

MARINE CORPS BASE CAMP LEJEUNE
UNDERGROUND STORAGE TANK MANAGEMENT PROGRAM
PROGRAM STRATEGY PLAN



NOVEMBER 29, 2005

PREPARED FOR:

**ENVIRONMENTAL QUALITY BRANCH
ENVIRONMENTAL MANAGEMENT DIVISION
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA**

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MARINE CORPS BASE CAMP LEJEUNE
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1.0 INTRODUCTION

The Marine Corps Base (MCB) Camp Lejeune Underground Storage Tank (UST) Management Program (hereinafter referred to as the *Program*) may be defined as an organized set of activities, procedures and documents designed to address monitoring of leaking underground storage tanks, pipeline leaks, and petroleum oil and lubricant (POL) spill sites under the jurisdiction of the MCB Camp Lejeune Environmental Quality Branch (EQB). The primary objectives of the *Program* are to enable MCB Camp Lejeune to:

Cost-Effectively Manage Monitoring Of Active UST Incidents

Meet Regulatory Permitting, Monitoring And Reporting Requirements

Achieve Site Closure At The Earliest Possible Date and at the Lowest Cost

2.0 SCOPE OF THE PROGRAM

The scope of the *Program* includes monitoring activities at both "monitoring only" sites and sites at which equipment-based active remediation systems are in place and operating. With respect to sites containing active remediation systems, the *Program* **does not** intend to cover operation and maintenance of remediation systems equipment per se; however, the *Program* **does** include collection of field data and analysis of samples at active remediation sites for the purpose of monitoring contaminant recovery rates, maintaining compliance with wastewater discharge permits, monitoring air emissions, and tracking groundwater and surface water quality.

Geographically speaking, the *Program* area includes MCB Camp Lejeune and Marine Corps Air Station (MCAS) New River. Management of all UST incidents at these locations falls within the jurisdiction of the EQB at MCB Camp Lejeune.

Although the primary emphasis of the *Program* is monitoring of UST incidents, the *Program* also encompasses releases of petroleum hydrocarbons from several underground pipelines and POL spills. For reasons of simplicity, it is inferred herein that underground pipeline leak and POL spill incidents are included whenever this document refers to UST sites.

3.0 PROGRAM STEPS AND ELEMENTS

The benefits of the *Program* will include enhancement of EQB's ability to make informed management decisions without having to perform intensive reviews of voluminous data and information. Three steps necessary to enable EQB managers to make effective, timely and informed decisions include:

Step 1: Collection Of Quality Field And Laboratory Data

Step 2: Effective Organization And Storage Of The Data

Step 3: Presentation Of Data, Findings And Conclusions In A Concise Format

The major elements of the *Program*, through which the three program steps are carried out, are listed below and described in further detail herein. This *Program Strategy Plan* document is intended to describe, in general terms, the concept and operations of the *Program*. Figure 1 includes a *Conceptual Overview* of how the steps and major elements of the *Program* fit together. Figure 2 presents an *Activity Flow Diagram* which provides further details of key activities within the *Program* and how they interrelate chronologically.

Program Strategy Plan

Monitoring Plan

Geographic Information System (GIS) and Database

Periodic Monitoring Reports

Management Recommendations Reports

4.0 STEP 1: DATA COLLECTION

At present, several contractors are involved in sampling and monitoring at UST sites including contractors performing petroleum hydrocarbon assessment and remedial design; remedial action construction; installation restoration activities; operation and maintenance of remedial systems; UST closures; and interim free product removal. Field and laboratory data will be transmitted by the various contractors to CATLIN for input into the *Geographic Information System (GIS) and Database*. To enhance efficiency and consistency in the transmittal and storage of data, the MCB Camp Lejeune Contractor's Electronic Data Deliverable Standards and Procedures and CATLIN's EDD Manual will be utilized by all contractors transmitting data.

Collection of quality data will be performed with the aid of a cost-effective monitoring plan. The *Monitoring Plan* will be developed to act as a guide and/or workplan for EQB and contractors involved in monitoring UST sites. The *Monitoring Plan*, developed by CATLIN for MCB Camp Lejeune, specifies locations, schedules, procedures and protocols designed to collect data at each UST incident site. It is envisioned that the data collected under the *Program* will consist primarily of field measurements obtained from groundwater monitoring wells and remediation system components; and laboratory analytical data associated with analysis of samples collected from groundwater monitoring wells, water supply wells, surface waters and remediation system wastestreams. More specifically, these data will typically include:

<i>Depth To Groundwater</i>	<i>Groundwater Pumping Rates/Volume</i>
<i>Free Product Thickness</i>	<i>Air Injection Rates/Volume</i>
<i>Groundwater pH</i>	<i>Air Emission Discharge Rates/Volume</i>
<i>Groundwater Temperature</i>	<i>Wastewater Discharge Rates/Volume</i>
<i>Dissolved Oxygen</i>	<i>Product Recovery Rates/Volume</i>
<i>Laboratory Analytical Results</i>	<i>Mass of Volatile Hydrocarbons Recovered</i>
<i>Remediation System Downtime</i>	

In recognition that monitoring requirements will change over time, the *Monitoring Plan* is structured in a manner that makes it easy to update. Copies of the *Monitoring Plan* will be provided to contractors prior to each scheduled gauging/sampling event.

5.0 STEP 2: DATA ORGANIZATION AND STORAGE

Organization and storage of the data will be accomplished using a database and shapefiles within a custom-designed *Geographic Information System (GIS)*. CATLIN will utilize the MCB Camp Lejeune GIS layers to produce an in-house GIS to accept, store and organize data in a manner that will provide for ease of data input and report generation.

The *GIS* will include, but not be limited to, site location maps, site base maps, monitoring well details, field measurements, and laboratory data. This *GIS* will be maintained at the office of CATLIN Engineers and Scientists in Wilmington, North Carolina. As indicated previously, CATLIN will receive data from contractors providing monitoring services to EQB and

continually update the *GIS*.

6.0 STEP 3: PRESENTATION OF DATA, FINDINGS AND CONCLUSIONS

Data, findings and conclusions will be presented in *Periodic Monitoring Reports* prepared by CATLIN which will be used to report results of monitoring performed during the preceding monitoring period. Each *Periodic Monitoring Report* will be accompanied by a separate *Management Recommendations Report* which is intended for internal use by EQB managers.

Periodic Monitoring Reports and *Management Recommendations Reports* will be prepared and submitted by CATLIN to EQB following the monitoring period in which the monitoring activities were performed. Upon approval by EQB of suggested modifications to the activities specified in the *Monitoring Plan*, updates to the *Monitoring Plan* will be prepared by CATLIN and distributed to all *Monitoring Plan* recipients.

In addition to the standard *Periodic Monitoring Reports* and *Management Recommendations Reports*, other types of reports may be generated using the *GIS* to meet a variety of management needs.

6.1 PERIODIC MONITORING REPORTS

The *Periodic Monitoring Report* is a multi-site report and is structured to accomplish the dual objective of minimizing redundancy in reporting while providing for easy disassembly into individual, site-specific, stand-alone mini-reports. An example report is contained in Appendix D of this document.

The *Periodic Monitoring Report* is intended for use by a variety of potential "end-users" including EQB, environmental regulatory agencies, Naval Facilities Engineering Command – Atlantic (NAVFAC Atlantic), MCB Camp Lejeune Resident Officer in Charge of Construction (ROICC), and O&M Contractors. These reports will aid decision-makers, including EQB managers and regulatory officials, in their efforts to:

Track Migration And Attenuation Of Dissolved-Phase Plumes

Track Migration And/Or Volume Reduction Of Free Product Plumes

Ensure Compliance With Surface Water Quality Standards

Monitor Quality Of Water Well Supplies

Evaluate Effectiveness Of Active Remediation Systems

Ensure Compliance With Treatment System Wastewater Discharge Permits

Monitor Treatment System Air Emissions

There is a significant diversity in the status of UST incidents at MCB Camp Lejeune and MCAS New River. By categorizing the sites, we can refer to a "type" of site and communicate information regarding the status and magnitude of the UST incident without having to write a lengthy description. This will also allow writeups in the *Periodic Monitoring Reports* to be brief. In general, UST sites subject to periodic monitoring under the *Program* fall into five main "types". For purposes of the *Program*, these types will be identified as follows:

Type "A": *Pre-CAP Monitoring*

Sites for which the Corrective Action Plan (CAP) is in progress but not yet approved by North Carolina Department of Environment and Natural Resources (NCDENR).

Type "B": *CAP Compliance Monitoring*

Sites for which the CAP and associated monitoring plan has been approved by NCDENR; however, the planned active remediation system has not been completed.

Type "C": *Interim and Product Recovery*

Typically small, low priority/low risk *Monitoring* sites characterized by low levels of dissolved-phase hydrocarbons and/or low volume product recovery for which no CAP will be prepared.

Type "D": *Remediation System Start-Up*

Sites at which remediation systems have recently be constructed and monitoring is being performed to optimize system operation and establish baseline, environmental quality.

Type "E": *Active Remediation and Natural Attenuation Monitoring*

Sites at which an active remediation system is in full operation and sites at which natural degradation and attenuation is being employed as the primary cleanup technology; CAP has typically been prepared and approved by NCDENR for these sites.

6.2 MANAGEMENT RECOMMENDATIONS REPORTS

The *Management Recommendations Report* will be prepared by CATLIN upon review and evaluation of data and completion of each *Periodic Monitoring Report*. As indicated previously, the *Management Recommendations Report* is intended for internal use by EQB. The *Management Recommendations Report* will include, but not be limited to, recommendations to EQB managers regarding:

Modifications To The Sampling Plan

Additional Assessment Work

Modifications To Active Remediation Systems

Installation Of New Monitoring Wells

Monitoring Well Abandonment

Site Closure

Upon acceptance of recommendations, EQB will notify NCDENR of proposed modifications to the *Monitoring Plan*, plans for monitoring well abandonment, remediation system modifications, and requests for site closures. EQB will then notify CATLIN of approved modifications to the *Monitoring Plan* and approved site closures. Notification will also be provided to CATLIN by EQB upon abandonment of wells and completion of modifications to active remediation systems. CATLIN will then incorporate these changes and modifications into the *Monitoring Plan* and the *GIS and Database*. This process is presented graphically in Figure 2 of this document. An example *Management Recommendations Report* is contained in Appendix E of this document.

