | | | |
|---|-----------------------------|------------|-------|-------|-----------------|----|----------------------------|----------|
| Analytical Group | Chemical | Type | ESV | Units | Hardness (mg/L) | pH | Reference | Comments |
| SVOCs | 4-Chlorophenyl-phenylether | Freshwater | NSV | -- | | | -- | |
| SVOCs | 4-Methylphenol | Freshwater | 543 | ug/L | | | USEPA 2006b | |
| SVOCs | 4-Nitroaniline | Freshwater | NSV | -- | | | -- | |
| SVOCs | 4-Nitrophenol | Freshwater | 300 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Acenaphthene | Freshwater | 23.0 | ug/L | | | USEPA 1996 | FCV |
| SVOCs | Acenaphthylene | Freshwater | 4,840 | ug/L | | | Buchman 2008 | |
| SVOCs | Acetophenone | Freshwater | NSV | -- | | | -- | |
| SVOCs | Anthracene | Freshwater | 0.73 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Atrazine | Freshwater | 1.80 | ug/L | | | USEPA 2006b | |
| SVOCs | Benzaldehyde | Freshwater | NSV | -- | | | -- | |
| SVOCs | Benzo(a)anthracene | Freshwater | 0.027 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Benzo(a)pyrene | Freshwater | 0.014 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Benzo(b)fluoranthene | Freshwater | 9.07 | ug/L | | | Buchman 2008 | |
| SVOCs | Benzo(g,h,i)perylene | Freshwater | 7.64 | ug/L | | | Buchman 2008 | |
| SVOCs | Benzo(k)fluoranthene | Freshwater | 9.07 | ug/L | | | Benzo(b)fluoranthene value | |
| SVOCs | Benzoic acid | Freshwater | 42.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Benzyl alcohol | Freshwater | 8.60 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | bis(2-Chloroethoxy)methane | Freshwater | NSV | -- | | | -- | |
| SVOCs | bis(2-Chloroethyl)ether | Freshwater | 1,900 | ug/L | | | Buchman 2008 | |
| SVOCs | bis(2-Chloroisopropyl)ether | Freshwater | NSV | -- | | | -- | |
| SVOCs | bis(2-Ethylhexyl)phthalate | Freshwater | 32.0 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | Butylbenzylphthalate | Freshwater | 19.0 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | Caprolactam | Freshwater | NSV | -- | | | -- | |
| SVOCs | Carbazole | Freshwater | NSV | -- | | | -- | |
| SVOCs | Chrysene | Freshwater | NSV | -- | | | -- | |
| SVOCs | Dibenz(a,h)anthracene | Freshwater | NSV | -- | | | -- | |
| SVOCs | Dibenzofuran | Freshwater | 3.70 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Diethylphthalate | Freshwater | 270 | ug/L | | | USEPA 2008 | SCV |
| SVOCs | Dimethyl phthalate | Freshwater | 330 | ug/L | | | USEPA 2001 | |
| SVOCs | Di-n-butylphthalate | Freshwater | 35.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Di-n-octylphthalate | Freshwater | 22.0 | ug/L | | | USEPA 2006b | |
| SVOCs | Fluoranthene | Freshwater | 8.10 | ug/L | | | USEPA 1996 | FCV |

| Appendix B-2 Ecological Screening Values (ESVs) for Freshwater (Surface Water, Pore Water, Seeps, Groundwater) | | | | | | | | |
|---|--|------------|-------|-------|-----------------|-----|---------------------|---------------|
| Analytical Group | Chemical | Type | ESV | Units | Hardness (mg/L) | pH | Reference | Comments |
| SVOCs | Fluorene | Freshwater | 3.90 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | Hexachlorobenzene | Freshwater | 3.68 | ug/L | | | Buchman 2008 | Proposed AWQC |
| SVOCs | Hexachlorobutadiene | Freshwater | 1.30 | ug/L | | | USEPA 2006b | |
| SVOCs | Hexachlorocyclopentadiene | Freshwater | 1.04 | ug/L | | | Buchman 2008 | LOEL/5 |
| SVOCs | Hexachloroethane | Freshwater | 12.0 | ug/L | | | USEPA 1996 | SCV |
| SVOCs | Indeno(1,2,3-cd)pyrene | Freshwater | 4.31 | ug/L | | | Buchman 2008 | |
| SVOCs | Isophorone | Freshwater | 1,170 | ug/L | | | USEPA 2001 | |
| SVOCs | Naphthalene | Freshwater | 12.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Nitrobenzene | Freshwater | 270 | ug/L | | | USEPA 2001 | Acute/10 |
| SVOCs | n-Nitroso-di-n-propylamine | Freshwater | NSV | -- | | | -- | |
| SVOCs | n-Nitrosodiphenylamine | Freshwater | 210 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Pentachlorophenol | Freshwater | 15.0 | ug/L | | 7.8 | USEPA 2009 | AWQC |
| SVOCs | Phenanthrene | Freshwater | 6.30 | ug/L | | | USEPA 1996 | FCV |
| SVOCs | Phenol | Freshwater | 110 | ug/L | | | Suter and Tsao 1996 | SCV |
| SVOCs | Pyrene | Freshwater | 0.025 | ug/L | | | USEPA 2006b | |
| VOCs | 1,1,1-Trichloroethane | Freshwater | 11.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,1,2,2-Tetrachloroethane | Freshwater | 610 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | Freshwater | NSV | -- | | | -- | |
| VOCs | 1,1,2-Trichloroethane | Freshwater | 1,200 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,1-Dichloroethane | Freshwater | 47.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,1-Dichloroethene | Freshwater | 25.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,2,3-Trichlorobenzene | Freshwater | 8.00 | ug/L | | | USEPA 2006b | |
| VOCs | 1,2,4-Trichlorobenzene | Freshwater | 110 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,2-Dibromo-3-chloropropane | Freshwater | NSV | -- | | | -- | |
| VOCs | 1,2-Dibromoethane | Freshwater | NSV | -- | | | -- | |
| VOCs | 1,2-Dichlorobenzene | Freshwater | 14.0 | ug/L | | | USEPA 1996 | SCV |
| VOCs | 1,2-Dichloroethane | Freshwater | 910 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,2-Dichloroethene (total) | Freshwater | 590 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 1,2-Dichloropropane | Freshwater | 525 | ug/L | | | USEPA 2001 | |
| VOCs | 1,3-Dichlorobenzene | Freshwater | 71.0 | ug/L | | | USEPA 1996 | SCV |
| VOCs | 1,4-Dichlorobenzene | Freshwater | 15.0 | ug/L | | | USEPA 1996 | SCV |
| VOCs | 1,4-Dioxane | Freshwater | NSV | -- | | | -- | |

| Appendix B-2 Ecological Screening Values (ESVs) for Freshwater (Surface Water, Pore Water, Seeps, Groundwater) | | | | | | | | |
|---|-----------------------------------|------------|--------|-------|-----------------|----|---------------------|---------------|
| Analytical Group | Chemical | Type | ESV | Units | Hardness (mg/L) | pH | Reference | Comments |
| VOCs | 2-Butanone | Freshwater | 14,000 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 2-Hexanone | Freshwater | 99.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | 4-Methyl-2-pentanone | Freshwater | 170 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Acetone | Freshwater | 1,500 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Benzene | Freshwater | 130 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Bromochloromethane | Freshwater | NSV | -- | | | -- | |
| VOCs | Bromodichloromethane | Freshwater | NSV | -- | | | -- | |
| VOCs | Bromoform | Freshwater | 320 | ug/L | | | USEPA 1996 | SCV |
| VOCs | Bromomethane | Freshwater | 110 | ug/L | | | USEPA 2001 | |
| VOCs | Carbon disulfide | Freshwater | 0.92 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Carbon tetrachloride | Freshwater | 240 | ug/L | | | USEPA 1996 | SCV |
| VOCs | Chlorobenzene | Freshwater | 64.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Chloroethane | Freshwater | NSV | -- | | | -- | |
| VOCs | Chloroform | Freshwater | 28.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Chloromethane | Freshwater | 5,500 | ug/L | | | USEPA 2001 | |
| VOCs | cis-1,2-Dichloroethene | Freshwater | 590 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | cis-1,3-Dichloropropene | Freshwater | 24.4 | ug/L | | | USEPA 2001 | |
| VOCs | Cyclohexane | Freshwater | NSV | -- | | | -- | |
| VOCs | Dibromochloromethane | Freshwater | NSV | -- | | | -- | |
| VOCs | Dichlorodifluoromethane(Freon-12) | Freshwater | NSV | -- | | | -- | |
| VOCs | Ethylbenzene | Freshwater | 290 | ug/L | | | USEPA 1996 | SCV |
| VOCs | Isopropylbenzene | Freshwater | 2.60 | ug/L | | | USEPA 2006b | |
| VOCs | m- and p-Xylene | Freshwater | 13.0 | ug/L | | | Suter and Tsao 1996 | Total xylenes |
| VOCs | Methyl acetate | Freshwater | NSV | -- | | | -- | |
| VOCs | Methylcyclohexane | Freshwater | NSV | -- | | | -- | |
| VOCs | Methylene chloride | Freshwater | 2,200 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Methyl-tert-butyl ether (MTBE) | Freshwater | 11,070 | ug/L | | | USEPA 2006b | |
| VOCs | o-Xylene | Freshwater | 13.0 | ug/L | | | Suter and Tsao 1996 | Total xylenes |
| VOCs | Styrene | Freshwater | 72.0 | ug/L | | | USEPA 2006b | |
| VOCs | Tetrachloroethene | Freshwater | 98.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Toluene | Freshwater | 9.80 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | trans-1,2-Dichloroethene | Freshwater | 590 | ug/L | | | Suter and Tsao 1996 | SCV |

| Appendix B-2 Ecological Screening Values (ESVs) for Freshwater (Surface Water, Pore Water, Seeps, Groundwater) | | | | | | | | |
|---|----------------------------------|------------|------|-------|-----------------|----|---------------------|----------|
| Analytical Group | Chemical | Type | ESV | Units | Hardness (mg/L) | pH | Reference | Comments |
| VOCs | trans-1,3-Dichloropropene | Freshwater | 24.4 | ug/L | | | USEPA 2001 | |
| VOCs | Trichloroethene | Freshwater | 47.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| VOCs | Trichlorofluoromethane(Freon-11) | Freshwater | NSV | -- | | | -- | |
| VOCs | Vinyl chloride | Freshwater | 930 | ug/L | | | USEPA 2006b | FCV |
| VOCs | Xylene, total | Freshwater | 13.0 | ug/L | | | Suter and Tsao 1996 | SCV |
| OTHER | Chromium (hexavalent) | Freshwater | 11.4 | ug/L | | | USEPA 2009 | AWQC |
| OTHER | Chromium (hexavalent), Dissolved | Freshwater | 11.0 | ug/L | | | USEPA 2009 | AWQC |
| NSV - No Screening Value | | | | | | | | |

Appendix B-3

Ecological Screening Values (ESVs) for Freshwater Sediment

| Analytical Group | Chemical | Type | ESV | Units | TOC (%) | Reference | Comment |
|------------------|----------------------------|------------|--------|-------|---------|------------------------|----------|
| Explosives | 1,3,5-Trinitrobenzene | Freshwater | 2.40 | ug/kg | 1 | Talmage et al. 1999 | |
| Explosives | 1,3-Dinitrobenzene | Freshwater | 6.70 | ug/kg | 1 | Talmage et al. 1999 | |
| Explosives | 2,4,6-Trinitrotoluene | Freshwater | 92.0 | ug/kg | 1 | Talmage et al. 1999 | |
| Explosives | 2,4-Dinitrotoluene | Freshwater | 41.6 | ug/kg | 1 | USEPA 2006b | |
| Explosives | 2,6-Dinitrotoluene | Freshwater | NSV | -- | | -- | |
| Explosives | 2-Amino-4,6-dinitrotoluene | Freshwater | 13.2 | ug/kg | 1 | NAVFAC 2007 | |
| Explosives | 2-Nitrotoluene | Freshwater | 6,204 | ug/kg | 1 | NAVFAC 2007 | |
| Explosives | 3,5-Dinitroaniline | Freshwater | NSV | -- | | -- | |
| Explosives | 3-Nitrotoluene | Freshwater | 1,922 | ug/kg | 1 | NAVFAC 2007 | |
| Explosives | 4-Amino-2,6-dinitrotoluene | Freshwater | 23.2 | ug/kg | 1 | NAVFAC 2007 | |
| Explosives | 4-Nitrotoluene | Freshwater | 4,062 | ug/kg | 1 | USEPA 2006b | |
| Explosives | HMX | Freshwater | 4.74 | ug/kg | 1 | Talmage et al. 1999 | |
| Explosives | Nitrobenzene | Freshwater | 1,779 | ug/kg | 1 | NAVFAC 2007 | |
| Explosives | Nitroglycerine | Freshwater | NSV | -- | | -- | |
| Explosives | Nitroguanidine | Freshwater | NSV | -- | | -- | |
| Explosives | Perchlorate | Freshwater | NSV | -- | | -- | |
| Explosives | PETN | Freshwater | NSV | -- | | -- | |
| Explosives | RDX | Freshwater | 12.7 | ug/kg | 1 | Talmage et al. 1999 | |
| Explosives | Tetryl | Freshwater | NSV | -- | | -- | |
| Inorganics | Aluminum | Freshwater | 25,500 | mg/kg | | Buchman 2008 | ARCS TEL |
| Inorganics | Antimony | Freshwater | 3.00 | mg/kg | | Buchman 2008 | UET |
| Inorganics | Arsenic | Freshwater | 9.79 | mg/kg | | MacDonald et al. 2000a | TEC |
| Inorganics | Barium | Freshwater | 20.0 | mg/kg | | MacDonald et al. 2003 | TEC |
| Inorganics | Beryllium | Freshwater | NSV | -- | | -- | |
| Inorganics | Cadmium | Freshwater | 0.99 | mg/kg | | MacDonald et al. 2000a | TEC |
| Inorganics | Calcium | Freshwater | NSV | -- | | -- | |
| Inorganics | Chromium | Freshwater | 43.4 | mg/kg | | MacDonald et al. 2000a | TEC |
| Inorganics | Cobalt | Freshwater | 50.0 | mg/kg | | Persuad et al. 1993 | OWDG |
| Inorganics | Copper | Freshwater | 31.6 | mg/kg | | MacDonald et al. 2000a | TEC |
| Inorganics | Cyanide | Freshwater | NSV | -- | | -- | |
| Inorganics | Iron | Freshwater | 20,000 | mg/kg | | Persuad et al. 1993 | LEL |
| Inorganics | Lead | Freshwater | 35.8 | mg/kg | | MacDonald et al. 2000a | TEC |

Appendix B-3

Ecological Screening Values (ESVs) for Freshwater Sediment

| Analytical Group | Chemical | Type | ESV | Units | TOC (%) | Reference | Comment |
|------------------|------------------------------|------------|-------|-------|---------|------------------------|---------|
| Inorganics | Magnesium | Freshwater | NSV | -- | | -- | |
| Inorganics | Manganese | Freshwater | 460 | mg/kg | | Persuad et al. 1993 | LEL |
| Inorganics | Mercury | Freshwater | 0.18 | mg/kg | | MacDonald et al. 2000a | TEC |
| Inorganics | Nickel | Freshwater | 22.7 | mg/kg | | MacDonald et al. 2000a | TEC |
| Inorganics | Potassium | Freshwater | NSV | -- | | -- | |
| Inorganics | Selenium | Freshwater | 2.00 | mg/kg | | USEPA 2006b | |
| Inorganics | Silver | Freshwater | 1.00 | mg/kg | | MacDonald et al. 2003 | TEC |
| Inorganics | Sodium | Freshwater | NSV | -- | | -- | |
| Inorganics | Thallium | Freshwater | NSV | -- | | -- | |
| Inorganics | Vanadium | Marine | 57.0 | mg/kg | | Buchman 2008 | AET |
| Inorganics | Zinc | Freshwater | 121 | mg/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | 1,1-Biphenyl | Freshwater | 1,100 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | 1,2,3-Trichlorobenzene | Freshwater | 858 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 1,2,4-Trichlorobenzene | Freshwater | 9,200 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | 1,2,4,5-Tetrachlorobenzene | Freshwater | 1,093 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 1,2-Dichlorobenzene | Freshwater | 340 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | 1,3-Dichlorobenzene | Freshwater | 1,700 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | 1,4-Dichlorobenzene | Freshwater | 350 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | 2,2'-Oxybis(1-chloropropane) | Freshwater | NSV | -- | | -- | |
| SVOCs | 2,3,4,6-Tetrachlorophenol | Freshwater | 284 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 2,4,5-Trichlorophenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 2,4,6-Trichlorophenol | Freshwater | 213 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 2,4-Dichlorophenol | Freshwater | 117 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 2,4-Dimethylphenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 2,4-Dinitrophenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 2,4-Dinitrotoluene | Freshwater | 41.6 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 2,6-Dinitrotoluene | Freshwater | NSV | -- | | -- | |
| SVOCs | 2-Chloronaphthalene | Freshwater | NSV | -- | | -- | |
| SVOCs | 2-Chlorophenol | Freshwater | 31.2 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 2-Methylnaphthalene | Marine | 70.0 | ug/kg | | Long et al. 1995 | ER-L |
| SVOCs | 2-Methylphenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 2-Nitroaniline | Freshwater | NSV | -- | | -- | |

Appendix B-3

Ecological Screening Values (ESVs) for Freshwater Sediment

| Analytical Group | Chemical | Type | ESV | Units | TOC (%) | Reference | Comment |
|------------------|-----------------------------|------------|--------|-------|---------|----------------------------|---------|
| SVOCs | 2-Nitrophenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 3- and 4-Methylphenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 3,3'-Dichlorobenzidine | Freshwater | 127 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | 3-Nitroaniline | Freshwater | NSV | -- | | -- | |
| SVOCs | 4,6-Dinitro-2-methylphenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 4-Bromophenyl-phenylether | Freshwater | 1,300 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | 4-Chloro-3-methylphenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 4-Chloroaniline | Freshwater | NSV | -- | | -- | |
| SVOCs | 4-Chlorophenyl-phenylether | Freshwater | NSV | -- | | -- | |
| SVOCs | 4-Methylphenol | Freshwater | NSV | -- | | -- | |
| SVOCs | 4-Nitroaniline | Freshwater | NSV | -- | | -- | |
| SVOCs | 4-Nitrophenol | Freshwater | NSV | -- | | -- | |
| SVOCs | Acenaphthene | Freshwater | 290 | ug/kg | | Buchman 2008 | UET |
| SVOCs | Acenaphthylene | Freshwater | 160 | ug/kg | | Buchman 2008 | UET |
| SVOCs | Acetophenone | Freshwater | NSV | -- | | -- | |
| SVOCs | Anthracene | Freshwater | 57.2 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Atrazine | Freshwater | 6.62 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | Benzaldehyde | Freshwater | NSV | -- | | -- | |
| SVOCs | Benzo(a)anthracene | Freshwater | 108 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Benzo(a)pyrene | Freshwater | 150 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Benzo(b)fluoranthene | Freshwater | 240 | ug/kg | | Benzo(k)fluoranthene value | |
| SVOCs | Benzo(g,h,i)perylene | Freshwater | 170 | ug/kg | | Persuad et al. 1993 | LEL |
| SVOCs | Benzo(k)fluoranthene | Freshwater | 240 | ug/kg | | Persuad et al. 1993 | LEL |
| SVOCs | Benzoic acid | Freshwater | NSV | -- | | -- | |
| SVOCs | Benzyl alcohol | Freshwater | NSV | -- | | -- | |
| SVOCs | bis(2-Chloroethoxy)methane | Freshwater | NSV | -- | | -- | |
| SVOCs | bis(2-Chloroethyl)ether | Freshwater | NSV | -- | | -- | |
| SVOCs | bis(2-Chloroisopropyl)ether | Freshwater | NSV | -- | | -- | |
| SVOCs | bis(2-Ethylhexyl)phthalate | Freshwater | 750 | ug/kg | | Buchman 2008 | UET |
| SVOCs | Butylbenzylphthalate | Freshwater | 11,000 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | Caprolactam | Freshwater | NSV | -- | | -- | |
| SVOCs | Carbazole | Freshwater | 140 | ug/kg | | Cubbage et al. 1997 | AET |

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Ecological Screening Values (ESVs) for Freshwater Sediment

| Analytical Group | Chemical | Type | ESV | Units | TOC (%) | Reference | Comment |
|------------------|--|------------|-------|-------|---------|------------------------|----------|
| SVOCs | Chrysene | Freshwater | 166 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Dibenz(a,h)anthracene | Freshwater | 33.0 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Dibenzofuran | Freshwater | 5,100 | ug/kg | | Buchman 2008 | UET |
| SVOCs | Diethylphthalate | Freshwater | 630 | ug/kg | | MacDonald et al. 2003 | TEC |
| SVOCs | Dimethyl phthalate | Freshwater | NSV | -- | | -- | |
| SVOCs | Di-n-butylphthalate | Freshwater | 110 | ug/kg | | Buchman 2008 | UET |
| SVOCs | Di-n-octylphthalate | Freshwater | NSV | -- | | -- | |
| SVOCs | Fluoranthene | Freshwater | 423 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Fluorene | Freshwater | 77.4 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Hexachlorobenzene | Freshwater | 20.0 | ug/kg | | Persuad et al. 1993 | LEL |
| SVOCs | Hexachlorobutadiene | Freshwater | 550 | ug/kg | 1 | MacDonald et al. 2003 | |
| SVOCs | Hexachlorocyclopentadiene | Freshwater | NSV | -- | | -- | |
| SVOCs | Hexachloroethane | Freshwater | 1,000 | ug/kg | 1 | USEPA 1996 | |
| SVOCs | Indeno(1,2,3-cd)pyrene | Freshwater | 200 | ug/kg | | Persuad et al. 1993 | LEL |
| SVOCs | Isophorone | Freshwater | NSV | -- | | -- | |
| SVOCs | Naphthalene | Freshwater | 176 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Nitrobenzene | Freshwater | 1,779 | ug/kg | 1 | NAVFAC 2007 | |
| SVOCs | n-Nitroso-di-n-propylamine | Freshwater | NSV | -- | | -- | |
| SVOCs | n-Nitrosodiphenylamine | Freshwater | 2,684 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | PAH (total) | Freshwater | 3,553 | ug/kg | | Jones et al. 1997 | ARCS TEC |
| SVOCs | PAH (HMW) | Freshwater | 2,900 | ug/kg | | Jones et al. 1997 | ARCS TEC |
| SVOCs | PAH (LMW) | Freshwater | 786 | ug/kg | | Jones et al. 1997 | ARCS TEC |
| SVOCs | Pentachlorophenol | Freshwater | 504 | ug/kg | 1 | USEPA 2006b | |
| SVOCs | Phenanthrene | Freshwater | 204 | ug/kg | | MacDonald et al. 2000a | TEC |
| SVOCs | Phenol | Freshwater | 48.0 | ug/kg | | Buchman 2008 | UET |
| SVOCs | Pyrene | Freshwater | 195 | ug/kg | | MacDonald et al. 2000a | TEC |
| VOCs | 1,1,1-Trichloroethane | Freshwater | 170 | ug/kg | 1 | USEPA 1996 | |
| VOCs | 1,1,2,2-Tetrachloroethane | Freshwater | 940 | ug/kg | 1 | USEPA 1996 | |
| VOCs | 1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113) | Freshwater | NSV | -- | | -- | |
| VOCs | 1,1,2-Trichloroethane | Freshwater | 1,200 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | 1,1-Dichloroethane | Freshwater | 27.0 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | 1,1-Dichloroethene | Freshwater | 31.0 | ug/kg | 1 | Jones et al. 1997 | |

Appendix B-3

Ecological Screening Values (ESVs) for Freshwater Sediment

| Analytical Group | Chemical | Type | ESV | Units | TOC (%) | Reference | Comment |
|------------------|-----------------------------------|------------|-------|-------|---------|-------------------|---------|
| VOCs | 1,2,3-Trichlorobenzene | Freshwater | 858 | ug/kg | 1 | USEPA 2006b | |
| VOCs | 1,2,4-Trichlorobenzene | Freshwater | 9,200 | ug/kg | 1 | USEPA 1996 | |
| VOCs | 1,2-Dibromo-3-chloropropane | Freshwater | NSV | -- | | -- | |
| VOCs | 1,2-Dibromoethane | Freshwater | NSV | -- | | -- | |
| VOCs | 1,2-Dichlorobenzene | Freshwater | 340 | ug/kg | 1 | USEPA 1996 | |
| VOCs | 1,2-Dichloroethane | Freshwater | 250 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | 1,2-Dichloroethene (total) | Freshwater | 400 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | 1,2-Dichloropropane | Freshwater | NSV | -- | | -- | |
| VOCs | 1,3-Dichlorobenzene | Freshwater | 1,700 | ug/kg | 1 | USEPA 1996 | |
| VOCs | 1,4-Dichlorobenzene | Freshwater | 350 | ug/kg | 1 | USEPA 1996 | |
| VOCs | 1,4-Dioxane | Freshwater | NSV | -- | | -- | |
| VOCs | 2-Butanone | Freshwater | 270 | ug/kg | 1 | Jones et al. 1997 | Polar |
| VOCs | 2-Hexanone | Freshwater | NSV | -- | | -- | |
| VOCs | 4-Methyl-2-pentanone | Freshwater | 33.0 | ug/kg | 1 | Jones et al. 1997 | Polar |
| VOCs | Acetone | Freshwater | NSV | -- | | -- | |
| VOCs | Benzene | Freshwater | 57.0 | ug/kg | 1 | USEPA 1996 | |
| VOCs | Bromochloromethane | Freshwater | NSV | -- | | -- | |
| VOCs | Bromodichloromethane | Freshwater | NSV | -- | | -- | |
| VOCs | Bromoform | Freshwater | 650 | ug/kg | 1 | USEPA 1996 | |
| VOCs | Bromomethane | Freshwater | NSV | -- | | -- | |
| VOCs | Carbon disulfide | Freshwater | 0.85 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | Carbon tetrachloride | Freshwater | 1,200 | ug/kg | 1 | USEPA 1996 | |
| VOCs | Chlorobenzene | Freshwater | 820 | ug/kg | 1 | USEPA 1996 | |
| VOCs | Chloroethane | Freshwater | NSV | -- | | -- | |
| VOCs | Chloroform | Freshwater | 22.0 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | Chloromethane | Freshwater | NSV | -- | | -- | |
| VOCs | cis-1,2-Dichloroethene | Freshwater | 400 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | cis-1,3-Dichloropropene | Freshwater | 0.051 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | Cyclohexane | Freshwater | NSV | -- | | -- | |
| VOCs | Dibromochloromethane | Freshwater | NSV | -- | | -- | |
| VOCs | Dichlorodifluoromethane(Freon-12) | Freshwater | NSV | -- | | -- | |
| VOCs | Ethylbenzene | Freshwater | 3,600 | ug/kg | 1 | USEPA 1996 | |

Appendix B-3

Ecological Screening Values (ESVs) for Freshwater Sediment

| Analytical Group | Chemical | Type | ESV | Units | TOC (%) | Reference | Comment |
|--------------------------|----------------------------------|------------|-------|-------|---------|-------------------|---------------|
| VOCs | Isopropylbenzene | Freshwater | 86.0 | ug/kg | 1 | USEPA 2006b | |
| VOCs | m- and p-Xylene | Freshwater | 160 | ug/kg | 1 | Jones et al. 1997 | Total xylenes |
| VOCs | Methyl acetate | Freshwater | NSV | -- | | -- | |
| VOCs | Methylcyclohexane | Freshwater | NSV | -- | | -- | |
| VOCs | Methylene chloride | Freshwater | 370 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | Methyl-tert-butyl ether (MTBE) | Freshwater | NSV | -- | | -- | |
| VOCs | o-Xylene | Freshwater | 160 | ug/kg | 1 | Jones et al. 1997 | Total xylenes |
| VOCs | Styrene | Freshwater | 559 | ug/kg | 1 | USEPA 2006b | |
| VOCs | Tetrachloroethene | Freshwater | 530 | ug/kg | 1 | USEPA 1996 | |
| VOCs | Toluene | Freshwater | 670 | ug/kg | 1 | USEPA 1996 | |
| VOCs | trans-1,2-Dichloroethene | Freshwater | 400 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | trans-1,3-Dichloropropene | Freshwater | 0.051 | ug/kg | 1 | Jones et al. 1997 | |
| VOCs | Trichloroethene | Freshwater | 1,600 | ug/kg | 1 | USEPA 1996 | |
| VOCs | Trichlorofluoromethane(Freon-11) | Freshwater | NSV | -- | | -- | |
| VOCs | Vinyl chloride | Freshwater | NSV | -- | | -- | |
| VOCs | Xylene, total | Freshwater | 160 | ug/kg | 1 | Jones et al. 1997 | |
| NSV - No Screening Value | | | | | | | |

Appendix B

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Appendix C
Laboratory Department of Defense
Environmental Laboratory Accreditation Letters



PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14623

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 “General Requirements for the competence of Testing and Calibration Laboratories” and the DoD Quality Systems Manual for Environmental Laboratories Version 4.2 10/26/10 and is accredited in accordance with the:

United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP)

***This accreditation demonstrates technical competence for the defined scope:
Environmental Testing
(As detailed in the supplement)***

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body’s duty to observe and comply with the said rules.