7.0 MONITORING STRATEGY

As indicated in Section 4.0, details of monitoring requirements and protocols will be specified in the *Monitoring Plan*. This section of the *Program Strategy Plan* is intended to describe the rationale for:

Establishing Monitoring Schedules

Selecting Monitoring Points

Targeting Field and Laboratory Parameters

During the course of conducting an assessment and implementing a remediation strategy at UST sites, several project documents are typically produced which may contain references to monitoring schedules, monitoring points and target parameters. These documents include:

- *Site Assessment Reports*
- *Corrective Action Plans*
- *RAC Workplans*
- *Remediation System Specifications*
- *Reports of Historical Monitoring Activities*

Upon implementation of the *Program*, references to monitoring schedules, monitoring points and target parameters will also be contained in *Management Recommendations Reports*.

In addition to the above-referenced project documents, regulatory rules and guidelines produced by NCDENR also contain references to monitoring requirements and protocols that must be considered when developing a site-specific monitoring plan. Specifically, these rules and guidelines include:

- *15A NCAC 2L Groundwater Classifications and Standards*
- *Risk-Based Assessment and Corrective Action for Petroleum Underground Storage Tanks 15A NCAC 2L .0115 (Risk-Based Rules)*
- *Groundwater Section Guidelines for The Investigation and Remediation of Soil and Groundwater, Division of Water Quality, Groundwater Section, July 2000 (2000 Guidelines)*
- *Guidelines for Assessment and Corrective Action, Division of Waste Management, Underground Storage Tank Section, July 1, 2001 (2001 Guidelines)*
- *UST Section Guidelines for Sampling, Division of Waste Management, Underground Storage Tank Section, Version 1.2, September 1, 2003 (2003 Guidelines for Sampling)*

Complete citations for these references are contained in Section 9.0 of this *Program Strategy Plan* document and copies of relevant sections of these references are contained in Appendices A through C.

Lastly, at sites where active remediation systems are being constructed and operated, permits and registrations issued by NCDENR may include requirements for monitoring of the following discharges:

Air Emissions to Atmosphere

Wastewater to Public Owned Treatment Works (POTW) Pursuant to Pre-Treatment Permit

Wastewater to Land Pursuant to Non-Discharge Permit

Wastewater to Surface Water Pursuant to NPDES Permit

Each of the above-referenced project documents, regulatory rules and guidelines, and permits and registrations will be consulted for information in the process of selecting monitoring schedules, monitoring points and target parameters. This information will be coupled with general guidelines contained in the following Sections 7.1 through 7.3 in developing site-specific monitoring plans to be included in the *Monitoring Plan* and in making recommendations for modifications to the *Monitoring Plan* via *Management Recommendations Reports*.

7.1 ESTABLISHING MONITORING SCHEDULES

In general, monitoring schedules will be established based on site priority rankings, site risk classifications, remediation system operations, approved Corrective Action Plans (CAPs), and permit requirements. Additional guidance which may be used in establishing schedules is found in the *2000 Guidelines* and in the *2001 Guidelines*. Since schedules for checking the operation and maintenance of remediation system equipment will likely be dictated by site-specific O & M Manuals, which may require frequent (weekly or biweekly) inspections, these schedules will be considered independent of the environmental monitoring schedules covered by the *Program*.

Sites ranked as "high risk" sites (as defined in *15A NCAC 2L .0115*) and sites with active remediation systems may be monitored on a quarterly basis with two of the four quarterly events each year coinciding with seasonal high and seasonal low water table conditions, respectively. At MCB Camp Lejeune, the quarterly monitoring events will take place in October, January (seasonal high water table), April and July (seasonal low water table).

For "intermediate risk" sites and "low risk" sites (as defined in *15A NCAC 2L .0115*), monitoring will typically take place on an annual or semi-annual basis with events in January and July. Depending upon the operational characteristics and history of the product recovery system, quarterly monitoring of product recovery rates/volume and system downtime may be specified.

7.2 SELECTING MONITORING POINTS

In most cases, only a select number of available monitoring points require periodic sampling in order to meet the goals outlined in Section 6.1. In general, dissolved-phase plume monitoring at sites with large plumes will require sampling of more than ten monitoring wells. Moderate plumes will typically be monitored using five to ten monitoring wells. Small plumes will typically be monitored using less than five monitoring wells. Specific wells will be selected to track potential horizontal migration of dissolved-phase and free-phase product plumes upgradient, crossgradient, and downgradient; monitor degradation of the plume "interior"; and provide adequate "early warning" in the presence of downgradient receptors.

With respect to active remediation systems, monitoring points may be specified by operating permits, RAC Workplans and/or remediation system specifications. Although the *Program* is not intended to cover monitoring of the operation and maintenance of remediation equipment per se, field measurements and sampling performed for the purpose of satisfying objectives listed in Section 6.1 will be managed by the *Program*.

Additional guidance for selection of monitoring points is contained in the *2000 Guidelines* and the *2001 Guidelines*.

7.3 TARGETING FIELD AND LABORATORY PARAMETERS

Field data collected will typically consist of product thickness, depth to water, groundwater pH, specific conductance, and groundwater temperature in each monitoring well selected for the monitoring program. Sites for which natural degradation and attenuation has been selected as the remediation strategy may also be targeted for other parameters such as redox potential, total organic carbon, or dissolved oxygen measurements.

With respect to sites with active remediation systems, field measurements may be dictated by requirements imposed by operating permits such as flow rates and volatile organic compound (VOC) concentrations for air emissions and flow rates (and possible pH, temperature, and dissolved oxygen) for wastewater effluent.

With respect to groundwater sample analysis, guidelines are specified in *15A NCAC 2L .0115 (o)*; Section 7.0 and Tables 10 and 11 of the *2001 Guidelines* for USTs, Tables 9 and 10 of the *2003 Guidelines for Sampling*; and Section 8.0 and Table 5 of the *2000 Guidelines* for non-USTs. Parameters to be included in the analysis of wastestreams from active remediation systems will typically be specified by the discharge permit and may include parameters such as oil and grease, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) for wastewater effluent. Benzene, toluene, ethylbenzene, xylenes (BTEX) and/or total VOCs may be specified for air emissions.

8.0 STRATEGY FOR SITE CLOSURE

Guidance to be used in evaluating a site for purposes of closure are found at paragraphs *15A NCAC 2L.0115 (f), (g), and (h)*; and Section 4.7 of the *2001 Guidelines* for USTs and Section 9.0 of the *2000 Guidelines* for non-USTs. In general, sites will be considered qualified for closure based on the following guidelines:

8.1 FREE PRODUCT SITES

For sites at which free product has been detected; no measurable (>0.125 inches; 0.01 feet) free product detected for four consecutive quarterly or semi-annual monitoring events over a period not to exceed two years and not less than one year.

8.2 GROUNDWATER REMEDIATION SITES

8.2.1 High Risk UST Sites

For high risk UST sites as determined by *15A NCAC 2L.0115 (d) (1)*, the requirements of paragraph (f) of the Rule shall apply. The goal of groundwater remediation shall be restoration to the levels of *15A NCAC 2L.0202* as closely thereto as is economically and technologically feasible and natural attenuation shall be used to the maximum extent possible.

8.2.2 Intermediate Risk UST Sites

For intermediate risk sites as determined by paragraph *15A NCAC 2L.0115 (d) (2)*, the requirements of paragraph (g) of the Rule shall apply. The goal of groundwater remediation shall be, at a minimum, 50 percent of the solubility of the contaminant at 25 degrees Celsius or 1,000 times the groundwater standard or interim standard as established in *15A NCAC 2L.0202*, except ethylene dibromide, benzene and alkane and aromatic carbon fractions. Ethylene dibromide and benzene shall be cleaned up to a level of 1,000 times the federal drinking water standard. In addition, the responsible party shall demonstrate that the cleanup levels are sufficient to prevent a violation of the following: 1) the surface water standards contained in *15A NCAC 2B*; 2) the *15A NCAC 2L.0202* standards in a deep aquifer as defined in *15A NCAC 2L.0115*; and 3) the *15A NCAC 2L.0202* standards at a location no closer than one year time of travel upgradient of a designated wellhead protection area. Natural attenuation shall be used to the maximum extent possible.

8.2.3 Non-UST Sites

For non-UST sites, the requirements of 15A NCAC 2L .0106 shall apply. The goal of groundwater remediation shall be restoration to the levels of 15A NCAC 2L .0202 or as economically and technologically feasible.

8.2.4 Active Remediation Systems

In general to obtain site closure for on-going active remediation systems, the groundwater remediation goals as established above, must be met and remain so for four consecutive quarterly or semi-annual monitoring events over a period not exceeding two years and not less than one year. After remediation system shut down, the groundwater remediation goals as established above must be met and remain so for four consecutive quarterly or semi-annual monitoring events over a period not exceeding two years and not less than one year.

8.2.5 Natural Attenuation Sites

In general, to obtain site closure for natural attenuation sites, the groundwater remediation goals as established above must be met and remain so for four consecutive quarterly or semi-annual monitoring events over a period not to exceed two years and not less than one year.

8.3 VADOSE (SOIL) CONTAMINATION SITES

For sites at which vadose contamination is present, demonstration via sample collection and analysis that soil contamination has been remediated in accordance with 15A NCAC 2L .0115 (i) and Section 4.4 of the *2001 Guidelines* for USTs and Section 5.0 of the *2000 Guidelines* for non-USTs, whichever is applicable. Laboratory methods for analysis of soil samples are specified in 15A NCAC 2L .0115 (n) and Section 6.0 and Tables 5, 6, and 7 of the *2001 Guidelines* for USTs, Tables 1 and 2 of the *2003 Guidelines for Sampling*, and Section 6.0 and Tables 1 and 2 of the *2000 Guidelines* for non-USTs.