For PJLA:

| | | | |
|------------------------------------|--------------------|---------------------------|-------------------------|
| <i>Initial Accreditation Date:</i> | <i>Issue Date:</i> | <i>Accreditation No.:</i> | <i>Certificate No.:</i> |
| January 22, 2010 | April 7, 2012 | 65817 | L12-48 |

Tracy Szerszen
President/Operations Manager

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjilabs.com



Certificate of Accreditation: Supplement
ISO/IEC 17025:2005 and DoD-ELAP

Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609
Lisa Reyes Phone: 585-288-5380

Accreditation is granted to the facility to perform the following testing:

| Matrix | Standard/Method | Technology | Analyte |
|---------------|------------------------|-------------------|------------------------------|
| Aqueous | (CAS SOP) GEN-TICW | UV-VIS | Total inorganic carbon |
| Aqueous | EPA 1631 | CVAFS | Mercury |
| Aqueous | EPA 1664A | Gravimetric | Oil and grease |
| Aqueous | EPA 1664A | Gravimetric | Total petroleum hydrocarbons |
| Aqueous | EPA 218.6 | IC-UV | Chromium, Hexavalent |
| Aqueous | EPA 245.1 | CVAA | Mercury |
| Aqueous | EPA 300.0 | IC | Chloride |
| Aqueous | EPA 300.0 | IC | Fluoride |
| Aqueous | EPA 300.0 | IC | Nitrate |
| Aqueous | EPA 300.0 | IC | Sulfate |
| Aqueous | EPA 351.2 | UV-VIS | Nitrogen, total Kjeldahl |
| Aqueous | EPA 353.2 | UV-VIS | Nitrite as N |
| Aqueous | EPA 410.4 | UV-VIS | Chemical oxygen demand |
| Aqueous | EPA 7470A | CVAA | Mercury |
| Aqueous | EPA 8151A | GC-ECD | Dinoseb |
| Aqueous | EPA 8260C | GC-MS-SIM | 1,1-Dichloroethene |
| Aqueous | EPA 8260C | GC-MS-SIM | 1,2-Dichlorobenzene |
| Aqueous | EPA 8260C | GC-MS-SIM | 1,2-Dichloroethane |
| Aqueous | EPA 8260C | GC-MS-SIM | 1,4-Dioxane |
| Aqueous | EPA 8260C | GC-MS-SIM | Carbon tetrachloride |
| Aqueous | EPA 8260C | GC-MS-SIM | Dichloromethane |
| Aqueous | EPA 8260C | GC-MS-SIM | Ethylbenzene |
| Aqueous | EPA 8260C | GC-MS-SIM | m- + p-Xylene |
| Aqueous | EPA 8260C | GC-MS-SIM | o-Xylene |
| Aqueous | EPA 8260C | GC-MS-SIM | Tetrachloroethene |
| Aqueous | EPA 8260C | GC-MS-SIM | Trichloroethene |
| Aqueous | EPA 8260C | GC-MS-SIM | Vinyl chloride |
| Aqueous | EPA 8260C | GC-MS-SIM | Xylenes, total |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Acenaphthene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Acenaphthylene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Anthracene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Benzo(a)anthracene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Benzo(a)pyrene |



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|---------------|--------------------------|-------------------|---|
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Benzo(b)fluoranthene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Benzo(g,h,i)perylene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Benzo(k)fluoranthene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Chrysene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Dibenzo(a,h)anthracene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Fluoranthene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Fluorene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Indeno(1,2,3-cd)pyrene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Naphthalene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Phenanthrene |
| Aqueous | EPA 8310 | HPLC-UV/FLUOR | Pyrene |
| Aqueous | EPA 9040B, C | POT | pH |
| Aqueous | EPA 9060, A | UV-VIS | Total organic carbon |
| Aqueous | EPA 9066 | UV-VIS | Phenolics, total |
| Aqueous | RSK-175 | GC-FID | Ethane |
| Aqueous | RSK-175 | GC-FID | Ethylene |
| Aqueous | RSK-175 | GC-FID | Methane |
| Aqueous | RSK-175 | GC-FID | Propane |
| Aqueous | RSK-175 | GC-FID | Acetylene |
| Aqueous | SM 2320B | Titration | Alkalinity, total, carbonate, and bicarbonate |
| Aqueous | SM 2340C | Titration | Hardness, total |
| Solids | (CAS SOP) GEN-351.2 | UV-VIS | Nitrogen, total Kjeldahl |
| Solids | (CAS SOP) GEN-420.4/9066 | UV-VIS | Phenolics, total |
| Solids | EPA Lloyd Kahn | UV-VIS | Total organic carbon |
| Solids | EPA 300.0 | IC | Chloride |
| Solids | EPA 300.0 | IC | Fluoride |
| Solids | EPA 300.0 | IC | Nitrate |
| Solids | EPA 300.0 | IC | Sulfate |
| Solids | EPA 7471B | CVAA | Mercury |
| Solids | EPA 8330A | HPLC-UV | 1,3,5-Trinitrobenzene |
| Solids | EPA 8330A | HPLC-UV | 1,3-Dinitrobenzene |
| Solids | EPA 8330A | HPLC-UV | 2,4,6-Trinitrotoluene |
| Solids | EPA 8330A | HPLC-UV | 2,4-Dinitrotoluene |



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| Matrix | Standard/Method | Technology | Analyte |
|----------------|-----------------|---------------|----------------------------|
| Solids | EPA 8330A | HPLC-UV | 2,6-Dinitrotoluene |
| Solids | EPA 8330A | HPLC-UV | 2-Amino-4,6-dinitrotoluene |
| Solids | EPA 8330A | HPLC-UV | 2-Nitrotoluene |
| Solids | EPA 8330A | HPLC-UV | 3-Nitrotoluene |
| Solids | EPA 8330A | HPLC-UV | 4-Amino-2,6-dinitrotoluene |
| Solids | EPA 8330A | HPLC-UV | 4-Nitrotoluene |
| Solids | EPA 8330A | HPLC-UV | HMX |
| Solids | EPA 8330A | HPLC-UV | Nitrobenzene |
| Solids | EPA 8330A | HPLC-UV | RDX |
| Solids | EPA 8330A | HPLC-UV | Tetryl |
| Solids | EPA 9045C, D | POT | pH |
| Solids | SM 5220B | Titration | Chemical oxygen demand |
| Aqueous/Solids | EPA 1010A | Pensky Martin | Ignitability |
| Aqueous/Solids | EPA 353.2 | UV-VIS | Nitrate/nitrite as N |
| Aqueous/Solids | EPA 6010C | ICP-AES | Aluminum |
| Aqueous/Solids | EPA 6010C | ICP-AES | Antimony |
| Aqueous/Solids | EPA 6010C | ICP-AES | Arsenic |
| Aqueous/Solids | EPA 6010C | ICP-AES | Barium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Beryllium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Boron |
| Aqueous/Solids | EPA 6010C | ICP-AES | Cadmium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Calcium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Chromium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Cobalt |
| Aqueous/Solids | EPA 6010C | ICP-AES | Copper |
| Aqueous/Solids | EPA 6010C | ICP-AES | Iron |
| Aqueous/Solids | EPA 6010C | ICP-AES | Lead |
| Aqueous/Solids | EPA 6010C | ICP-AES | Magnesium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Manganese |
| Aqueous/Solids | EPA 6010C | ICP-AES | Nickel |
| Aqueous/Solids | EPA 6010C | ICP-AES | Potassium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Selenium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Silver |



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| Matrix | Standard/Method | Technology | Analyte |
|----------------|------------------------|-------------------|-----------------------------|
| Aqueous/Solids | EPA 6010C | ICP-AES | Sodium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Thallium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Tin |
| Aqueous/Solids | EPA 6010C | ICP-AES | Vanadium |
| Aqueous/Solids | EPA 6010C | ICP-AES | Zinc |
| Aqueous/Solids | EPA 6020A | ICP-MS | Arsenic |
| Aqueous/Solids | EPA 6020A | ICP-MS | Antimony |
| Aqueous/Solids | EPA 6020A | ICP-MS | Barium |
| Aqueous/Solids | EPA 6020A | ICP-MS | Beryllium |
| Aqueous/Solids | EPA 6020A | ICP-MS | Cadmium |
| Aqueous/Solids | EPA 6020A | ICP-MS | Chromium |
| Aqueous/Solids | EPA 6020A | ICP-MS | Cobalt |
| Aqueous/Solids | EPA 6020A | ICP-MS | Copper |
| Aqueous/Solids | EPA 6020A | ICP-MS | Lead |
| Aqueous/Solids | EPA 6020A | ICP-MS | Manganese |
| Aqueous/Solids | EPA 6020A | ICP-MS | Nickel |
| Aqueous/Solids | EPA 6020A | ICP-MS | Selenium |
| Aqueous/Solids | EPA 6020A | ICP-MS | Silver |
| Aqueous/Solids | EPA 6020A | ICP-MS | Thallium |
| Aqueous/Solids | EPA 6020A | ICP-MS | Vanadium |
| Aqueous/Solids | EPA 6020A | ICP-MS | Zinc |
| Aqueous/Solids | EPA 680 | GC-MS | Monochlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Dichlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Trichlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Tetrachlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Pentachlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Hexachlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Heptachlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Octachlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Nonachlorobiphenyls, Total |
| Aqueous/Solids | EPA 680 | GC-MS | Decachlorobiphenyls, Total |
| Aqueous/Solids | EPA 6850 | HPLC-MS | Perchlorate |



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| Matrix | Standard/Method | Technology | Analyte |
|----------------|-----------------|------------|-------------------------|
| Aqueous/Solids | EPA 7196A | UV-VIS | Chromium, hexavalent |
| Aqueous/Solids | EPA 7199 | IC-UV | Chromium, hexavalent |
| Aqueous/Solids | EPA 8015C | GC-FID | Gasoline range organics |
| Aqueous/Solids | EPA 8015C | GC-FID | Diesel range organics |
| Aqueous/Solids | EPA 8081B | GC-ECD | 4,4'-DDD |
| Aqueous/Solids | EPA 8081B | GC-ECD | 4,4'-DDE |
| Aqueous/Solids | EPA 8081B | GC-ECD | 4,4'-DDT |
| Aqueous/Solids | EPA 8081B | GC-ECD | Aldrin |
| Aqueous/Solids | EPA 8081B | GC-ECD | α -BHC |
| Aqueous/Solids | EPA 8081B | GC-ECD | Alpha-chlordane |
| Aqueous/Solids | EPA 8081B | GC-ECD | β -BHC |
| Aqueous/Solids | EPA 8081B | GC-ECD | Chlordane, technical |
| Aqueous/Solids | EPA 8081B | GC-ECD | δ -BHC |
| Aqueous/Solids | EPA 8081B | GC-ECD | Dieldrin |
| Aqueous/Solids | EPA 8081B | GC-ECD | Endosulfan I |
| Aqueous/Solids | EPA 8081B | GC-ECD | Endosulfan II |
| Aqueous/Solids | EPA 8081B | GC-ECD | Endosulfan sulfate |
| Aqueous/Solids | EPA 8081B | GC-ECD | Endrin |
| Aqueous/Solids | EPA 8081B | GC-ECD | Endrin aldehyde |
| Aqueous/Solids | EPA 8081B | GC-ECD | Endrin ketone |
| Aqueous/Solids | EPA 8081B | GC-ECD | γ -BHC (Lindane) |
| Aqueous/Solids | EPA 8081B | GC-ECD | γ -Chlordane |
| Aqueous/Solids | EPA 8081B | GC-ECD | Heptachlor |
| Aqueous/Solids | EPA 8081B | GC-ECD | Heptachlor epoxide |
| Aqueous/Solids | EPA 8081B | GC-ECD | Hexachlorobenzene |
| Aqueous/Solids | EPA 8081B | GC-ECD | Methoxychlor |
| Aqueous/Solids | EPA 8081B | GC-ECD | Toxaphene |
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1016 |
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1221 |
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1232 |
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1242 |
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1248 |
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1254 |



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Accreditation is granted to the facility to perform the following testing:

| Matrix | Standard/Method | Technology | Analyte |
|----------------|-----------------|------------|--|
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1260 |
| Aqueous/Solids | EPA 8082A | GC-ECD | PCB 1268 |
| Aqueous/Solids | EPA 8151A | GC-ECD | 2,4-D |
| Aqueous/Solids | EPA 8151A | GC-ECD | Dicamba |
| Aqueous/Solids | EPA 8151A | GC-ECD | 2,4,5-T |
| Aqueous/Solids | EPA 8151A | GC-ECD | 2,4,5-TP |
| Aqueous/Solids | EPA 8151A | GC-ECD | Pentachlorophenol (PCP) |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1,1,2-Tetrachloroethane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1,1-Trichloroethane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1,2,2-Tetrachloroethane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113) |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1,2-Trichloroethane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1-Dichloroethane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1-Dichloroethene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,1-Dichloropropene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2,3-Trichlorobenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2,3-Trichloropropane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2,4-Trichlorobenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2,4-Trimethylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dibromo-3-chloropropane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dibromoethane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114) |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dichloro-1,1,2-trifluoroethane (Freon 123a) |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dichlorobenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dichloroethane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dichloroethene, total |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,2-Dichloropropane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,3,5-Trimethylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,3-Dichlorobenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,3-Dichloropropane |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,4-Dichlorobenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | 1,4-Dioxane |



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| Matrix | Standard/Method | Technology | Analyte |
|----------------|-----------------|------------|--|
| Aqueous/Solids | EPA 8260C | GC-MS | 2,2-Dichloro-1,1,1-trifluoroethane (Freon 123) |
| Aqueous/Solids | EPA 8260C | GC-MS | 2,2-Dichloropropane |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Butanone (MEK) |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Chloro-1,3-butadiene |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Chloroethylvinyl ether |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Chlorotoluene |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Hexanone |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Methyl-1-propanol (Isobutyl alcohol) |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Methyl-2-propanol (Tertbutyl alcohol) |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Nitropropane |
| Aqueous/Solids | EPA 8260C | GC-MS | 2-Propanol |
| Aqueous/Solids | EPA 8260C | GC-MS | 3-Chloro-1-propene (Allyl chloride) |
| Aqueous/Solids | EPA 8260C | GC-MS | 4-Chlorotoluene |
| Aqueous/Solids | EPA 8260C | GC-MS | 4-Ethyltoluene |
| Aqueous/Solids | EPA 8260C | GC-MS | 4-Isopropyltoluene |
| Aqueous/Solids | EPA 8260C | GC-MS | 4-Methyl-2-pentanone (MIBK) |
| Aqueous/Solids | EPA 8260C | GC-MS | Acetone |
| Aqueous/Solids | EPA 8260C | GC-MS | Acetonitrile |
| Aqueous/Solids | EPA 8260C | GC-MS | Acrolein |
| Aqueous/Solids | EPA 8260C | GC-MS | Acrylonitrile |
| Aqueous/Solids | EPA 8260C | GC-MS | Benzene |
| Aqueous/Solids | EPA 8260C | GC-MS | Benzyl chloride |
| Aqueous/Solids | EPA 8260C | GC-MS | Bromobenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | Bromochloromethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Bromodichloromethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Bromoform |
| Aqueous/Solids | EPA 8260C | GC-MS | Bromomethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Carbon disulfide |
| Aqueous/Solids | EPA 8260C | GC-MS | Carbon tetrachloride |
| Aqueous/Solids | EPA 8260C | GC-MS | Chlorobenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | Chloroethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Chloroform |
| Aqueous/Solids | EPA 8260C | GC-MS | Chloromethane |



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|----------------|-----------------|------------|------------------------------------|
| Aqueous/Solids | EPA 8260C | GC-MS | cis-1,2-Dichloroethene |
| Aqueous/Solids | EPA 8260C | GC-MS | cis-1,3-Dichloropropene |
| Aqueous/Solids | EPA 8260C | GC-MS | Cyclohexane |
| Aqueous/Solids | EPA 8260C | GC-MS | Cyclohexanone |
| Aqueous/Solids | EPA 8260C | GC-MS | Dibromochloromethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Dibromomethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Dichlorodifluoromethane (Freon 12) |
| Aqueous/Solids | EPA 8260C | GC-MS | Dichlorofluoromethane (Freon 21) |
| Aqueous/Solids | EPA 8260C | GC-MS | Dichloromethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Diethyl ether |
| Aqueous/Solids | EPA 8260C | GC-MS | Diisopropyl ether |
| Aqueous/Solids | EPA 8260C | GC-MS | Ethyl methacrylate |
| Aqueous/Solids | EPA 8260C | GC-MS | Ethyl tert-butyl ether |
| Aqueous/Solids | EPA 8260C | GC-MS | Ethylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | Hexachlorobutadiene |
| Aqueous/Solids | EPA 8260C | GC-MS | Iodomethane |
| Aqueous/Solids | EPA 8260C | GC-MS | Isopropylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | m- + p-Xylene |
| Aqueous/Solids | EPA 8260C | GC-MS | Methacrylonitrile |
| Aqueous/Solids | EPA 8260C | GC-MS | Methyl acetate |
| Aqueous/Solids | EPA 8260C | GC-MS | Methyl methacrylate |
| Aqueous/Solids | EPA 8260C | GC-MS | Methylcyclohexane |
| Aqueous/Solids | EPA 8260C | GC-MS | Methyl-tert-butyl ether (MTBE) |
| Aqueous/Solids | EPA 8260C | GC-MS | Napthalene |
| Aqueous/Solids | EPA 8260C | GC-MS | N-butylacetate |
| Aqueous/Solids | EPA 8260C | GC-MS | N-butylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | N-heptane |
| Aqueous/Solids | EPA 8260C | GC-MS | N-propylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | o-Xylene |
| Aqueous/Solids | EPA 8260C | GC-MS | Propionitrile |
| Aqueous/Solids | EPA 8260C | GC-MS | sec-butylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | Styrene |
| Aqueous/Solids | EPA 8260C | GC-MS | tert-amyl methyl ether |



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|----------------|-----------------|------------|-----------------------------------|
| Aqueous/Solids | EPA 8260C | GC-MS | tert-butylbenzene |
| Aqueous/Solids | EPA 8260C | GC-MS | Tetra hydrofuran |
| Aqueous/Solids | EPA 8260C | GC-MS | Tetrachloroethene |
| Aqueous/Solids | EPA 8260C | GC-MS | Toluene |
| Aqueous/Solids | EPA 8260C | GC-MS | trans-1,2-Dichloroethene |
| Aqueous/Solids | EPA 8260C | GC-MS | trans-1,3-Dichloropropene |
| Aqueous/Solids | EPA 8260C | GC-MS | trans-1,4-Dichloro-2-butene |
| Aqueous/Solids | EPA 8260C | GC-MS | Trichloroethene |
| Aqueous/Solids | EPA 8260C | GC-MS | Trichlorofluoromethane (Freon 11) |
| Aqueous/Solids | EPA 8260C | GC-MS | Vinyl acetate |
| Aqueous/Solids | EPA 8260C | GC-MS | Vinyl chloride |
| Aqueous/Solids | EPA 8260C | GC-MS | Xylenes, total |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,2,4,5-Tetrachlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,2,4-Trichlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,2-Dichlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,2-Diphenylhydrazine |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,3,5-Trinitrobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,3-Dichlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,3-Dinitrobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,4-Dichlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,4-Dioxane |
| Aqueous/Solids | EPA 8270D | GC-MS | 1,4-Naphthoquinone |
| Aqueous/Solids | EPA 8270D | GC-MS | 1-Methyl-2-pyrrolidinone |
| Aqueous/Solids | EPA 8270D | GC-MS | 1-Methylnaphthalene |
| Aqueous/Solids | EPA 8270D | GC-MS | 1-Naphthylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,3,4,6-Tetrachlorophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,4,5-Trichlorophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,4,6-Trichlorophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,4-Dichlorophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,4-Dimethylphenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,4-Dinitrophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,4-Dinitrotoluene |
| Aqueous/Solids | EPA 8270D | GC-MS | 2,6-Dichlorophenol |



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| Aqueous/Solids | EPA 8270D | GC-MS | 2,6-Dinitrotoluene |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Acetylaminofluorene |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Chloronaphthalene |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Chlorophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Methyl-5-nitroaniline (5-Nitro-o-toluidine) |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Methylnaphthalene |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Methylphenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Naphthylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Nitroaniline |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Nitrophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 2-Picoline |
| Aqueous/Solids | EPA 8270D | GC-MS | 3,3'-Dichlorobenzidine |
| Aqueous/Solids | EPA 8270D | GC-MS | 3,3'-Dimethylbenzidine |
| Aqueous/Solids | EPA 8270D | GC-MS | 3+4-Methylphenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 3-Methylcholanthrene |
| Aqueous/Solids | EPA 8270D | GC-MS | 3-Nitroaniline |
| Aqueous/Solids | EPA 8270D | GC-MS | 4,6-Dinitro-2-methylphenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Aminobiphenyl |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Bromophenyl-phenylether |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Chloro-3-methylphenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Chloroaniline |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Chlorophenyl-phenylether |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Nitroaniline |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Nitrophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | 4-Nitroquinoline-1-oxide |
| Aqueous/Solids | EPA 8270D | GC-MS | 7,12-Dimethylbenz(a)anthracene |
| Aqueous/Solids | EPA 8270D | GC-MS | α,α -Dimethylphenethylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | Acenaphthene |
| Aqueous/Solids | EPA 8270D | GC-MS | Acenaphthylene |
| Aqueous/Solids | EPA 8270D | GC-MS | Acetophenone |
| Aqueous/Solids | EPA 8270D | GC-MS | Aniline |
| Aqueous/Solids | EPA 8270D | GC-MS | Anthracene |
| Aqueous/Solids | EPA 8270D | GC-MS | Aramite |



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|----------------|------------------------|-------------------|------------------------------|
| Aqueous/Solids | EPA 8270D | GC-MS | Atrazine |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzaldehyde |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzidine |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzo(a)anthracene |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzo(a)pyrene |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzo(b)fluoranthene |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzo(g,h,i)perylene |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzo(k)fluoranthene |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzoic acid |
| Aqueous/Solids | EPA 8270D | GC-MS | Benzyl alcohol |
| Aqueous/Solids | EPA 8270D | GC-MS | Biphenyl |
| Aqueous/Solids | EPA 8270D | GC-MS | Bis(1-chloroisopropyl)ether |
| Aqueous/Solids | EPA 8270D | GC-MS | Bis(-2-chloroethoxy)methane |
| Aqueous/Solids | EPA 8270D | GC-MS | Bis(2-chloroethyl)ether |
| Aqueous/Solids | EPA 8270D | GC-MS | Bis(2-ethylhexyl)phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS | Butyl benzyl phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS | Caprolactam |
| Aqueous/Solids | EPA 8270D | GC-MS | Carbazole |
| Aqueous/Solids | EPA 8270D | GC-MS | Chlorobenzilate |
| Aqueous/Solids | EPA 8270D | GC-MS | Chrysene |
| Aqueous/Solids | EPA 8270D | GC-MS | Cyclohexane, isothiocyanato- |
| Aqueous/Solids | EPA 8270D | GC-MS | Diallate |
| Aqueous/Solids | EPA 8270D | GC-MS | Dibenzo(a,h)anthracene |
| Aqueous/Solids | EPA 8270D | GC-MS | Dibenzofuran |
| Aqueous/Solids | EPA 8270D | GC-MS | Diethylphthalate |
| Aqueous/Solids | EPA 8270D | GC-MS | Dimethoate |
| Aqueous/Solids | EPA 8270D | GC-MS | Dimethyl phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS | Di-n-butylphthalate |
| Aqueous/Solids | EPA 8270D | GC-MS | Di-n-octyl phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS | Dinoseb |
| Aqueous/Solids | EPA 8270D | GC-MS | Diphenylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | Disulfoton |
| Aqueous/Solids | EPA 8270D | GC-MS | Ethyl methanesulfonate |



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|----------------|------------------------|-------------------|---------------------------------|
| Aqueous/Solids | EPA 8270D | GC-MS | Fluoranthene |
| Aqueous/Solids | EPA 8270D | GC-MS | Fluorene |
| Aqueous/Solids | EPA 8270D | GC-MS | Hexachlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | Hexachlorobutadiene |
| Aqueous/Solids | EPA 8270D | GC-MS | Hexachlorocyclopentadiene |
| Aqueous/Solids | EPA 8270D | GC-MS | Hexachloroethane |
| Aqueous/Solids | EPA 8270D | GC-MS | Hexachlorophene |
| Aqueous/Solids | EPA 8270D | GC-MS | Hexachloropropene |
| Aqueous/Solids | EPA 8270D | GC-MS | Indeno(1,2,3-cd)pyrene |
| Aqueous/Solids | EPA 8270D | GC-MS | Isodrin |
| Aqueous/Solids | EPA 8270D | GC-MS | Isophorone |
| Aqueous/Solids | EPA 8270D | GC-MS | Isosafrole |
| Aqueous/Solids | EPA 8270D | GC-MS | Methapyrilene |
| Aqueous/Solids | EPA 8270D | GC-MS | Methyl methanesulfonate |
| Aqueous/Solids | EPA 8270D | GC-MS | Methyl parathion |
| Aqueous/Solids | EPA 8270D | GC-MS | Naphthalene |
| Aqueous/Solids | EPA 8270D | GC-MS | Nitrobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosodiethylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosodimethylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosodi-n-butylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitroso-di-n-propylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosodiphenylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosomethylethylamine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosomorpholine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosopiperidine |
| Aqueous/Solids | EPA 8270D | GC-MS | N-nitrosopyrrolidine |
| Aqueous/Solids | EPA 8270D | GC-MS | Octachlorostyrene |
| Aqueous/Solids | EPA 8270D | GC-MS | o,o,o-triethyl phosphorothioate |
| Aqueous/Solids | EPA 8270D | GC-MS | o-toluidine |
| Aqueous/Solids | EPA 8270D | GC-MS | Parathion (ethyl) |
| Aqueous/Solids | EPA 8270D | GC-MS | p-dimethylaminoazobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | Pentachlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | Pentachloroethane |



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| Aqueous/Solids | EPA 8270D | GC-MS | Pentachloronitrobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS | Pentachlorophenol |
| Aqueous/Solids | EPA 8270D | GC-MS | Phenacetin |
| Aqueous/Solids | EPA 8270D | GC-MS | Phenanthrene |
| Aqueous/Solids | EPA 8270D | GC-MS | Phenol |
| Aqueous/Solids | EPA 8270D | GC-MS | Phorate |
| Aqueous/Solids | EPA 8270D | GC-MS | Phthalimide |
| Aqueous/Solids | EPA 8270D | GC-MS | Pyrene |
| Aqueous/Solids | EPA 8270D | GC-MS | Pyridine |
| Aqueous/Solids | EPA 8270D | GC-MS | Safrole |
| Aqueous/Solids | EPA 8270D | GC-MS | Sulfotepp |
| Aqueous/Solids | EPA 8270D | GC-MS | Thionazin |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | 1,4-Dioxane |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | 1-Methylnaphthalene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | 2-Methylnaphthalene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Acenaphthene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Acenaphthylene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Anthracene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Benzo(a)anthracene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Benzo(a)pyrene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Benzo(b)fluoranthene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Benzo(g,h,i)perylene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Benzo(k)fluoranthene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Bis(2-ethylhexyl)phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Butyl benzyl phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Carbazole |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Chrysene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Dibenzo(a,h)anthracene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Dibenzofuran |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Diethyl phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Dimethyl phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Di-n-butyl phthalate |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Di-n-octyl phthalate |