8.3.1 High or Intermediate Risk UST Sites

For high or intermediate risk sites as determined by 15A NCAC 2L .0115 (d) (1) or (d) (2), the requirements of paragraph (i) (4) of the Rule shall apply. Soil contamination must be remediated to the lowest of the following:

- 1) the residential or industrial/commercial maximum soil contaminant concentration, whichever is applicable; or
- 2) the soil-to-groundwater maximum soil contaminant concentration.

8.3.2 Low Risk UST Sites

For low risk UST sites as determined by 15A NCAC 2L.0115 (d) (3), the requirements of paragraph (i) (3) of the rule shall apply. Soil contamination must be remediated to either the residential or industrial/commercial maximum soil contaminant concentration, whichever is applicable.

8.3.3 Non-UST Sites

For non-UST sites, the requirements of Section 5.0 and Table 3 of the *2000 Guidelines* shall apply. Contaminated soil must be cleaned up to the residential or soil-to-groundwater maximum contaminant concentrations, whichever are lower.

8.4 "LOW RISK" SITES

Any low risk site, as determined by 15A NCAC 2L .0115 (d) (3), will be considered qualified for closure.

8.5 NOTICE OF RESIDUAL PETROLEUM OR LAND USE RESTRICTIONS

Any site that is considered qualified for closure where soil or groundwater contamination has not been remediated to "unrestricted use standards" is required by the North Carolina General Statute (NCGS) 143B-279.9 and 143B-279.11 to file a Notice of Residual Petroleum (Land Use Restrictions) with the Register of Deeds in the county where the release is located. The Notice is required prior to the site receiving a Notice of No Further Action for a release if soil contamination caused by the release has not been remediated to below the residential maximum soil contaminant concentrations established in Title 15A NCAC 2L.0115 (m) or if groundwater contamination caused by the release has not been remediated to below the Title 15A NCAC 2L.0202 groundwater quality standards or interim standards.

9.0 REFERENCES

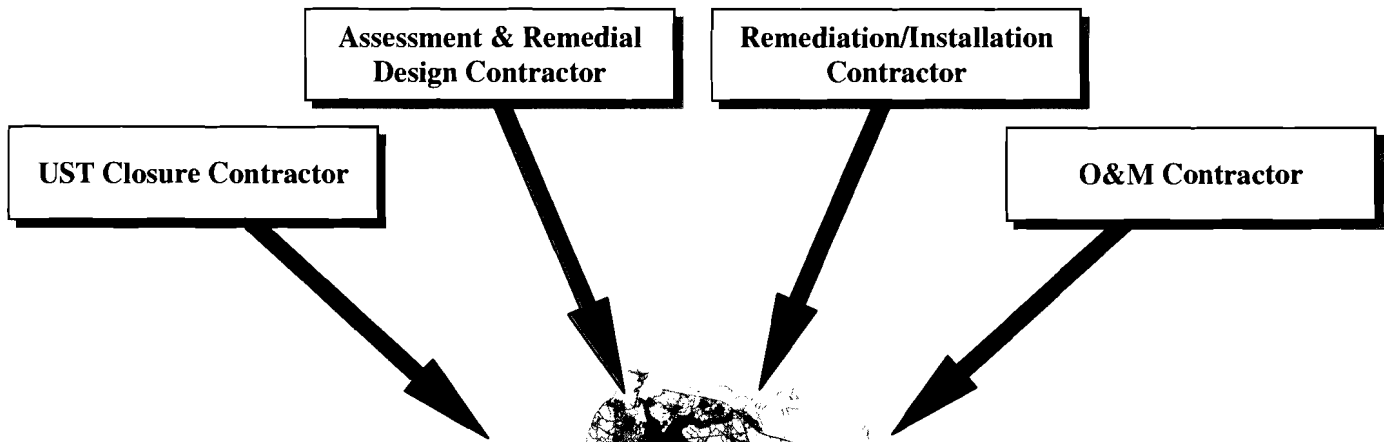
- Environmental Management Commission, Raleigh, North Carolina, *15A NCAC 2L Classifications and Groundwater Quality Standards*, Amended effective December 30, 1983.
- Marine Corps Base Camp Lejeune, *Final Contractor Electronic Data Deliverable Standards And Procedures*, Environmental Management Division, Marine Corps Base Camp Lejeune, August 1, 2004.
- North Carolina Department of Environment and Natural Resources, *15A NCAC 2L.0115 Risk-Based Assessment and Corrective Action For Petroleum Underground Storage Tanks*, Amended effective October 29, 1998.
- State of North Carolina, Department of Environment and Natural Resources, Division of Waste Management, Underground Storage Tank Section, *Guidelines for Assessment and Corrective Action*, July 1, 2001.
- State of North Carolina, Department of Environment and Natural Resources, Division of Water Quality, Groundwater Section, *Groundwater Section Guidelines For The Investigation and Remediation of Soil and Groundwater*, July 2000.
- State of North Carolina, Department of Environment and Natural Resources, Division of Waste Management, Underground Storage Tank Section, *UST Section, Guidelines for Sampling*, Version 1.2, September 1, 2003.

FIGURES

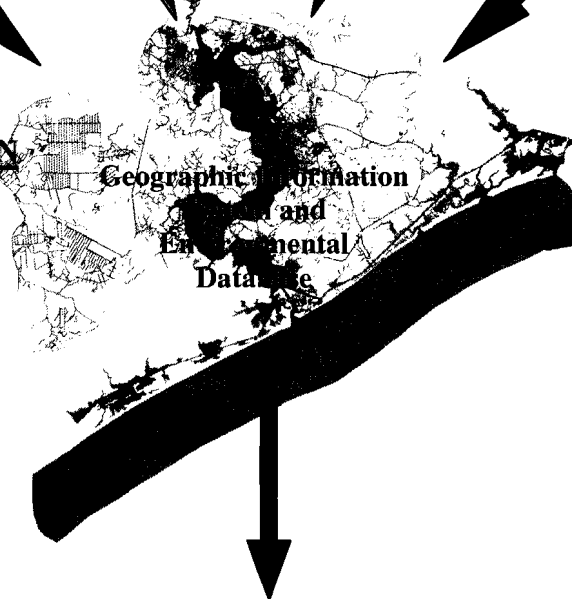
FIGURE 1
CONCEPTUAL OVERVIEW

MCB CAMP LEJEUNE
UST MANAGEMENT PROGRAM

STEP 1 DATA COLLECTION



STEP 2 DATA ORGANIZATION AND STORAGE



STEP 3 PRESENTATION OF DATA FINDINGS AND CONCLUSIONS

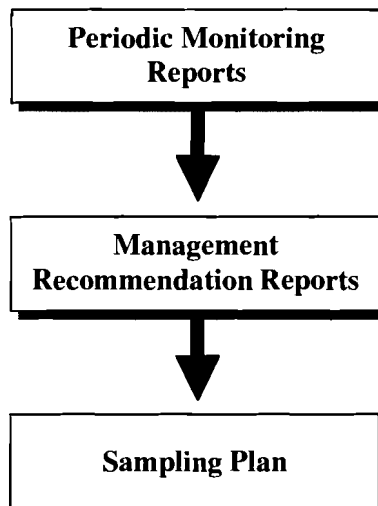
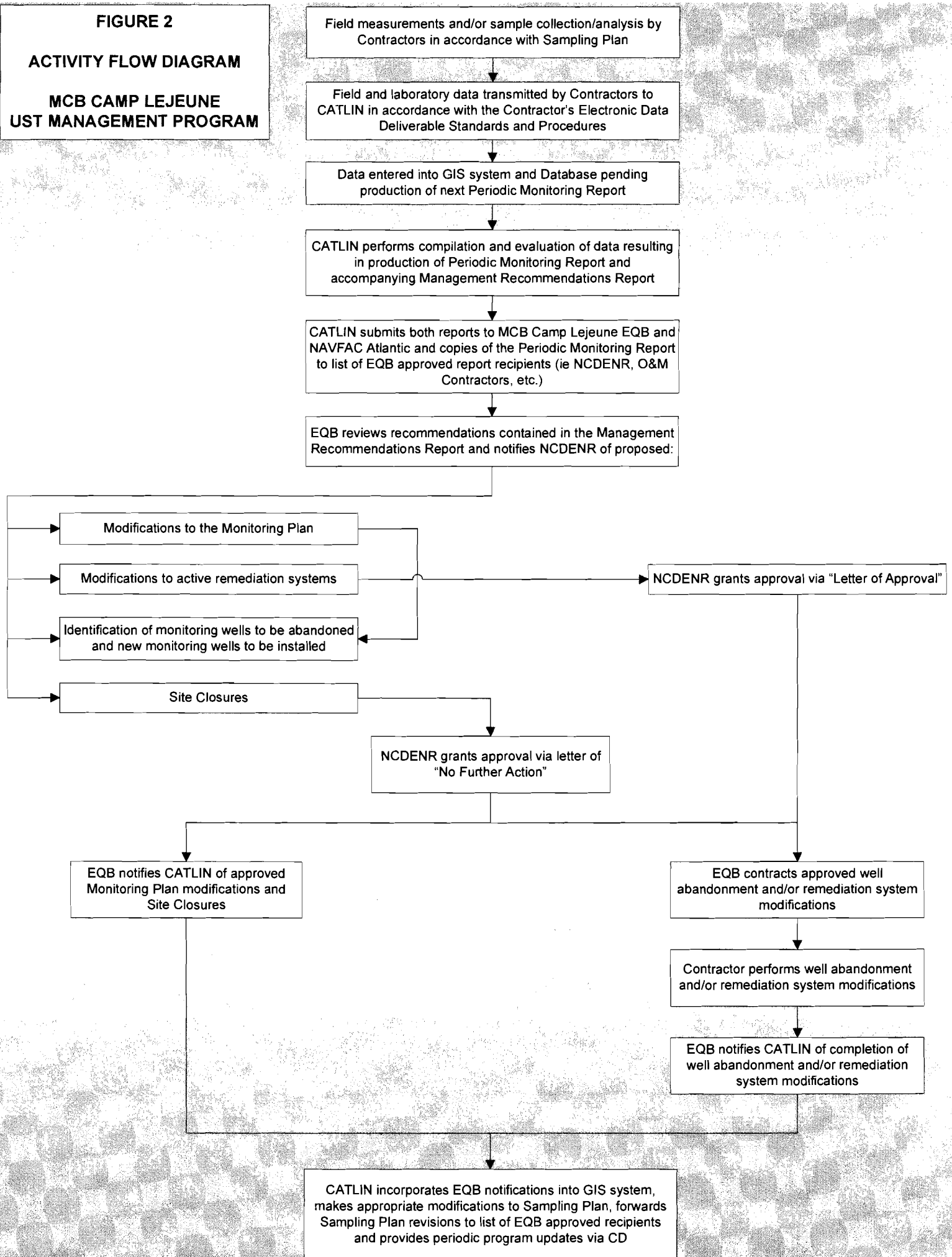


FIGURE 2

ACTIVITY FLOW DIAGRAM

**MCB CAMP LEJEUNE
UST MANAGEMENT PROGRAM**



APPENDIX A

15A NCAC 2L GROUNDWATER CLASSIFICATIONS AND STANDARDS [SECTION.0202]

NORTH CAROLINA ADMINISTRATIVE CODE**TITLE 15A
DEPARTMENT OF ENVIRONMENT, HEALTH, AND
NATURAL RESOURCES****SUBCHAPTER 2L - GROUNDWATER CLASSIFICATIONS AND
STANDARDS****SECTION .0100 - GENERAL CONSIDERATIONS**

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**APPENDIX # 1 - INTERIM MAXIMUM ALLOWABLE CONCENTRATIONS
FOR NORTH CAROLINA GROUNDWATERS (Pages 1 - 2)**

SUBCHAPTER 2L - GROUNDWATER CLASSIFICATION AND STANDARDS

SECTION .0100 - GENERAL CONSIDERATIONS

15A NCAC 02L .0101 AUTHORIZATION

(a) N.C. General Statute 143-214.1 directs that the Commission develop and adopt after proper study a series of classifications and standards which will be appropriate for the purpose of classifying each of the waters of the state in such a way as to promote the policy and purposes of the act. Pursuant to this statute, the rules in this Subchapter establish a series of classifications and water quality standards applicable to the groundwaters of the state.

(b) These rules are applicable to all activities or actions, intentional or accidental, which contribute to the degradation of groundwater quality, regardless of any permit issued by a governmental agency authorizing such action or activity except an innocent landowner who is a bona fide purchaser of property which contains a source of groundwater contamination, who purchased such property without knowledge or a reasonable basis for knowing that groundwater contamination had occurred, or a person whose interest or ownership in the property is based or derived from a security interest in the property, shall not be considered a responsible party.

History Note: Authority G.S. 143-214.1; 143-214.2; 143-215.3(a)(1); 143B-282;

Eff. June 10, 1979;

Amended Eff. August 1, 1989; July 1, 1988; September 1, 1984; December 30, 1983.

15A NCAC 02L .0102 DEFINITIONS

The definition of any word or phrase used in these Rules shall be the same as given in G.S. 143-212 and G.S. 143-213 except that the following words and phrases shall have the following meanings:

- (1) "Bedrock" means any consolidated rock encountered in the place in which it was formed or deposited and which cannot be readily excavated without the use of explosives or power equipment.
- (2) "Commission" means the Environmental Management Commission as organized under G.S. 143B.
- (3) "Compliance boundary" means a boundary around a disposal system at and beyond which groundwater quality standards may not be exceeded and only applies to facilities which have received a permit issued under the authority of G.S. 143-215.1 or G.S. 130A.
- (4) "Contaminant" means any substance occurring in groundwater in concentrations which exceed the groundwater quality standards specified in Rule .0202 of this Subchapter.
- (5) "Corrective action plan" means a plan for eliminating sources of groundwater contamination or for achieving groundwater quality restoration or both.
- (6) "Director" means Director of the Division of Environmental Management.
- (7) "Division" means the Division of Environmental Management.

- (8) "Exposure pathway" means a course taken by a contaminant by way of a transport medium after its release to the environment.
- (9) "Free product" means a non-aqueous phase liquid which may be present within the saturated zone or in surface water.
- (10) "Fresh groundwaters" means those groundwaters having a chloride concentration equal to or less than 250 milligrams per liter.
- (11) "Groundwaters" means those waters occurring in the subsurface under saturated conditions.
- (12) "Hazardous substance" means any substance as defined by Section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA).
- (13) "Licensed geologist" means a person who has been duly licensed as a geologist in accordance with the requirements of G.S. 89E.
- (14) "Natural remediation" means those natural processes acting to restore groundwater quality, including dilution, filtration, sorption, ion-exchange, chemical transformation and biodegradation.
- (15) "Practical Quantitation Limit" means the lowest concentration of a given material that can be reliably achieved among laboratories within specified limits of precision and accuracy by a given analytical method during routine laboratory analysis.
- (16) "Natural conditions" means the physical, biological, chemical and radiological conditions which occur naturally.
- (17) "Potable waters" means those waters suitable for drinking by humans.
- (18) "Professional Engineer" means a person who has been duly registered and licensed as a professional engineer in accordance with the requirements of G.S. 89C.
- (19) "Receptor" means any human, plant, animal, or structure which is, or has the potential to be, adversely effected by the release or migration of contaminants. Any well constructed for the purpose of monitoring groundwater and contaminant concentrations shall not be considered a receptor.
- (20) "Review boundary" means a boundary around a permitted disposal facility, midway between a waste boundary and a compliance boundary at which groundwater monitoring is required.
- (21) "Saline groundwaters" means those groundwaters having a chloride concentration of more than 250 mg/l.
- (22) "Saturated zone" means that part of the subsurface below the water table in which all the interconnected voids are filled with water under pressure at or greater than atmospheric. It does not include the capillary fringe.
- (23) "Standards" means groundwater quality standards as specified in Rule .0202 of this Subchapter.
- (24) "Suitable for drinking" means a quality of water which does not contain substances in concentrations which, either singularly or in combination if ingested into the human body, may cause death, disease, behavioral abnormalities, congenital defects, genetic mutations, or result in an incremental lifetime cancer risk in excess of 1×10^{-6} , or render the water unacceptable due to aesthetic qualities, including taste, odor or appearance.

- (25) "Time of travel" means the time required for contaminants in groundwater to move a unit distance.
- (26) "Waste boundary" means the perimeter of the permitted waste disposal area.
- (27) "Water table" means the surface of the saturated zone below which all interconnected voids are filled with water and at which the pressure is atmospheric.

History Note: Authority G.S. 143-214.1; 143-215; 143B-282;

Eff. June 10, 1979.

Amended Eff. October 1, 1993; August 1, 1989; July 1, 1988; March 1, 1985.

15A NCAC 02L .0103 POLICY

(a) The rules established in this Subchapter are intended to maintain and preserve the quality of the groundwaters, prevent and abate pollution and contamination of the waters of the state, protect public health, and permit management of the groundwaters for their best usage by the citizens of North Carolina. It is the policy of the Commission that the best usage of the groundwaters of the state is as a source of drinking water. These groundwaters generally are a potable source of drinking water without the necessity of significant treatment. It is the intent of these Rules to protect the overall high quality of North Carolina's groundwaters to the level established by the standards and to enhance and restore the quality of degraded groundwaters where feasible and necessary to protect human health and the environment, or to ensure their suitability as a future source of drinking water.

(b) It is the intention of the Commission to protect all groundwaters to a level of quality at least as high as that required under the standards established in Rule .0202 of this Subchapter. In keeping with the policy of the Commission to protect, maintain, and enhance groundwater quality within the State of North Carolina, the Commission will not approve any disposal system subject to the provisions of G.S. 143-215.1 which would result in:

- (1) the significant degradation of groundwaters which have existing quality that is better than the assigned standard, unless such degradation is found to be in the best interests of the citizens of North Carolina based upon the projected economic benefits of the facility and a determination that public health will be protected, or
- (2) a violation of a groundwater quality standard beyond a designated compliance boundary, or
- (3) the impairment of existing groundwater uses or increased risk to the health or safety of the public due to the operation of a waste disposal system.

(c) Violations of standards resulting from groundwater withdrawals which are in compliance with water use permits issued pursuant to G.S. 143-215.15, shall not be subject to the corrective action requirements of Rule .0106 of this Subchapter.

(d) No person shall conduct or cause to be conducted, any activity which causes the concentration of any substance to exceed that specified in Rule .0202 of this Subchapter, except as authorized by the rules of this Subchapter.

(e) Work that is within the scope of the practice of geology and engineering, performed pursuant to the requirements of this Subchapter, which involves site assessment, the interpretation of subsurface geologic conditions, preparation of conceptual corrective action plans or any work

requiring detailed technical knowledge of site conditions which is submitted to the Director, shall be performed by persons, firms or professional corporations who are duly licensed to offer geological or engineering services by the appropriate occupational licensing board or are exempted from such licensing by G.S. 89E-6. Work which involves design of remedial systems or specialized construction techniques shall be performed by persons, firms or professional corporations who are duly licensed to offer engineering services. Corporations that are authorized by law to perform engineering or geological services and are exempt from the Professional Corporation Act, G.S. 55B, may perform these services.