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| Aqueous/Solids | EPA 8270D | GC-MS-LL | Fluoranthene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Fluorene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Hexachlorobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Indeno(1,2,3-cd)pyrene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Naphthalene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Nitrobenzene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Octachlorostyrene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Phenanthrene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Pyrene |
| Aqueous/Solids | EPA 8270D | GC-MS-LL | Pyridine |
| Aqueous/Solids | EPA 9012A, B | UV-VIS | Cyanide, total |
| Aqueous/Solids | EPA 9034 | Titration | Sulfide, acid soluble |
| Aqueous/Solids | EPA 9056A | IC | Bromide |
| Aqueous/Solids | EPA 9056A | IC | Chloride |
| Aqueous/Solids | EPA 9056A | IC | Fluoride |
| Aqueous/Solids | EPA 9056A | IC | Nitrate as Nitrogen |
| Aqueous/Solids | EPA 9056A | IC | Nitrite as Nitrogen |
| Aqueous/Solids | EPA 9056A | IC | Sulfate |
| Aqueous/Solids | GEN-AVS | Titrimetric | Acid Volatile Sulfide |
| Aqueous/Solids | EPA 8330B | HPLC | 1,3,5-Trinitrobenzene |
| Aqueous/Solids | EPA 8330B | HPLC | 1,3-Dinitrobenzene |
| Aqueous/Solids | EPA 8330B | HPLC | 2,4,6-Trinitrotoluene (TNT) |
| Aqueous/Solids | EPA 8330B | HPLC | 2,4-Dinitrotoluene |
| Aqueous/Solids | EPA 8330B | HPLC | 2,6-Dinitrotoluene |
| Aqueous/Solids | EPA 8330B | HPLC | 2-Amino 4,6-Dinitrotoluene |
| Aqueous/Solids | EPA 8330B | HPLC | 2-Nitrotoluene |
| Aqueous/Solids | EPA 8330B | HPLC | 3,5-Dinitroaniline |
| Aqueous/Solids | EPA 8330B | HPLC | 3-Nitrotoluene |
| Aqueous/Solids | EPA 8330B | HPLC | 4-Amino 2,6-Dinitrotoluene |
| Aqueous/Solids | EPA 8330B | HPLC | 4-Nitrotoluene |
| Aqueous/Solids | EPA 8330B | HPLC | Hexahydro 1,3,5-Trinitro 1,3,5-Triazine |
| Aqueous/Solids | EPA 8330B | HPLC | Methyl 2,4,6 Trinitrophenylnitramine |
| Aqueous/Solids | EPA 8330B | HPLC | Nitrobenzene |
| Aqueous/Solids | EPA 8330B | HPLC | Nitroglycerin |



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| Matrix | Standard/Method | Technology | Analyte |
|----------------|------------------------|-------------------|---|
| Aqueous/Solids | EPA 8330B | HPLC | Octahydro 1.3.5.7 Tetranitro 1,3,5,7 Tetraz |
| Aqueous/Solids | EPA 8330B | HPLC | Pentaerythritol Tetranitrate (PETN) |
| Aqueous/Solids | HPLC-METACID | HPLC | Acetic Acid |
| Aqueous/Solids | HPLC-METACID | HPLC | Butanoic Acid (Butyric Acid) |
| Aqueous/Solids | HPLC-METACID | HPLC | Lactic Acid |
| Aqueous/Solids | HPLC-METACID | HPLC | Propionic Acid |
| Aqueous/Solids | HPLC-METACID | HPLC | Pyruvic Acid |

| Matrix | Standard/Method | Technology | Analyte |
|----------------|------------------------|-----------------------|--------------------------------------|
| Aqueous | EPA 3010A | Acid Digestion | Metals prep |
| Aqueous | EPA 3510C | SF Extraction | Semivolatiles, pesticides, PCBs, DRO |
| Aqueous | EPA 5030B | P&T | Volatiles |
| Solids | EPA 3050B | Acid Digestion | Metals prep |
| Solids | EPA 3060A | Digestion | Hexavalent chromium digestion |
| Solids | EPA 3541 | SOX Extraction | Semivolatiles, pesticides, PCBs, DRO |
| Solids | EPA 5035 | P&T closed | Volatiles |
| Aqueous/Solids | EPA 1311 | TCLP | Physical Extraction |
| Aqueous/Solids | EPA 1312 | SPLP | Physical Extraction |
| Aqueous/Solids | EPA 3620B | Florisil Cleanup | Semivolatiles, pesticides, PCBs |
| Aqueous/Solids | EPA 3660B | Sulfur Cleanup | Semivolatiles, pesticides, PCBs |
| Aqueous/Solids | EPA 3665A | Sulfuric Acid Cleanup | PCBs |
| Aqueous/Solids | EPA 9012A, B | Distillation | Cyanide |
| Aqueous/Solids | EPA 9030B | Distillation | Sulfide, acid soluble |



PJLA

Perry Johnson Laboratory Accreditation, Inc.



April 7, 2012

Ms. Lisa Reyes
Columbia Analytical Services
1565 Jefferson Road, Building 300
Suite 360
Rochester, NY 14609

Dear Ms. Reyes

This letter is to confirm that you have successfully completed your reaccreditation assessment. A certificate has now been granted and posted on our website. As you are aware, PJLA will no longer be issuing expiration dates on our certificates. Your certificate # **L12-48** will remain valid as long as you continue to maintain your annual assessments and reaccreditation assessments as stated in your customer agreement with PJLA. At this time, we have confirmed that your annual assessments will be conducted during the month of **October** each calendar year. This will include an interim surveillance assessment and a full system reassessment to be completed by **October 2013**. Once your reassessment is conducted and approved by our accreditation committee a revised status letter will be provided to you. Please allow PJLA at least 120 days from your assessment due date to issue this letter.

Please feel free to release this letter to any interested parties as confirmation of your certificate validity. Also, please remind them that your certificate is posted on our website at all times. Any changes in regards to your accreditation status will be reflected on our website.

We would like to thank you for your patronage over the past years and look forward to continuously serving your accreditation needs in the future. If we can assist you any further, please feel free to contact us at any time.

Sincerely,

Tracy Szerszen
President/Operations Manager

Scope of Accreditation

For CHEMTECH

284 Sheffield Street
Mountainside, NJ 07092
Divyajit Mehta
908-789-8900

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to CHEMTECH to perform the following tests:

Accreditation granted through: October 20, 2015

Testing – Environmental

| Non-Potable Water | | |
|-------------------|-------------|---|
| Technology | Method | Analyte |
| GC/ECD | EPA 8081A,B | 4,4'-DDD |
| GC/ECD | EPA 8081A,B | 4,4'-DDE |
| GC/ECD | EPA 8081A,B | 4,4'-DDT |
| GC/ECD | EPA 8081A,B | Aldrin |
| GC/ECD | EPA 8081A,B | alpha-BHC (alpha-Hexachlorocyclohexane) |
| GC/ECD | EPA 8081A,B | alpha Chlordane |
| GC/ECD | EPA 8081A,B | beta-BHC (beta-Hexachlorocyclohexane) |
| GC/ECD | EPA 8081A,B | Chlordane (tech.) |
| GC/ECD | EPA 8081A,B | delta-BHC |
| GC/ECD | EPA 8081A,B | Dieldrin |
| GC/ECD | EPA 8081A,B | Endosulfan I |
| GC/ECD | EPA 8081A,B | Endosulfan II |
| GC/ECD | EPA 8081A,B | Endosulfan sulfate |
| GC/ECD | EPA 8081A,B | Endrin aldehyde |
| GC/ECD | EPA 8081A,B | Endrin ketone |
| GC/ECD | EPA 8081A,B | Endrin |
| GC/ECD | EPA 8081A,B | gamma-BHC (Lindane gamma-Hexachlorocyclohexane) |

| Non-Potable Water | | |
|--------------------------|----------------|----------------------------------|
| Technology | Method | Analyte |
| GC/ECD | EPA 8081A,B | gamma Chlordane |
| GC/ECD | EPA 8081A,B | Heptachlor epoxide |
| GC/ECD | EPA 8081A,B | Heptachlor |
| GC/ECD | EPA 8081A,B | Methoxychlor |
| GC/ECD | EPA 8081A,B | Toxaphene (Chlorinated camphene) |
| GC/ECD | EPA 8082/8082A | Aroclor-1016 (PCB-1016) |
| GC/ECD | EPA 8082/8082A | Aroclor-1221 (PCB-1221) |
| GC/ECD | EPA 8082/8082A | Aroclor-1232 (PCB-1232) |
| GC/ECD | EPA 8082/8082A | Aroclor-1242 (PCB-1242) |
| GC/ECD | EPA 8082/8082A | Aroclor-1248 (PCB-1248) |
| GC/ECD | EPA 8082/8082A | Aroclor-1254 (PCB-1254) |
| GC/ECD | EPA 8082/8082A | Aroclor-1260 (PCB-1260) |
| GC/ECD | EPA 8151A | 2,4,5-T |
| GC/ECD | EPA 8151A | 2,4-D |
| GC/ECD | EPA 8151A | Dalapon |
| GC/ECD | EPA 8151A | Dicamba |
| GC/ECD | EPA 8151A | Dinoseb |
| GC/ECD | EPA 8151A | Picloram |
| GC/ECD | EPA 8151A | Silvex (2,4,5-TP) |
| GC/FID | RSK 175 | Methane |
| GC/FID | RSK 175 | Ethane |
| GC/FID | RSK 175 | Ethene |
| GC/FID | EPA 8015B/D | Diesel range organics (DRO) |
| GC/FID | EPA 8015B/D | Gasoline range organics (GRO) |
| GC/MS | EPA 8260B,C | 1,1,1,2-Tetrachloroethane |
| GC/MS | EPA 8260B,C | 1,1,1-Trichloroethane |
| GC/MS | EPA 8260B,C | 1,1,2,2-Tetrachloroethane |
| GC/MS | EPA 8260B,C | 1,1,2-Trichloroethane |
| GC/MS | EPA 8260B,C | 1,1-Dichloroethane |
| GC/MS | EPA 8260B,C | 1,1-Dichloroethylene |
| GC/MS | EPA 8260B,C | 1,1-Dichloropropene |

| Non-Potable Water | | |
|--------------------------|---------------|--|
| Technology | Method | Analyte |
| GC/MS | EPA 8260B,C | 1,2,3-Trichlorobenzene |
| GC/MS | EPA 8260B,C | 1,2,3-Trichloropropane |
| GC/MS | EPA 8260B,C | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8260B,C | 1,2,4-Trimethylbenzene |
| GC/MS | EPA 8260B,C | 1,2-Dibromo-3-chloropropane (DBCP) |
| GC/MS | EPA 8260B,C | 1,2-Dibromoethane (EDB Ethylene dibromide) |
| GC/MS | EPA 8260B,C | 1,2-Dichlorobenzene |
| GC/MS | EPA 8260B,C | 1,2-Dichloroethane |
| GC/MS | EPA 8260B,C | 1,2-Dichloropropane |
| GC/MS | EPA 8260B,C | 1,3,5-Trimethylbenzene |
| GC/MS | EPA 8260B,C | 1,3-Dichlorobenzene |
| GC/MS | EPA 8260B,C | 1,3-Dichloropropane |
| GC/MS | EPA 8260B,C | 1,4-Dichlorobenzene |
| GC/MS | EPA 8260B,C | 2,2-Dichloropropane |
| GC/MS | EPA 8260B,C | 2-Butanone (Methyl ethyl ketone MEK) |
| GC/MS | EPA 8260B,C | 2-Chloroethyl vinyl ether |
| GC/MS | EPA 8260B,C | 2-Chlorotoluene |
| GC/MS | EPA 8260B,C | 2-Hexanone |
| GC/MS | EPA 8260B,C | 4-Chlorotoluene |
| GC/MS | EPA 8260B,C | 4-Methyl-2-pentanone (MIBK) |
| GC/MS | EPA 8260B,C | Acetone |
| GC/MS | EPA 8260B,C | Acrolein (Propenal) |
| GC/MS | EPA 8260B,C | Acrylonitrile |
| GC/MS | EPA 8260B,C | 1,1,2-Trichlorotrifluoroethane |
| GC/MS | EPA 8260B,C | Allyl chloride (3-Chloropropene) |
| GC/MS | EPA 8260B,C | Benzene |
| GC/MS | EPA 8260B,C | Bromobenzene |
| GC/MS | EPA 8260B,C | Bromochloromethane |
| GC/MS | EPA 8260B,C | Bromodichloromethane |
| GC/MS | EPA 8260B,C | Bromoform |
| GC/MS | EPA 8260B,C | Carbon disulfide |



| Non-Potable Water | | |
|-------------------|-------------|---|
| Technology | Method | Analyte |
| GC/MS | EPA 8260B,C | Carbon tetrachloride |
| GC/MS | EPA 8260B,C | Chlorobenzene |
| GC/MS | EPA 8260B,C | Chloroethane |
| GC/MS | EPA 8260B,C | Chloroform |
| GC/MS | EPA 8260B,C | cis-1,2-Dichloroethylene |
| GC/MS | EPA 8260B,C | cis-1,3-Dichloropropene |
| GC/MS | EPA 8260B,C | Dibromochloromethane |
| GC/MS | EPA 8260B,C | Dibromomethane |
| GC/MS | EPA 8260B,C | Dichlorodifluoromethane |
| GC/MS | EPA 8260B,C | Ethyl acetate |
| GC/MS | EPA 8260B,C | Ethyl methacrylate |
| GC/MS | EPA 8260B,C | Ethylbenzene |
| GC/MS | EPA 8260B,C | Hexachlorobutadiene |
| GC/MS | EPA 8260B,C | Isopropylbenzene |
| GC/MS | EPA 8260B,C | m+p-Xylenes |
| GC/MS | EPA 8260B,C | Methacrylonitrile |
| GC/MS | EPA 8260B,C | Methyl bromide (Bromomethane) |
| GC/MS | EPA 8260B,C | Methyl chloride (Chloromethane) |
| GC/MS | EPA 8260B,C | Methyl tert-butyl ether (MTBE) |
| GC/MS | EPA 8260B,C | Methylene chloride |
| GC/MS | EPA 8260B,C | Naphthalene |
| GC/MS | EPA 8260B,C | n-Butylbenzene |
| GC/MS | EPA 8260B,C | n-Propylbenzene |
| GC/MS | EPA 8260B,C | o-Xylene |
| GC/MS | EPA 8260B,C | p-Dioxane |
| GC/MS | EPA 8260B,C | p-Isopropyltoluene |
| GC/MS | EPA 8260B,C | sec-Butylbenzene |
| GC/MS | EPA 8260B,C | Styrene |
| GS/MS | EPA 8260B,C | Tert-butyl alcohol |
| GC/MS | EPA 8260B,C | tert-Butylbenzene |
| GC/MS | EPA 8260B,C | Tetrachloroethylene (Perchloroethylene) |