History Note: Authority G.S. 143-214; 143-214.1; 143-214.2; 143-215.3(e); 143-215.3(a)(1); 143B-282;

Eff. June 10, 1979;

Amended Eff. August 1, 1989; July 1, 1988; September 1, 1984; December 30, 1983;

RRC Objection Eff. September 17, 1993, due to lack of necessity for Paragraph (e);

Amended Eff. November 4, 1993.

15A NCAC 02L .0104 RESTRICTED DESIGNATION (RS)

(a) The RS designation serves as a warning that groundwater so designated may not be suitable for use as a drinking water supply without treatment. The designation is temporary and will be removed by the Director upon a determination that the quality of the groundwater so designated has been restored to the level of the applicable standards or when the groundwaters have been reclassified by the Commission. The Director is authorized to designate GA or GSA groundwaters as RS under any of the following circumstances:

- (1) Where, as a result of man's activities, groundwaters have been contaminated and the Director has approved a corrective action plan, or termination of corrective action, that will not result in the immediate restoration of such groundwaters to the standards established under this Subchapter.
- (2) Where a statutory variance has been granted as provided in Rule .0113 of this Subchapter.

(b) Groundwaters occurring within an area defined by a compliance boundary in a waste disposal permit are deemed to be designated RS.

(c) The boundary of a designated RS area may be approximated in the absence of analytical data sufficient to define the dimension of the area. The boundary shall be located at least 250 feet away from the predicted edge of the contaminant plume, and shall include any areas into which the contamination is expected to migrate.

(d) In areas designated RS, the person responsible for groundwater contamination shall establish and implement a groundwater monitoring system sufficient to detect changes in groundwater quality within the RS designated area. Monitoring shall be quarterly for the first year and may be reduced to semi-annually thereafter until the applicable standards have been achieved. If during the monitoring period, contaminant concentrations increase, additional remedial action or monitoring pursuant to these Rules may be required.

(e) The applicant for an RS designation shall also provide written verification that all property owners within and adjacent to the proposed RS area have been notified of the requested RS designation.

(f) The Division shall provide public notice of the intent to designate any groundwater RS in accordance with the following requirements:

- (1) Notice shall be published at least 30 days prior to any proposed final action in accordance with G.S. 143-215.4. In addition, notice shall be provided to all property owners identified pursuant to Paragraph (e) of this Rule and to the local County Health Director and the chief administrative officer of the political jurisdiction(s) in which the contamination occurs.
- (2) The notice shall contain the following information:
 - (A) name, address, and phone number of the agency issuing the public notice;
 - (B) the location and extent of the designated area;
 - (C) the county title number, county tax identification number, or the property tax book and page identifiers;
 - (D) a brief description of the action or actions which resulted in the degradation of groundwater in the area;
 - (E) actions or intended actions taken to restore groundwater quality;
 - (F) the significance of the RS designation;
 - (G) conditions applicable to removal of the RS designation;
 - (H) address and phone number of a Division contact from whom interested parties may obtain further information.
- (3) The Director shall consider all requests for a public hearing, and if he determines that there is significant public interest he shall issue public notice and hold a public hearing in accordance with G.S. 143-215.4(b) and Rule .0113(e) of this Section.
- (4) These requirements shall not apply to groundwaters defined in Paragraph (b) of this Rule.

History Note: Authority G.S. 143-214.1; 143-215.3(a)(1); 143B-282(2);

Eff. June 10, 1979;

Amended Eff. October 1, 1993; December 1, 1989; August 1, 1989; December 30, 1983.

15A NCAC 02L .0105

ADOPTION BY REFERENCE

History Note: Authority G.S. 143-214.1;

Eff. December 30, 1983;

Repealed Eff. August 1, 1989.

15A NCAC 02L .0106 CORRECTIVE ACTION

(a) Where groundwater quality has been degraded, the goal of any required corrective action shall be restoration to the level of the standards, or as closely thereto as is economically and technologically feasible. In all cases involving requests to the Director for approval of corrective action plans, or termination of corrective action, the responsibility for providing all information required by this Rule lies with the person(s) making the request.

(b) Any person conducting or controlling an activity which results in the discharge of a waste or hazardous substance or oil to the groundwaters of the State, or in proximity thereto, shall take immediate action to terminate and control the discharge, mitigate any hazards resulting from exposure to the pollutants and notify the Division of the discharge.

(c) Any person conducting or controlling an activity which has not been permitted by the Division and which results in an increase in the concentration of a substance in excess of the standard, other than agricultural operations, shall:

- (1) immediately notify the Division of the activity that has resulted in the increase and the contaminant concentration levels;
- (2) take immediate action to eliminate the source or sources of contamination;
- (3) submit a report to the Director assessing the cause, significance and extent of the violation; and
- (4) implement an approved corrective action plan for restoration of groundwater quality in accordance with a schedule established by the Director, or his designee. In establishing a schedule the Director, or his designee shall consider any reasonable schedule proposed by the person submitting the plan. A report shall be made to the Health Director of the county or counties in which the contamination occurs in accordance with the requirements of Rule .0114(a) in this Section.

(d) Any person conducting or controlling an activity which is conducted under the authority of a permit issued by the Division and which results in an increase in concentration of a substance in excess of the standards:

- (1) at or beyond a review boundary, shall demonstrate, through predictive calculations or modeling, that natural site conditions, facility design and operational controls will prevent a violation of standards at the compliance boundary; or submit a plan for alteration of existing site conditions, facility design or operational controls that will prevent a violation at the compliance boundary, and implement that plan upon its approval by the Director, or his designee.
- (2) at or beyond a compliance boundary, shall assess the cause, significance and extent of the violation of standards and submit the results of the investigation, and a plan and proposed schedule for corrective action to the Director, or his designee. The permittee shall implement the plan as approved by and in accordance with a schedule established by the Director, or his designee. In establishing a schedule the Director, or his designee shall consider any reasonable schedule proposed by the permittee.

(e) For the purposes of Paragraphs (c) and (d) of this Rule, an activity conducted under the authority of a permit issued by the Division, and subject to Paragraph (d) of this Rule, is one for which:

- (1) a permit has been issued pursuant to G.S. 143-215.1;
- (2) the permit was originally issued after December 30, 1983;

- (3) the substance for which a standard has been exceeded outside the compliance boundary has been released to groundwater as a result of the permitted activity;
 - (4) all other activities shall for the purpose of this Rule be deemed not permitted by the Division and subject to the provisions of Paragraph (c) of this Rule.
- (f) Corrective action required following discovery of the unauthorized release of a contaminant to the surface or subsurface of the land, and prior to or concurrent with the assessment required in Paragraphs (c) and (d) of this Rule, shall include, but is not limited to:
- (1) Prevention of fire, explosion or the spread of noxious fumes;
 - (2) Abatement, containment or control of the migration of contaminants;
 - (3) Removal, or treatment and control of any primary pollution source such as buried waste, waste stockpiles or surficial accumulations of free products;
 - (4) Removal, treatment or control of secondary pollution sources which would be potential continuing sources of pollutants to the groundwaters such as contaminated soils and non-aqueous phase liquids. Contaminated soils which threaten the quality of groundwaters must be treated, contained or disposed of in accordance with applicable rules. The treatment or disposal of contaminated soils shall be conducted in a manner that will not result in a violation of standards or North Carolina Hazardous Waste Management rules.
- (g) The site assessment conducted pursuant to the requirements of Paragraph (c) of this Rule, shall include:
- (1) The source and cause of contamination;
 - (2) Any imminent hazards to public health and safety and actions taken to mitigate them in accordance with Paragraph (f) of this Rule;
 - (3) All receptors and significant exposure pathways;
 - (4) The horizontal and vertical extent of soil and groundwater contamination and all significant factors affecting contaminant transport; and
 - (5) Geological and hydrogeological features influencing the movement, chemical, and physical character of the contaminants.

Reports of site assessments shall be submitted to the Division as soon as practicable or in accordance with a schedule established by the Director, or his designee. In establishing a schedule the Director, or his designee shall consider any reasonable proposal by the person submitting the report.

(h) Corrective action plans for restoration of groundwater quality, submitted pursuant to Paragraphs (c) and (d) of this Rule shall include:

- (1) A description of the proposed corrective action and reasons for its selection.
 - (2) Specific plans, including engineering details where applicable, for restoring groundwater quality.
 - (3) A schedule for the implementation and operation of the proposed plan.
 - (4) A monitoring plan for evaluating the effectiveness of the proposed corrective action and the movement of the contaminant plume.
- (i) In the evaluation of corrective action plans, the Director, or his designee shall consider the extent of any violations, the extent of any threat to human health or safety, the extent of damage or potential adverse impact to the environment, technology available to accomplish restoration, the potential for degradation of the contaminants in the environment, the time and costs estimated to achieve groundwater quality restoration, and the public and economic benefits to be derived from groundwater quality restoration.

(j) A corrective action plan prepared pursuant to Paragraph (c) or (d) of this Rule must be implemented using the best available technology for restoration of groundwater quality to the level of the standards, except as provided in Paragraphs (k), (l), (m), (r) and (s) of this Rule.

(k) Any person required to implement an approved corrective action plan for a non-permitted site pursuant to this Rule may request that the Director approve such a plan without requiring groundwater remediation to the standards. A request submitted to the Director under this Paragraph shall include a description of site specific conditions, including information on the availability of public water supplies for the affected area; the technical basis for the request; and any other information requested by the Director to thoroughly evaluate the request. In addition, the person making the request must demonstrate to the satisfaction of the Director:

- (1) that all sources of contamination and free product have been removed or controlled pursuant to Paragraph (f) of this Rule;
- (2) that the time and direction of contaminant travel can be predicted with reasonable certainty;
- (3) that contaminants have not and will not migrate onto adjacent properties, or that:
 - (A) such properties are served by an existing public water supply system dependent on surface waters or hydraulically isolated groundwater, or
 - (B) the owners of such properties have consented in writing to the request;
- (4) that the standards specified in Rule .0202 of this Subchapter will be met at a location no closer than one year time of travel upgradient of an existing or foreseeable receptor, based on travel time and the natural attenuation capacity of subsurface materials or on a physical barrier to groundwater migration that exists or will be installed by the person making the request;
- (5) that, if the contaminant plume is expected to intercept surface waters, the groundwater discharge will not possess contaminant concentrations that would result in violations of standards for surface waters contained in 15A NCAC 2B .0200;
- (6) that public notice of the request has been provided in accordance with Rule .0114(b) of this Section;
- (7) that the proposed corrective action plan would be consistent with all other environmental laws.