| Non-Potable Water | | |
|-------------------|-------------|-------------------------------------|
| Technology | Method | Analyte |
| GC/MS | EPA 8260B,C | Toluene |
| GC/MS | EPA 8260B,C | trans-1,2-Dichloroethylene |
| GC/MS | EPA 8260B,C | trans-1,3-Dichloropropylene |
| GC/MS | EPA 8260B,C | trans-1,4-Dichloro-2-butene |
| GC/MS | EPA 8260B,C | Trichloroethene (Trichloroethylene) |
| GC/MS | EPA 8260B,C | Trichlorofluoromethane |
| GC/MS | EPA 8260B,C | Vinyl acetate |
| GC/MS | EPA 8260B,C | Vinyl chloride |
| GC/MS | EPA 8260B,C | Xylene (total) |
| GC/MS | EPA 8260B,C | Cyclohexane |
| GC/MS | EPA 8260B,C | Diethyl Ether |
| GC/MS | EPA 8260B,C | Diisopropyl ether |
| GC/MS | EPA 8260B,C | Hexachloroethane |
| GC/MS | EPA 8260B,C | Isopropyl Acetate |
| GC/MS | EPA 8260B,C | Methyl Acetate |
| GC/MS | EPA 8260B,C | Methyl Iodide |
| GC/MS | EPA 8260B,C | Methyl methacrylate |
| GC/MS | EPA 8260B,C | Methylcyclohexane |
| GC/MS | EPA 8260B,C | Tetrahydrofuran |
| GC/MS | EPA 8270C,D | 1,2,4,5-Tetrachlorobenzene |
| GC/MS | EPA 8270C,D | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8270C,D | 1,2-Dichlorobenzene |
| GC/MS | EPA 8270C,D | 1,2-Diphenylhydrazine |
| GC/MS | EPA 8270C,D | 1,3-Dichlorobenzene |
| GC/MS | EPA 8270C,D | 1,4-Dichlorobenzene |
| GC/MS | EPA 8270C,D | 2,3,4,6-Tetrachlorophenol |
| GC/MS | EPA 8270C,D | 2,4,5-Trichlorophenol |
| GC/MS | EPA 8270C,D | 2,4,6-Trichlorophenol |
| GC/MS | EPA 8270C,D | 2,4-Dichlorophenol |
| GC/MS | EPA 8270C,D | 2,4-Dimethylphenol |
| GC/MS | EPA 8270C,D | 2,4-Dinitrophenol |

| Non-Potable Water | | |
|--------------------------|---------------|------------------------------|
| Technology | Method | Analyte |
| GC/MS | EPA 8270C,D | 2,4-Dinitrotoluene (2,4-DNT) |
| GC/MS | EPA 8270C,D | 2,6-Dinitrotoluene (2,6-DNT) |
| GC/MS | EPA 8270C,D | 2-Chloronaphthalene |
| GC/MS | EPA 8270C,D | 2-Chlorophenol |
| GC/MS | EPA 8270C,D | 2-Methyl-4,6-dinitrophenol |
| GC/MS | EPA 8270C,D | 2-Methylnaphthalene |
| GC/MS | EPA 8270C,D | 2-Methylphenol (o-Cresol) |
| GC/MS | EPA 8270C,D | 2-Nitroaniline |
| GC/MS | EPA 8270C,D | 2-Nitrophenol |
| GC/MS | EPA 8270C,D | 3,3'-Dichlorobenzidine |
| GC/MS | EPA 8270C,D | 3+4-Methylphenol |
| GC/MS | EPA 8270C,D | 3-Nitroaniline |
| GC/MS | EPA 8270C,D | 4-Bromophenyl phenyl ether |
| GC/MS | EPA 8270C,D | 4-Chloro-3-methylphenol |
| GC/MS | EPA 8270C,D | 4-Chloroaniline |
| GC/MS | EPA 8270C,D | 4-Chlorophenyl phenylether |
| GC/MS | EPA 8270C,D | 4-Nitroaniline |
| GC/MS | EPA 8270C,D | 4-Nitrophenol |
| GC/MS | EPA 8270C,D | Acenaphthene |
| GC/MS | EPA 8270C,D | Acenaphthylene |
| GC/MS | EPA 8270C,D | Acetophenone |
| GC/MS | EPA 8270C,D | Aniline |
| GC/MS | EPA 8270C,D | Anthracene |
| GC/MS | EPA 8270C,D | Benzidine |
| GC/MS | EPA 8270C,D | Benzo(a)anthracene |
| GC/MS | EPA 8270C,D | Benzo(a)pyrene |
| GC/MS | EPA 8270C,D | Benzo(b)fluoranthene |
| GC/MS | EPA 8270C,D | Benzo(g,h,i)perylene |
| GC/MS | EPA 8270C,D | Benzo(k)fluoranthene |
| GC/MS | EPA 8270C,D | Benzoic acid |
| GC/MS | EPA 8270C,D | Benzyl alcohol |



| Non-Potable Water | | |
|-------------------|-------------|---|
| Technology | Method | Analyte |
| GC/MS | EPA 8270C,D | bis(2-Chloroethoxy)methane |
| GC/MS | EPA 8270C,D | bis(2-Chloroethyl) ether |
| GC/MS | EPA 8270C,D | bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane)) |
| GC/MS | EPA 8270C,D | bis(2-Ethylhexyl) phthalate (DEHP) |
| GC/MS | EPA 8270C,D | Butyl benzyl phthalate |
| GC/MS | EPA 8270C,D | Carbazole |
| GC/MS | EPA 8270C,D | Chrysene |
| GC/MS | EPA 8270C,D | Dibenz(a,h)anthracene |
| GC/MS | EPA 8270C,D | Dibenzofuran |
| GC/MS | EPA 8270C,D | Diethyl phthalate |
| GC/MS | EPA 8270C,D | Dimethyl phthalate |
| GC/MS | EPA 8270C,D | Di-n-butyl phthalate |
| GC/MS | EPA 8270C,D | Di-n-octyl phthalate |
| GC/MS | EPA 8270C,D | Diphenylamine |
| GC/MS | EPA 8270C,D | Fluoranthene |
| GC/MS | EPA 8270C,D | Fluorene |
| GC/MS | EPA 8270C,D | Hexachlorobenzene |
| GC/MS | EPA 8270C,D | Hexachlorobutadiene |
| GC/MS | EPA 8270C,D | Hexachlorocyclopentadiene |
| GC/MS | EPA 8270C,D | Hexachloroethane |
| GC/MS | EPA 8270C,D | Indeno(1,2,3-cd)pyrene |
| GC/MS | EPA 8270C,D | Isophorone |
| GC/MS | EPA 8270C,D | Naphthalene |
| GC/MS | EPA 8270C,D | Nitrobenzene |
| GC/MS | EPA 8270C,D | n-Nitrosodimethylamine |
| GC/MS | EPA 8270C,D | n-Nitrosodi-n-propylamine |
| GC/MS | EPA 8270C,D | n-Nitrosodiphenylamine |
| GC/MS | EPA 8270C,D | Pentachlorophenol |
| GC/MS | EPA 8270C,D | Phenanthrene |
| GC/MS | EPA 8270C,D | Phenol |
| GC/MS | EPA 8270C,D | Pyrene |

| Non-Potable Water | | |
|--------------------------|-------------------|----------------------------|
| Technology | Method | Analyte |
| GC/MS | EPA 8270C,D | Pyridine |
| GC/MS | EPA 8270C,D | 1,4-Dioxane |
| GC/MS | EPA 8270C,D | 1,1'-Biphenyl |
| GC/MS | EPA 8270C,D | Atrazine |
| GC/MS | EPA 8270C,D | Benzaldehyde |
| GC/MS | EPA 8270C,D | Caprolactam |
| GC/MS | EPA 8270C,D | Azobenzene |
| GC/MS | EPA 8270C,D-SIM | 1,4-Dioxane |
| GC/MS | Chemtech SOP M.5 | White Phosphorus |
| IC | Chemtech SOP J.21 | Nitrocellulose |
| HPLC | EPA 8330/8330A | 1,3,5-Trinitrobenzene |
| HPLC | EPA 8330/8330A | 1,3-Dinitrobenzene |
| HPLC | EPA 8330/8330A | 2,4,6-Trinitrotoluene |
| HPLC | EPA 8330/8330A | 2,4-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 2,6-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 2-Amino-4,6-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 2-Nitrotoluene |
| HPLC | EPA 8330/8330A | 3-Nitrotoluene |
| HPLC | EPA 8330/8330A | 4-Amino-2,6-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 4-Nitrotoluene |
| HPLC | EPA 8330/8330A | HMX |
| HPLC | EPA 8330/8330A | Nitrobenzene |
| HPLC | EPA 8330/8330A | RDX |
| HPLC | EPA 8330/8330A | Tetryl |
| HPLC | EPA 8330B | 1,3,5-TNB |
| HPLC | EPA 8330B | 1,3-DNB |
| HPLC | EPA 8330B | 2,4,6-TNT |
| HPLC | EPA 8330B | 2,4-DNT |
| HPLC | EPA 8330B | 2,6-DNT |
| HPLC | EPA 8330B | 2-Amino-4,6-DNT |
| HPLC | EPA 8330B | 2-NT |

| Non-Potable Water | | |
|--------------------------|----------------|------------------------------------|
| Technology | Method | Analyte |
| HPLC | EPA 8330B | 3,5-Dinitroaniline |
| HPLC | EPA 8330B | 3-NT |
| HPLC | EPA 8330B | 4-Amino-2,6-DNT |
| HPLC | EPA 8330B | 4-NT |
| HPLC | EPA 8330B | Nitrobenzene |
| HPLC | EPA 8330B | Nitroglycerin |
| HPLC | EPA 8330B | HMX |
| HPLC | EPA 8330B | Pentaerythritoltetranitrate |
| HPLC | EPA 8330B | RDX |
| HPLC | EPA 8330B | Tetryl |
| Gravimetric | EPA 1664A | Oil & Grease |
| Gravimetric | EPA 1664A | Total Petroleum Hydrocarbons (TPH) |
| Colorimetric | HACH 8146 | Ferrous Iron |
| IC | EPA 9056/9056A | Bromide |
| IC | EPA 9056/9056A | Chloride |
| IC | EPA 9056/9056A | Fluoride |
| IC | EPA 9056/9056A | Nitrate |
| IC | EPA 9056/9056A | Nitrite |
| IC | EPA 9056/9056A | O-phosphate |
| IC | EPA 9056/9056A | Sulfate |
| CVAA | EPA 7470A | Mercury |
| ICP | EPA 6010B,C | Aluminum |
| ICP | EPA 6010B,C | Antimony |
| ICP | EPA 6010B,C | Arsenic |
| ICP | EPA 6010B,C | Barium |
| ICP | EPA 6010B,C | Beryllium |
| ICP | EPA 6010B,C | Boron |
| ICP | EPA 6010B,C | Cadmium |
| ICP | EPA 6010B,C | Calcium |
| ICP | EPA 6010B,C | Chromium |
| ICP | EPA 6010B,C | Cobalt |



| Non-Potable Water | | |
|--------------------------|----------------|----------------|
| Technology | Method | Analyte |
| ICP | EPA 6010B,C | Copper |
| ICP | EPA 6010B,C | Iron |
| ICP | EPA 6010B,C | Lead |
| ICP | EPA 6010B,C | Magnesium |
| ICP | EPA 6010B,C | Manganese |
| ICP | EPA 6010B,C | Molybdenum |
| ICP | EPA 6010B,C | Nickel |
| ICP | EPA 6010B,C | Potassium |
| ICP | EPA 6010B,C | Selenium |
| ICP | EPA 6010B,C | Silicon |
| ICP | EPA 6010B,C | Silver |
| ICP | EPA 6010B,C | Sodium |
| ICP | EPA 6010B,C | Thallium |
| ICP | EPA 6010B,C | Tin |
| ICP | EPA 6010B,C | Titanium |
| ICP | EPA 6010B,C | Vanadium |
| ICP | EPA 6010B,C | Zinc |
| ICP-MS | EPA 6020/6020A | Aluminum |
| ICP-MS | EPA 6020/6020A | Antimony |
| ICP-MS | EPA 6020/6020A | Arsenic |
| ICP-MS | EPA 6020/6020A | Barium |
| ICP-MS | EPA 6020/6020A | Beryllium |
| ICP-MS | EPA 6020/6020A | Boron |
| ICP-MS | EPA 6020/6020A | Cadmium |
| ICP-MS | EPA 6020/6020A | Calcium |
| ICP-MS | EPA 6020/6020A | Chromium |
| ICP-MS | EPA 6020/6020A | Cobalt |
| ICP-MS | EPA 6020/6020A | Copper |
| ICP-MS | EPA 6020/6020A | Iron |
| ICP-MS | EPA 6020/6020A | Lead |
| ICP-MS | EPA 6020/6020A | Magnesium |

| Non-Potable Water | | |
|--------------------------|----------------|------------------------------|
| Technology | Method | Analyte |
| ICP-MS | EPA 6020/6020A | Manganese |
| ICP-MS | EPA 6020/6020A | Molybdenum |
| ICP-MS | EPA 6020/6020A | Nickel |
| ICP-MS | EPA 6020/6020A | Potassium |
| ICP-MS | EPA 6020/6020A | Selenium |
| ICP-MS | EPA 6020/6020A | Silicon |
| ICP-MS | EPA 6020/6020A | Silver |
| ICP-MS | EPA 6020/6020A | Sodium |
| ICP-MS | EPA 6020/6020A | Thallium |
| ICP-MS | EPA 6020/6020A | Tin |
| ICP-MS | EPA 6020/6020A | Titanium |
| ICP-MS | EPA 6020/6020A | Vanadium |
| ICP-MS | EPA 6020/6020A | Zinc |
| Preparation | Method | Type |
| ISE | EPA 9040C | Corrosivity (pH) |
| ISE | EPA 9040C | pH |
| pH Paper | EPA 9041A | pH |
| ISE | EPA 9050A | Conductivity |
| Physical | EPA 1010A | Ignitability |
| Titrimetric | EPA 9034 | Sulfide |
| Probe21 | EPA 9040C | pH |
| TOC | EPA 9060/9060A | Total organic carbon |
| Turbidimetric | EPA 9038 | Sulfate |
| UV/VIS | EPA 7196A | Chromium VI |
| Distillation | EPA 9010C | Total cyanide |
| UV/VIS | EPA 9012B | Total cyanide |
| UV/VIS | EPA 9065 | Total phenolics |
| Organic Preparation | 3510C | Separatory Funnel |
| Organic Preparation | 3541 | Automated Soxhlet Extraction |
| Clean Up | 3620C | Florisil Cleanup |
| Clean Up | 3630C | Silica Gel Cleanup |
| Clean Up | 3640A | Gel-Permeation Cleanup |

| Non-Potable Water | | |
|------------------------------|-------------------|---|
| Technology | Method | Analyte |
| Clean Up | 3660 | Sulfur Cleanup |
| Inorganic Preparation | 3050B | Hotblock |
| Inorganic Preparation | 3010A | Hotblock |
| Volatile Organic Preparation | 5030B | Purge and Trap |
| Distillation | 9030B | Sulfide |
| Extraction/Titrimetric | 9031 | Sulfide |
| Extraction | Chemtech SOP O.20 | Extraction of White Phosphorous from Aqueous Samples by Separatory Funnel |
| Colorimetric | Chemtech SOP J.21 | Nitrocellulose |

| Solid and Chemical Waste | | |
|---------------------------------|---------------|---|
| Technology | Method | Analyte |
| GC/ECD | EPA 8081A,B | 4,4`-DDD |
| GC/ECD | EPA 8081A,B | 4,4`-DDE |
| GC/ECD | EPA 8081A,B | 4,4`-DDT |
| GC/ECD | EPA 8081A,B | Aldrin |
| GC/ECD | EPA 8081A,B | alpha-BHC (alpha-Hexachlorocyclohexane) |
| GC/ECD | EPA 8081A,B | alpha Chlordane |
| GC/ECD | EPA 8081A,B | beta-BHC (beta-Hexachlorocyclohexane) |
| GC/ECD | EPA 8081A,B | Chlordane (tech.) |
| GC/ECD | EPA 8081A,B | delta-BHC |
| GC/ECD | EPA 8081A,B | Dieldrin |
| GC/ECD | EPA 8081A,B | Endosulfan I |
| GC/ECD | EPA 8081A,B | Endosulfan II |
| GC/ECD | EPA 8081A,B | Endosulfan sulfate |
| GC/ECD | EPA 8081A,B | Endrin aldehyde |
| GC/ECD | EPA 8081A,B | Endrin ketone |
| GC/ECD | EPA 8081A,B | Endrin |
| GC/ECD | EPA 8081A,B | gamma-BHC (Lindane gamma-Hexachlorocyclohexane) |

| Solid and Chemical Waste | | |
|---------------------------------|----------------|----------------------------------|
| Technology | Method | Analyte |
| GC/ECD | EPA 8081A,B | gamma Chlordane |
| GC/ECD | EPA 8081A,B | Heptachlor epoxide |
| GC/ECD | EPA 8081A,B | Heptachlor |
| GC/ECD | EPA 8081A,B | Methoxychlor |
| GC/ECD | EPA 8081A,B | Toxaphene (Chlorinated camphene) |
| GC/ECD | EPA 8082/8082A | Aroclor-1016 (PCB-1016) |
| GC/ECD | EPA 8082/8082A | Aroclor-1221 (PCB-1221) |
| GC/ECD | EPA 8082/8082A | Aroclor-1232 (PCB-1232) |
| GC/ECD | EPA 8082/8082A | Aroclor-1242 (PCB-1242) |
| GC/ECD | EPA 8082/8082A | Aroclor-1248 (PCB-1248) |
| GC/ECD | EPA 8082/8082A | Aroclor-1254 (PCB-1254) |
| GC/ECD | EPA 8082/8082A | Aroclor-1260 (PCB-1260) |
| GC/ECD | EPA 8151A | 2,4,5-T |
| GC/ECD | EPA 8151A | 2,4-D |
| GC/ECD | EPA 8151A | Dalapon |
| GC/ECD | EPA 8151A | Dicamba |
| GC/ECD | EPA 8151A | Dinoseb |
| GC/ECD | EPA 8151A | Picloram |
| GC/ECD | EPA 8151A | Silvex (2,4,5-TP) |
| GC/FID | EPA 8015B/D | Diesel range organics (DRO) |
| GC/MS | EPA 8015B/D | GRO |
| GC/MS | EPA 8260B,C | 1,1,1,2-Tetrachloroethane |
| GC/MS | EPA 8260B,C | 1,1,1-Trichloroethane |
| GC/MS | EPA 8260B,C | 1,1,2,2-Tetrachloroethane |
| GC/MS | EPA 8260B,C | 1,1,2-Trichloroethane |
| GC/MS | EPA 8260B,C | 1,1,2-Trichlorotrifluoroethane |
| GC/MS | EPA 8260B,C | 1,1-Dichloroethane |
| GC/MS | EPA 8260B,C | 1,1-Dichloroethylene |
| GC/MS | EPA 8260B,C | 1,1-Dichloropropene |
| GC/MS | EPA 8260B,C | 1,2,3-Trichlorobenzene |

| Solid and Chemical Waste | | |
|---------------------------------|---------------|--|
| Technology | Method | Analyte |
| GC/MS | EPA 8260B,C | 1,2,3-Trichloropropane |
| GC/MS | EPA 8260B,C | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8260B,C | 1,2,4-Trimethylbenzene |
| GC/MS | EPA 8260B,C | 1,2-Dibromo-3-chloropropane (DBCP) |
| GC/MS | EPA 8260B,C | 1,2-Dibromoethane (EDB Ethylene dibromide) |
| GC/MS | EPA 8260B,C | 1,2-Dichlorobenzene |
| GC/MS | EPA 8260B,C | 1,2-Dichloroethane |
| GC/MS | EPA 8260B,C | 1,2-Dichloropropane |
| GC/MS | EPA 8260B,C | 1,3,5-Trimethylbenzene |
| GC/MS | EPA 8260B,C | 1,3-Dichlorobenzene |
| GC/MS | EPA 8260B,C | 1,3-Dichloropropane |
| GC/MS | EPA 8260B,C | 1,4-Dichlorobenzene |
| GC/MS | EPA 8260B,C | 2,2-Dichloropropane |
| GC/MS | EPA 8260B,C | 2-Butanone (Methyl ethyl ketone MEK) |
| GC/MS | EPA 8260B,C | 2-Chloroethyl vinyl ether |
| GC/MS | EPA 8260B,C | 2-Chlorotoluene |
| GC/MS | EPA 8260B,C | 2-Hexanone |
| GC/MS | EPA 8260B,C | 4-Chlorotoluene |
| GC/MS | EPA 8260B,C | 4-Methyl-2-pentanone (MIBK) |
| GC/MS | EPA 8260B,C | Acetone |
| GC/MS | EPA 8260B,C | Acrolein (Propenal) |
| GC/MS | EPA 8260B,C | Acrylonitrile |
| GC/MS | EPA 8260B,C | Allyl chloride (3-Chloropropene) |
| GC/MS | EPA 8260B,C | Benzene |
| GC/MS | EPA 8260B,C | Bromobenzene |
| GC/MS | EPA 8260B,C | Bromochloromethane |
| GC/MS | EPA 8260B,C | Bromodichloromethane |
| GC/MS | EPA 8260B,C | Bromoform |
| GC/MS | EPA 8260B,C | Carbon disulfide |
| GC/MS | EPA 8260B,C | Carbon tetrachloride |

| Solid and Chemical Waste | | |
|---------------------------------|---------------|---|
| Technology | Method | Analyte |
| GC/MS | EPA 8260B,C | Chlorobenzene |
| GC/MS | EPA 8260B,C | Chloroethane |
| GC/MS | EPA 8260B,C | Chloroform |
| GC/MS | EPA 8260B,C | Methylcyclohexane |
| GC/MS | EPA 8260B,C | m+p-xylene |
| GC/MS | EPA 8260B,C | o-xylene |
| GC/MS | EPA 8260B,C | cis-1,2-Dichloroethylene |
| GC/MS | EPA 8260B,C | cis-1,3-Dichloropropene |
| GC/MS | EPA 8260B,C | Dibromochloromethane |
| GC/MS | EPA 8260B,C | Dibromomethane |
| GC/MS | EPA 8260B,C | Dichlorodifluoromethane |
| GC/MS | EPA 8260B,C | Ethyl methacrylate |
| GC/MS | EPA 8260B,C | Ethylbenzene |
| GC/MS | EPA 8260B,C | Hexachlorobutadiene |
| GC/MS | EPA 8260B,C | Isopropylbenzene |
| GC/MS | EPA 8260B,C | Methacrylonitrile |
| GC/MS | EPA 8260B,C | Methyl bromide (Bromomethane) |
| GC/MS | EPA 8260B,C | Methyl chloride (Chloromethane) |
| GC/MS | EPA 8260B,C | Methyl tert-butyl ether (MTBE) |
| GC/MS | EPA 8260B,C | Methylene chloride |
| GC/MS | EPA 8260B,C | Naphthalene |
| GC/MS | EPA 8260B,C | n-Butylbenzene |
| GC/MS | EPA 8260B,C | n-Propylbenzene |
| GC/MS | EPA 8260B,C | p-Dioxane |
| GC/MS | EPA 8260B,C | p-Isopropyltoluene |
| GC/MS | EPA 8260B,C | sec-Butylbenzene |
| GC/MS | EPA 8260B,C | Styrene |
| GC/MS | EPA 8260B,C | tert-butyl alcohol |
| GC/MS | EPA 8260B,C | tert-Butylbenzene |
| GC/MS | EPA 8260B,C | Tetrachloroethylene (Perchloroethylene) |



| Solid and Chemical Waste | | |
|--------------------------|-------------|-------------------------------------|
| Technology | Method | Analyte |
| GC/MS | EPA 8260B,C | Toluene |
| GC/MS | EPA 8260B,C | trans-1,2-Dichloroethylene |
| GC/MS | EPA 8260B,C | trans-1,3-Dichloropropylene |
| GC/MS | EPA 8260B,C | trans-1,4-Dichloro-2-butene |
| GC/MS | EPA 8260B,C | Trichloroethene (Trichloroethylene) |
| GC/MS | EPA 8260B,C | Trichlorofluoromethane |
| GC/MS | EPA 8260B,C | Vinyl acetate |
| GC/MS | EPA 8260B,C | Vinyl chloride |
| GC/MS | EPA 8260B,C | Xylene (total) |
| GC/MS | EPA 8260B,C | Cyclohexane |
| GC/MS | EPA 8260B,C | Diethyl Ether |
| GC/MS | EPA 8260B,C | Diisopropyl ether |
| GC/MS | EPA 8260B,C | Hexachloroethane |
| GC/MS | EPA 8260B,C | Isopropyl Acetate |
| GC/MS | EPA 8260B,C | Methyl Acetate |
| GC/MS | EPA 8260B,C | Methyl Iodide |
| GC/MS | EPA 8260B,C | Methyl methacrylate |
| GC/MS | EPA 8260B,C | Tetrahydrofuran |
| GC/MS | EPA 8270C,D | 1,2,4,5-Tetrachlorobenzene |
| GC/MS | EPA 8270C,D | 1,2,4-Trichlorobenzene |
| GC/MS | EPA 8270C,D | 1,2-Dichlorobenzene |
| GC/MS | EPA 8270C,D | 1,2-Diphenylhydrazine |
| GC/MS | EPA 8270C,D | 1,3-Dichlorobenzene |
| GC/MS | EPA 8270C,D | 1,4-Dichlorobenzene |
| GC/MS | EPA 8270C,D | 2,3,4,6-Tetrachlorophenol |
| GC/MS | EPA 8270C,D | 2,4,5-Trichlorophenol |
| GC/MS | EPA 8270C,D | 2,4,6-Trichlorophenol |
| GC/MS | EPA 8270C,D | 2,4-Dichlorophenol |
| GC/MS | EPA 8270C,D | 2,4-Dimethylphenol |
| GC/MS | EPA 8270C,D | 2,4-Dinitrophenol |

| Solid and Chemical Waste | | |
|---------------------------------|---------------|------------------------------|
| Technology | Method | Analyte |
| GC/MS | EPA 8270C,D | 2,4-Dinitrotoluene (2,4-DNT) |
| GC/MS | EPA 8270C,D | 2,6-Dinitrotoluene (2,6-DNT) |
| GC/MS | EPA 8270C,D | 2-Chloronaphthalene |
| GC/MS | EPA 8270C,D | 2-Chlorophenol |
| GC/MS | EPA 8270C,D | 2-Methyl-4,6-dinitrophenol |
| GC/MS | EPA 8270C,D | 2-Methylnaphthalene |
| GC/MS | EPA 8270C,D | 2-Methylphenol (o-Cresol) |
| GC/MS | EPA 8270C,D | 2-Nitroaniline |
| GC/MS | EPA 8270C,D | 2-Nitrophenol |
| GC/MS | EPA 8270C,D | 3,3`-Dichlorobenzidine |
| GC/MS | EPA 8270C,D | 3+4-Methylphenol |
| GC/MS | EPA 8270C,D | 3-Nitroaniline |
| GC/MS | EPA 8270C,D | 4-Bromophenyl phenyl ether |
| GC/MS | EPA 8270C,D | 4-Chloro-3-methylphenol |
| GC/MS | EPA 8270C,D | 4-Chloroaniline |
| GC/MS | EPA 8270C,D | 4-Chlorophenyl phenylether |
| GC/MS | EPA 8270C,D | 4-Nitroaniline |
| GC/MS | EPA 8270C,D | 4-Nitrophenol |
| GC/MS | EPA 8270C,D | Acenaphthene |
| GC/MS | EPA 8270C,D | Acenaphthylene |
| GC/MS | EPA 8270C,D | Acetophenone |
| GC/MS | EPA 8270C,D | Aniline |
| GC/MS | EPA 8270C,D | Anthracene |
| GC/MS | EPA 8270C,D | Aramite |
| GC/MS | EPA 8270C,D | Benzidine |
| GC/MS | EPA 8270C,D | Benzo(a)anthracene |
| GC/MS | EPA 8270C,D | Benzo(a)pyrene |
| GC/MS | EPA 8270C,D | Benzo(b)fluoranthene |
| GC/MS | EPA 8270C,D | Benzo(g,h,i)perylene |
| GC/MS | EPA 8270C,D | Benzo(k)fluoranthene |

| Solid and Chemical Waste | | |
|---------------------------------|---------------|---|
| Technology | Method | Analyte |
| GC/MS | EPA 8270C,D | Benzoic acid |
| GC/MS | EPA 8270C,D | Benzyl alcohol |
| GC/MS | EPA 8270C,D | bis(2-Chloroethoxy)methane |
| GC/MS | EPA 8270C,D | bis(2-Chloroethyl) ether |
| GC/MS | EPA 8270C,D | bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane)) |
| GC/MS | EPA 8270C,D | bis(2-Ethylhexyl) phthalate (DEHP) |
| GC/MS | EPA 8270C,D | Butyl benzyl phthalate |
| GC/MS | EPA 8270C,D | Carbazole |
| GC/MS | EPA 8270C,D | Chrysene |
| GC/MS | EPA 8270C,D | Dibenz(a,h)anthracene |
| GC/MS | EPA 8270C,D | Dibenzofuran |
| GC/MS | EPA 8270C,D | Diethyl phthalate |
| GC/MS | EPA 8270C,D | Dimethyl phthalate |
| GC/MS | EPA 8270C,D | Di-n-butyl phthalate |
| GC/MS | EPA 8270C,D | Di-n-octyl phthalate |
| GC/MS | EPA 8270C,D | Diphenylamine |
| GC/MS | EPA 8270C,D | Fluoranthene |
| GC/MS | EPA 8270C,D | Fluorene |
| GC/MS | EPA 8270C,D | Hexachlorobenzene |
| GC/MS | EPA 8270C,D | Hexachlorobutadiene |
| GC/MS | EPA 8270C,D | Hexachlorocyclopentadiene |
| GC/MS | EPA 8270C,D | Hexachloroethane |
| GC/MS | EPA 8270C,D | Indeno(1,2,3-cd)pyrene |
| GC/MS | EPA 8270C,D | Isophorone |
| GC/MS | EPA 8270C,D | Naphthalene |
| GC/MS | EPA 8270C,D | Nitrobenzene |
| GC/MS | EPA 8270C,D | n-Nitrosodimethylamine |
| GC/MS | EPA 8270C,D | n-Nitroso-di-n-butylamine |
| GC/MS | EPA 8270C,D | n-Nitrosodi-n-propylamine |
| GC/MS | EPA 8270C,D | n-Nitrosodiphenylamine |