(l) Any person required to implement an approved corrective action plan for a non-permitted site pursuant to this Rule may request that the Director approve such a plan based upon natural processes of degradation and attenuation of contaminants. A request submitted to the Director under this Paragraph shall include a description of site specific conditions, including written documentation of projected groundwater use in the contaminated area based on current state or local government planning efforts; the technical basis for the request; and any other information requested by the Director to thoroughly evaluate the request. In addition, the person making the request must demonstrate to the satisfaction of the Director:

- (1) that all sources of contamination and free product have been removed or controlled pursuant to Paragraph (f) of this Rule;
- (2) that the contaminant has the capacity to degrade or attenuate under the site-specific conditions;
- (3) that the time and direction of contaminant travel can be predicted with reasonable certainty;

- (4) that contaminant migration will not result in any violation of applicable groundwater standards at any existing or foreseeable receptor;
 - (5) that contaminants have not and will not migrate onto adjacent properties, or that:
 - (A) such properties are served by an existing public water supply system dependent on surface waters or hydraulically isolated groundwater, or
 - (B) the owners of such properties have consented in writing to the request;
 - (6) that, if the contaminant plume is expected to intercept surface waters, the groundwater discharge will not possess contaminant concentrations that would result in violations of standards for surface waters contained in 15A NCAC 2B .0200;
 - (7) that the person making the request will put in place a groundwater monitoring program sufficient to track the degradation and attenuation of contaminants and contaminant by-products within and down gradient of the plume and to detect contaminants and contaminant by-products prior to their reaching any existing or foreseeable receptor at least one year's time of travel upgradient of the receptor and no greater than the distance the groundwater at the contaminated site is predicted to travel in five years;
 - (8) that all necessary access agreements needed to monitor groundwater quality pursuant to Subparagraph (7) of this Paragraph have been or can be obtained;
 - (9) that public notice of the request has been provided in accordance with Rule .0114(b) of this Section; and
 - (10) that the proposed corrective action plan would be consistent with all other environmental laws.
- (m) The Division or any person required to implement an approved corrective action plan for a non-permitted site pursuant to this Rule may request that the Director approve termination of corrective action.
- (1) A request submitted to the Director under this Paragraph shall include:
 - (A) a discussion of the duration of the corrective action, the total project's cost, projected annual cost for continuance and evaluation of the success of the corrective action;
 - (B) an evaluation of alternate treatment technologies which could result in further reduction of contaminant levels projected capital and annual operating costs for each technology;
 - (C) effects, including health and safety impacts, on groundwater users if contaminant levels remain at levels existing at the time corrective action is terminated; and
 - (D) any other information requested by the Director to thoroughly evaluate the request.
 - (2) In addition, the person making the request must demonstrate to the satisfaction of the Director:
 - (A) that continuation of corrective action would not result in a significant reduction in the concentration of contaminants (At a minimum this demonstration must show the duration and degree of success of existing remedial efforts to attain standards and include a showing that the asymptotic slope of the contaminants curve of decontamination is less than a ratio of 1:40 over a term of one year based on quarterly sampling);

- (B) that contaminants have not and will not migrate onto adjacent properties, or that:
 - (i) such properties are served by an existing public water supply system dependent on surface waters or hydraulically isolated groundwater, or
 - (ii) the owners of such properties have consented in writing to the request;
 - (C) that, if the contaminant plumes expected to intercept surface waters, the groundwater discharge will not possess contaminant concentrations that would result in violations of standards for surface waters contained in 15A NCAC 2B .0200;
 - (D) that public notice of the request has been provided in accordance with Rule .0114(b) of this Section; and
 - (E) that the proposed termination would be consistent with all other environmental laws.
- (3) The Director shall not authorize termination of corrective action for any area that, at the time the request is made, has been identified by a state or local groundwater use planning process for resource development.
 - (4) The Director may authorize the termination of corrective action, or amend the corrective action plan after considering all the information in the request. Upon termination of corrective action, the Director shall require implementation of a groundwater monitoring program sufficient to track the degradation and attenuation of contaminants at a location of at least one year's predicted time of travel upgradient of any existing or foreseeable receptor. The monitoring program shall remain in effect until there is sufficient evidence that the contaminant concentrations have been reduced to the level of the standards.
- (n) Upon a determination by the Director that continued corrective action would result in no significant reduction in contaminant concentrations, and the contaminated groundwaters can be rendered potable by treatment using readily available and economically reasonable technologies, the Director may designate the remaining area of degraded groundwater RS. Where the remaining degraded groundwaters cannot be made potable by such treatment, the Director may consider a request for reclassification of the groundwater to a GC classification as outlined in Rule .0201 of this Subchapter.
- (o) If at any time the Director determines that a new technology is available that would remediate the contaminated groundwater to the standards specified in Rule .0202 of this Subchapter, the Director may require the responsible party to evaluate the economic and technological feasibility of implementing the new technology in an active groundwater corrective action plan in accordance with a schedule established by the Director. The Director's determination to utilize new technology at any site or for any particular constituent shall include a consideration of the factors in Paragraph (h) of this Rule.
- (p) Where standards are exceeded as a result of the application of pesticides or other agricultural chemicals, the Director shall request the Pesticide Board or the Department of Agriculture to assist the Division of Environmental Management in determining the cause of the violation. If the violation is determined to have resulted from the use of pesticides, the Director shall request the Pesticide Board to take appropriate regulatory action to control the use of the chemical or chemicals responsible for, or contributing to, such violations, or to discontinue their use.

(q) The approval pursuant to this Rule of any corrective action plan, or modification or termination thereof, which permits the migration of a contaminant onto adjacent property, shall not affect any private right of action by any party which may be effected by that contamination.

(r) If a discharge or release is not governed by 15A NCAC 2L .0115 and the increase in the concentration of a substance in excess of the standard resulted in whole or in part from a release from a commercial or noncommercial underground storage tank as defined in G.S. 143-215.94A, any person required to implement an approved corrective action plan pursuant to this Rule and seeking reimbursement for the Commercial or Noncommercial Leaking Petroleum Underground Storage Tank Cleanup Funds shall implement a corrective action plan meeting the requirements of Paragraph (k) or (l) of this Rule unless such a person demonstrates to the Director that:

- (1) contamination resulting from the discharge cannot qualify for approval of a plan based on the requirements of the Paragraphs; or
- (2) the cost of making such a demonstration would exceed the cost of implementing a corrective action plan submitted pursuant to Paragraph (c) of this Rule.

(s) If a discharge or release is not governed by 15A NCAC 2L .0115 and the increase in the concentration of a substance in excess of the standard resulted in whole or in part from a release from a commercial or noncommercial underground storage tank as defined in G.S. 143-215.94A, the Director may require any person implementing or operating a previously approved corrective action plan pursuant to this Rule to:

- (1) develop and implement a corrective action plan meeting the requirements of Paragraphs (k) and (l) of this Rule; or
- (2) seek discontinuance of corrective action pursuant to Paragraph (m) of this Rule.

*History Note: Authority G.S. 143-215.2; 143-215.3(a)(1); 143-215.94A; 143-215.94T; 143-215.94V; 143B-282;
1995 (Reg. Sess. 1996) c. 648, s. 1;
Eff. August 1, 1989;
Amended Eff. October 1, 1993; September 1, 1992;
Temporary Amendment Eff. January 2, 1998; January 2, 1996;
Amended Eff. October 29, 1998.*

15A NCAC 02L .0107 COMPLIANCE BOUNDARY

(a) For disposal systems individually permitted prior to December 30, 1983, the compliance boundary is established at a horizontal distance of 500 feet from the waste boundary or at the property boundary, whichever is closer to the source.

(b) For disposal systems individually permitted on or after December 30, 1983, a compliance boundary shall be established 250 feet from the waste boundary, or 50 feet within the property boundary, whichever point is closer to the source.

(c) The boundary shall be established by the Director, or his designee at the time of permit issuance. Any sale or transfer of property which affects a compliance boundary shall be reported immediately to the Director, or his designee. For disposal systems which are not governed by Paragraphs (e) or (f) of this Rule, the compliance boundary affected by the sale or transfer of property will be re-established consistent with Paragraphs (a) or (b) of this Rule, whichever is applicable.

(d) Except as provided in Paragraph (g) of this Rule, no water supply wells shall be constructed or operated within the compliance boundary of a disposal system individually permitted or repermitted after January 1, 1993.

(e) Except as provided in Paragraph (g) of this Rule, a permittee shall not transfer land within an established compliance boundary of a disposal system permitted or repermitted after January 1, 1993 unless:

- (1) the land transferred is serviced by a community water system as defined in 15A NCAC 18C, the source of which is located outside the compliance boundary; and
- (2) the deed transferring the property:
 - (A) contains notice of the permit, including the permit number, a description of the type of permit, and the name, address and telephone number of the permitting agency; and
 - (B) contains a restrictive covenant running with the land and in favor of the permittee and the State, as a third party beneficiary, which prohibits the construction and operation of water supply wells within the compliance boundary; and
 - (C) contains a restrictive covenant running with the land and in favor of the permittee and the State, as a third party beneficiary, which grants the right to the permittee and the State to enter on such property within the compliance boundary for groundwater monitoring and remediation purposes.

(f) Except as provided in Paragraph (g) of this Rule, if at the time a permit is issued or reissued after January 1, 1993, the permittee is not the owner of the land within the compliance boundary, it shall be a condition of the permit issued or renewed that the landowner of the land within the compliance boundary, if other than the permittee, execute and file in the Register of Deeds in the county in which the land is located, an easement running with the land which:

- (1) contains:
 - (A) either a notice of the permit, including the permit number, a description of the type of permit, and the name, address and telephone number of the permitting agency; or
 - (B) a reference to a notice of the permit with book and page number of its recordation if such notice is required to be filed by statute;
- (2) prohibits the construction and operation of water supply wells within the compliance boundary; and
- (3) reserves the right to the permittee and the State to enter on such property within the compliance boundary for groundwater monitoring and remediation purposes. The easement may be terminated by the Director when its purpose has been fulfilled or the need for the easement no longer exists. Under those conditions the Director shall, upon request by the landowner, file a document terminating the easement with the appropriate Register of Deeds.

(g) The requirements of Paragraphs (d), (e) and (f) of this Rule are not applicable to ground adsorption treatment systems serving four or fewer single family dwellings or multiunit dwellings of four or fewer units.

(h) The boundary shall form a vertical plane extending from the water table to the maximum depth of saturation.

(i) For ground absorption sewage treatment and disposal systems which are permitted under 15A NCAC 18A .1900, the compliance boundary shall be established at the property boundary.

(j) Penalties authorized pursuant to G.S. 143-215.6A(a)(1) will not be assessed for violations of standards within a compliance boundary unless the violations are the result of violations of permit conditions or negligence in the management of the facility.

(k) The Director shall require:

- (1) that permits for all activities governed by G.S. 143-215.1 be written to protect the quality of groundwater established by applicable standards, at the compliance boundary;
- (2) that necessary groundwater quality monitoring shall be conducted within the compliance boundary; and
- (3) that a violation of standards within the compliance boundary resulting from activities conducted by the permitted facility be remedied through clean-up, recovery, containment, or other response when any of the following conditions occur:
 - (A) a violation of any standard in adjoining classified groundwaters occurs or can be reasonably predicted to occur considering hydrogeologic conditions, modeling, or other available evidence;
 - (B) an imminent hazard or threat to the public health or safety exists; or
 - (C) a violation of any standard in groundwater occurring in the bedrock other than limestones found in the Coastal Plain sediments, unless it can be demonstrated that the violation will not adversely affect, or have the potential to adversely affect a water supply well.

*History Note: Authority G.S. 143-215.1(b); 143-215.3(a)(1); 143B-282;
Eff. August 1, 1989;
Amended Eff. October 1, 1993; November 2, 1992.*

15A NCAC 02L .0108 REVIEW BOUNDARY

A review boundary is established around any disposal system midway between the compliance boundary and the waste boundary. When the concentration of any substance equals or exceeds the standard at the review boundary as determined by monitoring, the permittee shall take action in accordance with the provisions of Rule .0106(c)(2)(A) of this Subchapter.

*History Note: Authority G.S. 143-215.1(b); 143-215.3(a)(1); 143B-282;
Eff. August 1, 1989.*

15A NCAC 02L .0109 DELEGATION

(a) The Director is delegated the authority to enter into consent special orders under G.S. 143-215.2 for violations of the standards except when a public meeting is required as provided in 15A NCAC 2H .1203.

(b) The Director is delegated the authority to prepare a proposed special order to be issued by the Commission without the consent of the person affected and to notify the affected person of that proposed order and of the procedure set out in G.S. 150B-23 to contest the proposed special order.

(c) The Director, or his designee shall give public notice of proposed consent special orders as specified in 15A NCAC 2H .1203.

History Note: Authority G.S. 143-215.2; 143-215.3(a)(1); 143-215.3(a)(4);

Eff. August 1, 1989;

Amended Eff. October 1, 1993; October 1, 1990.

15A NCAC 02L .0110 MONITORING

(a) Except where exempted by statute or this Subchapter, any person who causes, permits or has control over any discharge of waste, or groundwater cleanup program, shall install and implement a monitoring system, at such locations, and in such detail, as the Director, or his designee may require to evaluate the effects of the discharge upon the waters of the state, including the effect of any actions taken to restore groundwater quality, as well as the efficiency of any treatment facility. The monitoring plan shall be prepared under the responsible charge of a Professional Engineer or Licensed Geologist and bear the seal of the same.

(b) Monitoring systems shall be constructed in a manner that will not result in the contamination of adjacent groundwaters of a higher quality.

(c) Monitoring shall be conducted and results reported in a manner and at a frequency specified by the Director, or his designee.

History Note: Authority G.S. 143-215.1(b); 143-215.3(a)(1); 143-215.65; 143-215.66; 143B-282;

Eff. August 1, 1989;

Amended Eff. October 1, 1993.

15A NCAC 02L .0111 REPORTS

(a) Any person subject to the requirements for corrective action specified in Rule .0106 of this Section shall submit to the Director, in such detail as the Director may require, a written report that describes:

- (1) the results of the investigation specified in Paragraphs (c) and (d) of Rule .0106 of this Section, including but not limited to:
 - (A) a description of the sampling procedures followed and methods of chemical analyses used; and
 - (B) all technical data utilized in support of any conclusions drawn or determinations made.
- (2) the results of the predictive calculations or modeling, including a copy of the calculations or model runs and all supporting technical data, used in the demonstration required in Paragraph (d) of Rule .0106 of this Section; and

- (3) the proposed methodology and timetable associated with the corrective action for those situations identified in Paragraphs (c) and (d) of Rule .0106 of this Section.
- (b) The report shall be prepared under the responsible charge of a Professional Engineer or Licensed Geologist and bear the seal of the same as specified in Rule .0106(d) of this Section.

*History Note: Authority G.S. 143-215.1(b); 143-215.3(a)(1); 143-215.65; 143B-282;
Eff. August 1, 1989;
Amended Eff. October 1, 1993.*

15A NCAC 02L .0112 ANALYTICAL PROCEDURES

Tests or analytical procedures to determine compliance or noncompliance with the standards established in Rule .0202 of this Subchapter will be in accordance with:

- (1) The most sensitive of the following methods or procedures for substances where the standard is at or above the method detection limit value:
 - (a) The most recent version of Standard Methods for the Examination of Water and Wastewater, published jointly by American Public Health Association, American Water Works Association and Water Pollution Control Federation;
 - (b) Methods for Chemical Analysis of Water and Waste, 1979, U.S. Environmental Protection Agency publication number EPA-600/4-79-020, as revised March 1983;
 - (c) Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, 3rd Edition, 1986, U.S. Environmental Protection Agency publication number SW-846;
 - (d) Test Procedures for the Analysis of Pollutants Under the Clean Water Act, Federal Register Vol. 49, No. 209, 40 CFR Part 136, October 26, 1984;
 - (e) Methods or procedures approved by letter from the Director upon application by the regulated source; or
- (2) A method or procedure approved by the Director for substances where the standard is less than the method detection limit value.

*History Note: Authority G.S. 143-215.3(a)(1); 143B-282;
Eff. August 1, 1989;
Amended Eff. October 1, 1993.*

15A NCAC 02L .0113 VARIANCE

- (a) The Commission, on its own initiative or pursuant to a request under G.S. 143-215.3(e), may grant variances to the rules of this Subchapter.
- (b) Requests for variances are filed by letter from the applicant to the Environmental Management Commission. The application shall be mailed to the chairman of the Commission in care of the Director, Division of Environmental Management, Post Office Box 29535, Raleigh, N.C. 27626-0535.
- (c) The application shall contain the following information:

- (1) Applications filed by counties or municipalities must include a resolution of the County Board of Commissioners or the governing board of the municipality requesting the variance.
 - (2) A description of the past, existing or proposed activities or operations that have or would result in a discharge of contaminants to the groundwaters.
 - (3) Description of the proposed area for which a variance is requested. A detailed location map, showing the orientation of the facility, potential for groundwater contaminant migration, as well as the area covered by the variance request, with reference to at least two geographic references (numbered roads, named streams/rivers, etc.) must be included.
 - (4) Supporting information to establish that the variance will not endanger the public health and safety, including health and environmental effects from exposure to groundwater contaminants. (Location of wells and other water supply sources including details of well construction within 1/2 mile of site must be shown on a map).
 - (5) Supporting information to establish that requirements of this Rule cannot be achieved by providing the best available technology economically reasonable. This information must identify specific technology considered, and the costs of implementing the technology and the impact of the costs on the applicant.
 - (6) Supporting information to establish that compliance would produce serious financial hardship on the applicant.
 - (7) Supporting information that compliance would produce serious financial hardship without equal or greater public benefit.
 - (8) A copy of any Special Order that was issued in connection with contaminants in the proposed area and supporting information that applicant has complied with the Special Order.
 - (9) A list of the names and addresses of any property owners within the proposed area of the variance as well as any property owners adjacent to the site covered by the variance.
- (d) Upon receipt of the application, the Director will review it for completeness and request additional information if necessary. When the application is complete, the Director shall give public notice of the application and schedule the matter for a public hearing in accordance with G.S. 143-215.4(b) and the procedures set out in Paragraph (e) of this Rule.
- (e) Notice of Public Hearing:
- (1) Notice of public hearing on any variance application shall be circulated in the geographical areas of the proposed variance by the Director at least 30 days prior to the date of the hearing:
 - (A) by publishing the notice one time in a newspaper having general circulation in said county;
 - (B) by mailing to the North Carolina Department of Environment, Health, and Natural Resources, Division of Environmental Health and appropriate local health agency;
 - (C) by mailing to any other federal, state or local agency upon request;
 - (D) by mailing to the local governmental unit or units having jurisdiction over the geographic area covered by the variance;

- (E) by mailing to any property owner within the proposed area of the variance, as well as any property owners adjacent to the site covered by the variance; and
 - (F) by mailing to any person or group upon request.
- (2) The contents of public notice of any hearing shall include at least the following:
- (A) name, address, and phone number of agency holding the public hearing;
 - (B) name and address of each applicant whose application will be considered at the meeting;
 - (C) brief summary of the variance request;
 - (D) geographic description of a proposed area for which a variance is requested;
 - (E) brief description of activities or operations which have or will result in the discharge of contaminants to the groundwaters described in the variance application;
 - (F) a brief reference to the public notice issued for each variance application;
 - (G) information regarding the time and location for the hearing;
 - (H) the purpose of the hearing;
 - (I) address and phone number of premises at which interested persons may obtain further information, request a copy of each application, and inspect and copy forms and related documents; and
 - (J) a brief description of the nature of the hearing including the rules and procedures to be followed. The notice shall also state that additional information is on file with the Director and may be inspected at any time during normal working hours. Copies of the information on file will be made available upon request and payment of cost or reproduction.
- (f) All comments received within 30 days following the date of the public hearing shall be made part of the application file and shall be considered by the Commission prior to taking final action on the application.
- (g) In determining whether to grant a variance, the Commission shall consider whether the applicant has complied with any Special Order, or Special Order by Consent issued under G.S. 143-215.2.
- (h) If the Commission's final decision is unacceptable, the applicant may file a petition for a contested case in accordance with Chapter 150B of the General Statutes. If the petition is not filed within 60 days, the decision on the variance shall be final and binding.
- (i) A variance shall not operate as a defense to an action at law based upon a public or private nuisance theory or any other cause of action.