| Solid and Chemical Waste | | |
|---------------------------------|-------------------|----------------------------|
| Technology | Method | Analyte |
| GC/MS | EPA 8270C,D | Pentachlorophenol |
| GC/MS | EPA 8270C,D | Phenanthrene |
| GC/MS | EPA 8270C,D | Phenol |
| GC/MS | EPA 8270C,D | Butylbenzylphthalate |
| GC/MS | EPA 8270C,D | Pyridine |
| GC/MS | EPA 8270C,D | Pyridine |
| GC/MS | EPA 8270C,D | 1,4-Dioxane |
| GC/MS | EPA 8270C,D | 1,1'-Biphenyl |
| GC/MS | EPA 8270C,D | Atrazine |
| GC/MS | EPA 8270C,D | Benzaldehyde |
| GC/MS | EPA 8270C,D | Caprolactam |
| GC/MS | EPA 8270C,D | Azobenzene |
| GC/MS | EPA 8270C,D-SIM | 1,4-Dioxane |
| GC/MS | Chemtech SOP M.5 | White Phosphorus |
| IC | Chemtech SOP J.21 | Nitrocellulose |
| HPLC | EPA 8330/8330A | 1,3,5-Trinitrobenzene |
| HPLC | EPA 8330/8330A | 1,3-Dinitrobenzene |
| HPLC | EPA 8330/8330A | 2,4,6-Trinitrotoluene |
| HPLC | EPA 8330/8330A | 2,4-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 2,6-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 2-Nitrotoluene |
| HPLC | EPA 8330/8330A | 3-Nitrotoluene |
| HPLC | EPA 8330/8330A | 4-Amino-2,6-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 2-Amino-4,6-Dinitrotoluene |
| HPLC | EPA 8330/8330A | 4-Nitrotoluene |
| HPLC | EPA 8330/8330A | HMX |
| HPLC | EPA 8330/8330A | Nitrobenzene |
| HPLC | EPA 8330/8330A | RDX |
| HPLC | EPA 8330/8330A | Tetryl |
| HPLC | EPA 8330B | 1,3,5-Trinitrobenzene |



| Solid and Chemical Waste | | |
|--------------------------|----------------|-----------------------------|
| Technology | Method | Analyte |
| HPLC | EPA 8330B | 1,3-Dinitrobenzene |
| HPLC | EPA 8330B | 2,4,6-Trinitrotoluene |
| HPLC | EPA 8330B | 2,4-Dinitrotoluene |
| HPLC | EPA 8330B | 2,6-Dinitrotoluene |
| HPLC | EPA 8330B | 2-Amino-4,6-Dinitrotoluene |
| HPLC | EPA 8330B | 2-Nitrotoluene |
| HPLC | EPA 8330B | 3-Nitrotoluene |
| HPLC | EPA 8330B | 4-Amino-2,6-Dinitrotoluene |
| HPLC | EPA 8330B | 4-Nitrotoluene |
| HPLC | EPA 8330B | HMX |
| HPLC | EPA 8330B | Nitrobenzene |
| HPLC | EPA 8330B | RDX |
| HPLC | EPA 8330B | Tetryl |
| HPLC | EPA 8330B | 3,5-Dinitroaniline |
| HPLC | EPA 8330B | Nitroglycerin |
| HPLC | EPA 8330B | Pentaerythritoltetranitrate |
| Colorimetric | EPA 9012B | Total cyanide |
| CVAA | EPA 7471A,B | Mercury |
| Gravimetric | EPA 9071B | Oil & Grease |
| Colorimetric | HACH 8146 | Ferrous Iron |
| IC | EPA 9056/9056A | Nitrite |
| IC | EPA 9056/9056A | Nitrate |
| IC | EPA 9056/9056A | Bromide |
| IC | EPA 9056/9056A | Chloride |
| IC | EPA 9056/9056A | Fluoride |
| IC | EPA 9056/9056A | O-phosphate |
| ICP | EPA 6010B,C | Aluminum |
| ICP | EPA 6010B,C | Antimony |
| ICP | EPA 6010B,C | Arsenic |
| ICP | EPA 6010B,C | Barium |



| Solid and Chemical Waste | | |
|---------------------------------|----------------|----------------|
| Technology | Method | Analyte |
| ICP | EPA 6010B,C | Beryllium |
| ICP | EPA 6010B,C | Boron |
| ICP | EPA 6010B,C | Cadmium |
| ICP | EPA 6010B,C | Calcium |
| ICP | EPA 6010B,C | Chromium |
| ICP | EPA 6010B,C | Cobalt |
| ICP | EPA 6010B,C | Copper |
| ICP | EPA 6010B,C | Iron |
| ICP | EPA 6010B,C | Lead |
| ICP | EPA 6010B,C | Magnesium |
| ICP | EPA 6010B,C | Manganese |
| ICP | EPA 6010B,C | Molybdenum |
| ICP | EPA 6010B,C | Nickel |
| ICP | EPA 6010B,C | Potassium |
| ICP | EPA 6010B,C | Selenium |
| ICP | EPA 6010B,C | Silicon |
| ICP | EPA 6010B,C | Silver |
| ICP | EPA 6010B,C | Sodium |
| ICP | EPA 6010B,C | Thallium |
| ICP | EPA 6010B,C | Tin |
| ICP | EPA 6010B,C | Titanium |
| ICP | EPA 6010B,C | Vanadium |
| ICP | EPA 6010B,C | Zinc |
| ICP-MS | EPA 6020/6020A | Aluminum |
| ICP-MS | EPA 6020/6020A | Antimony |
| ICP-MS | EPA 6020/6020A | Arsenic |
| ICP-MS | EPA 6020/6020A | Barium |
| ICP-MS | EPA 6020/6020A | Beryllium |
| ICP-MS | EPA 6020/6020A | Boron |
| ICP-MS | EPA 6020/6020A | Cadmium |

| Solid and Chemical Waste | | |
|---------------------------------|----------------------------|---------------------------|
| Technology | Method | Analyte |
| ICP-MS | EPA 6020/6020A | Calcium |
| ICP-MS | EPA 6020/6020A | Chromium |
| ICP-MS | EPA 6020/6020A | Cobalt |
| ICP-MS | EPA 6020/6020A | Copper |
| ICP-MS | EPA 6020/6020A | Iron |
| ICP-MS | EPA 6020/6020A | Lead |
| ICP-MS | EPA 6020/6020A | Magnesium |
| ICP-MS | EPA 6020/6020A | Manganese |
| ICP-MS | EPA 6020/6020A | Molybdenum |
| ICP-MS | EPA 6020/6020A | Nickel |
| ICP-MS | EPA 6020/6020A | Potassium |
| ICP-MS | EPA 6020/6020A | Selenium |
| ICP-MS | EPA 6020/6020A | Silicon |
| ICP-MS | EPA 6020/6020A | Silver |
| ICP-MS | EPA 6020/6020A | Sodium |
| ICP-MS | EPA 6020/6020A | Thallium |
| ICP-MS | EPA 6020/6020A | Tin |
| ICP-MS | EPA 6020/6020A | Titanium |
| ICP-MS | EPA 6020/6020A | Vanadium |
| ICP-MS | EPA 6020/6020A | Zinc |
| Preparation | Method | Type |
| pH Paper | EPA 9041A | pH |
| Probe | EPA 9045C | pH |
| ISE | EPA 9040C | pH/Corrosivity |
| TOC | EPA 9060 Mod/ 9060A Mod | Total organic carbon |
| Physical | EPA 1010A | Ignitability |
| Titrimetric | EPA 9034 | Sulfide |
| Turbidimetric | EPA 9038 | Sulfate |
| Physical | EPA 9095A,B | Paint Filter Liquids Test |

| Solid and Chemical Waste | | |
|---------------------------------|-------------------|---|
| Technology | Method | Analyte |
| Preparation | EPA 3060A | Chromium VI |
| UV/VIS | EPA 7196A | Chromium VI |
| Distillation | EPA 9010C | Total cyanide |
| UV/VIS | EPA 9012B | Total cyanide |
| Distillation | EPA 9013 | Total cyanide |
| UV/VIS | EPA 9065 | Total phenolics |
| Preparation | EPA 1311 | Toxicity Characteristic Leaching Procedure |
| Preparation | EPA 1312 | SPLP |
| Organic Preparation | 3541 | Automated Soxhlet Extraction |
| Clean Up | 3620C | Florisil Cleanup |
| Clean Up | 3630C | Silica Gel Cleanup |
| Clean Up | 3640A | Gel-Permeation Cleanup |
| Clean Up | 3660 | Sulfur Cleanup |
| Inorganics Preparation | 3050B | Hotblock |
| Volatile Organics Preparation | 5035A | Closed System Purge and Trap |
| Organic Preparation | 3580A | Waste dilution |
| Distillation | 9030B | Sulfide |
| Extraction/Titrimetric | 9031 | Sulfide |
| Extraction | Chemtech SOP O.19 | Extraction of White Phosphorous from Soil and Sediment Sample by Sonication |
| Sonication | EPA 3550B | Extraction Preparation Method |
| Soxhlet | EPA 3540C | Extraction Preparation Method |
| Colorimetric | Chemtech SOP J.21 | Nitrocellulose |

| Air | | |
|-------------------|---------------|--------------------------------|
| Technology | Method | Analyte |
| GC/MS | TO-15 | 1,1,1-Trichloroethane |
| GC/MS | TO-15 | 1,1,2,2-Tetrachloroethane |
| GC/MS | TO-15 | 1,1,2-Trichloroethane |
| GC/MS | TO-15 | 1,1,2-Trichlorotrifluoroethane |
| GC/MS | TO-15 | 1,1-Dichloroethane |
| GC/MS | TO-15 | 1,1-Dichloroethene |
| GC/MS | TO-15 | 1,2,4-Trichlorobenzene |
| GC/MS | TO-15 | 1,2,4-Trimethylbenzene |
| GC/MS | TO-15 | 1,2-Dibromoethane |
| GC/MS | TO-15 | 1,2-Dichlorobenzene |
| GC/MS | TO-15 | 1,2-Dichloroethane |
| GC/MS | TO-15 | 1,2-Dichloropropane |
| GC/MS | TO-15 | 1,3,5-Trimethylbenzene |
| GC/MS | TO-15 | 1,3-Butadiene |
| GC/MS | TO-15 | 1,3-Dichlorobenzene |
| GC/MS | TO-15 | 1,4-Dichlorobenzene |
| GC/MS | TO-15 | 1,4-Dioxane |
| GC/MS | TO-15 | 2,2,4-Trimethylpentane |
| GC/MS | TO-15 | 2-Butanone |
| GC/MS | TO-15 | 2-Chlorotoluene |
| GC/MS | TO-15 | 2-Hexanone |
| GC/MS | TO-15 | 4-Ethyltoluene |
| GC/MS | TO-15 | 4-Methyl-2-Pentanone |
| GC/MS | TO-15 | Acetone |
| GC/MS | TO-15 | Allyl Chloride |
| GC/MS | TO-15 | Benzene |
| GC/MS | TO-15 | Benzyl Chloride |
| GC/MS | TO-15 | Bromodichloromethane |
| GC/MS | TO-15 | Bromoethene |
| GC/MS | TO-15 | Bromoform |
| GC/MS | TO-15 | Bromomethane |

| Air | | |
|-------------------|---------------|---------------------------|
| Technology | Method | Analyte |
| GC/MS | TO-15 | Carbon Disulfide |
| GC/MS | TO-15 | Carbon Tetrachloride |
| GC/MS | TO-15 | Chlorobenzene |
| GC/MS | TO-15 | Chloroethane |
| GC/MS | TO-15 | Chloroform |
| GC/MS | TO-15 | Chloromethane |
| GC/MS | TO-15 | cis-1,2-Dichloroethene |
| GC/MS | TO-15 | cis-1,3-Dichloropropene |
| GC/MS | TO-15 | Cyclohexane |
| GC/MS | TO-15 | Dibromochloromethane |
| GC/MS | TO-15 | Dichlorodifluoromethane |
| GC/MS | TO-15 | Dichlorotetrafluoroethane |
| GC/MS | TO-15 | Ethanol |
| GC/MS | TO-15 | Ethyl Acetate |
| GC/MS | TO-15 | Ethyl Benzene |
| GC/MS | TO-15 | Heptane |
| GC/MS | TO-15 | Hexachloro-1,3-Butadiene |
| GC/MS | TO-15 | Hexane |
| GC/MS | TO-15 | Isopropyl Alcohol |
| GC/MS | TO-15 | m/p-Xylene |
| GC/MS | TO-15 | Methyl methacrylate |
| GC/MS | TO-15 | Methyl tert-Butyl Ether |
| GC/MS | TO-15 | Methylene Chloride |
| GC/MS | TO-15 | Naphthalene |
| GC/MS | TO-15 | o-Xylene |
| GC/MS | TO-15 | Propene |
| GC/MS | TO-15 | Styrene |
| GC/MS | TO-15 | t-1,3-Dichloropropene |
| GC/MS | TO-15 | tert-butyl alcohol |
| GC/MS | TO-15 | Tetrachloroethene |
| GC/MS | TO-15 | Tetrahydrofuran |

| Air | | |
|------------|--------|--------------------------|
| Technology | Method | Analyte |
| GC/MS | TO-15 | Toluene |
| GC/MS | TO-15 | trans-1,2-Dichloroethene |
| GC/MS | TO-15 | Trichloroethene |
| GC/MS | TO-15 | Trichlorofluoromethane |
| GC/MS | TO-15 | Vinyl Acetate |
| GC/MS | TO-15 | Vinyl Chloride |
| GC/MS | TO-15 | Isopropylbenzene |
| GC/MS | TO-15 | n-Butylbenzene |
| GC/MS | TO-15 | n-propylbenzene |
| GC/MS | TO-15 | p-Isopropyltoluene |
| GC/MS | TO-15 | sec-Butylbenzene |
| GC/MS | TO-15 | tert-Butylbenzene |

Notes:

- 1.) This laboratory offers commercial testing service.

Approved by:



 R. Douglas Leonard
 Chief Technical Officer

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