*History Note: Authority G.S. 143-215.3(a)(1); 143-215.3(a)(3); 143-215.3(a)(4); 143-215.3(e); 143-215.4;
 Eff. August 1, 1989;
 Amended Eff. October 1, 1993.*

15A NCAC 02L .0114 NOTIFICATION REQUIREMENTS

(a) Any person subject to the requirements of Rule .0106(c) of this Section shall submit to the local Health Director, and the chief administrative officer of the political jurisdictions in which the groundwater contamination has occurred, a report that describes:

- (1) The area extent of the contaminant plume;
- (2) The chemical constituents in the groundwater which exceed the standards described in Rule .0202 of this Subchapter;
- (3) Actions taken and intended to mitigate threats to human health;
- (4) The location of any wells installed for the purpose of monitoring the contaminant plume and the frequency of sampling.

The report described in this Rule shall be submitted no later than five working days after submittal of the completed report assessing the cause, significance and extent of the violation as required by Rule .0106(c).

(b) Any person who submits a request under Rule .0106(k), (l), or (m) of this Section shall notify the local Health Director and the chief administrative officer of the political jurisdictions in which the contaminant plume occurs, and all property owners and occupants within or contiguous to the area underlain by the contaminant plume, and under the areas where it is expected to migrate, of the nature of the request and reasons supporting it. Notification shall be made by certified mail concurrent with the submittal of the request to the Director. A final decision by the Director shall be postponed for a period of 30 days following receipt of the request so that the Director may consider comments submitted by individuals interested in the request.

(c) Any person whose request under Rule .0106(k), (l), or (m) of this Section is granted by the Director shall notify parties specified in Paragraph (b) of this Rule of the Director's decision. Notification shall be made by certified mail within 30 days of receipt of the Director's decision.

*History Note: Authority G.S. 143-214.1; 143-215.3(a)(1); 143B-282(2)b;
Eff. October 1, 1993.*

15A NCAC 02L .0115 RISK-BASED ASSESSMENT AND CORRECTIVE ACTION FOR PETROLEUM UNDERGROUND STORAGE TANKS

(a) The purpose of this Rule is to establish procedures for risk-based assessment and corrective action sufficient to:

- (1) protect human health and the environment;
- (2) abate and control contamination of the waters of the State as deemed necessary to protect human health and the environment;
- (3) permit management of the State's groundwaters to protect their designated current usage and potential future uses;
- (4) provide for anticipated future uses of the State's groundwater;
- (5) recognize the diversity of contaminants, the State's geology and the characteristics of each individual site; and
- (6) accomplish these goals in a cost-efficient manner to assure the best use of the limited resources available to address groundwater pollution within the State.

(b) This Rule applies to any discharge or release from a "commercial underground storage tank" or a "noncommercial underground storage tank," as those terms are defined in G.S. 143-

215.94A, which is reported on or after the effective date of this Rule. This Rule shall apply to any discharge or release from a "commercial underground storage tank" or a "noncommercial underground storage tank," as those terms are defined in G.S. 143-215.94A which is reported before the effective date of this Rule as provided in Paragraph (r) of this Rule. The requirements of this Rule shall apply to the owner and operator of the underground storage tank from which the discharge or release occurred, a landowner seeking reimbursement from the Commercial Leaking Underground Storage Tank Fund or the Noncommercial Leaking Underground Storage Tank Fund under G.S. 143-215.94E, and any other person responsible for the assessment or cleanup of a discharge or release from an underground storage tank, including any person who has conducted or controlled an activity which results in the discharge or release of petroleum or petroleum products as defined in G.S. 143-215.94A(10) to the groundwaters of the State, or in proximity thereto; these persons shall be collectively referred to for purposes of this Rule as the "responsible party." This Rule shall be applied in a manner consistent with the rules found in 15A NCAC 2N in order to assure that the State's requirements regarding assessment and cleanup from underground storage tanks are no less stringent than Federal requirements.

(c) A responsible party shall:

- (1) take immediate action to prevent any further discharge or release of petroleum from the underground storage tank; identify and mitigate any fire, explosion or vapor hazard; remove any free product; and comply with the requirements of Rules .0601 through .0604 and .0701 through .0703 and .0705 of Subchapter 2N;
- (2) incorporate the requirements of 15A NCAC 2N .0704 into the submittal required under Subparagraph (3) of this Paragraph or the limited site assessment report required under Subparagraph (4) of this Paragraph, whichever is applicable. Such submittals shall constitute compliance with the reporting requirements of 15A NCAC 2N .0704(b);
- (3) submit within 90 days of the discovery of the discharge or release a soil contamination report containing information sufficient to show that remaining unsaturated soil in the side walls and at the base of the excavation does not contain contaminant levels which exceed either the "soil-to-groundwater" or the residential maximum soil contaminant concentrations established by the Department pursuant to Paragraph (m) of this Rule, whichever is lower. If such showing is made, the discharge or release shall be classified as low risk by the Department;
- (4) if the required showing cannot be made under Subparagraph (3) of this Paragraph, submit within 120 days of the discovery of the discharge or release, or within such other greater time limit approved by the Department, a report containing information needed by the Department to classify the level of risk to human health and the environment posed by a discharge or release under Paragraph (d) of this Rule. Such report shall include, at a minimum:
 - (A) a location map, based on a USGS topographic map, showing the radius of 1500 feet from the source area of a confirmed release or discharge and depicting all water supply wells and, surface waters and designated wellhead protection areas as defined in 42 U.S.C. 300h-7(e) within the 1500-foot radius. For purposes of this Rule, source area means point of release or discharge from the underground storage tank system;

- (B) a determination of whether the source area of the discharge or release is within a designated wellhead protection area as defined in 42 U.S.C. 300h-7(e);
- (C) if the discharge or release is in the Coastal Plain physiographic region as designated on a map entitled "Geology of North Carolina" published by the Department in 1985, a determination of whether the source area of the discharge or release is located in an area in which there is recharge to an unconfined or semi-confined deeper aquifer which is being used or may be used as a source of drinking water;
- (D) a determination of whether vapors from the discharge or release pose a threat of explosion due to the accumulation of vapors in a confined space or pose any other serious threat to public health, public safety or the environment;
- (E) scaled site map(s) showing the location of the following which are on or adjacent to the property where the source is located: site boundaries, roads, buildings, basements, floor and storm drains, subsurface utilities, septic tanks and leach fields, underground storage tank systems, monitoring wells, borings and the sampling points;
- (F) the results from a limited site assessment which shall include:
 - (i) the analytical results from soil samples collected during the construction of a monitoring well installed in the source area of each confirmed discharge or release from a noncommercial or commercial underground storage tank and either the analytical results of a groundwater sample collected from the well or, if free product is present in the well, the amount of free product in the well. The soil samples shall be collected every five feet in the unsaturated zone unless a water table is encountered at or greater than a depth of 25 feet from land surface in which case soil samples shall be collected every 10 feet in the unsaturated zone. The soil samples shall be collected from suspected worst-case locations exhibiting visible contamination or elevated levels of volatile organic compounds in the borehole;
 - (ii) if any constituent in the groundwater sample from the source area monitoring well installed in accordance with Subpart (i) of this Part exceeds the standards or interim standards established in 15A NCAC 2L .0202 by a factor of 10 and is a discharge or release from a commercial underground storage tank, the analytical results from a groundwater sample collected from each of four additional monitoring wells or, if free product is present in any of the wells, the amount of free product in such well. The four additional monitoring wells shall be installed as follows: as best as can be determined, one upgradient of the source of contamination; two downgradient of the source of contamination; and one vertical-extent well immediately downgradient from the source but within the area of contamination. The monitoring wells installed upgradient and downgradient of the source of contamination must

be located such that groundwater flow direction can be determined;
and

- (iii) potentiometric data from all required wells;
- (G) the availability of public water supplies and the identification of properties served by the public water supplies within 1500 feet of the source area of a confirmed discharge or release;
- (H) the land use, including zoning if applicable, within 1500 feet of the source area of a confirmed discharge or release;
- (I) a discussion of site specific conditions or possible actions which could result in lowering the risk classification assigned to the release. Such discussion shall be based on information known or required to be obtained under this Paragraph; and
- (J) names and current addresses of all owners and operators of the underground storage tank systems for which a discharge or release is confirmed, the owner(s) of the land upon which such systems are located, and all potentially affected real property owners. When considering a request from a responsible party for additional time to submit the report, the Division shall consider the extent to which the request for additional time is due to factors outside of the control of the responsible party, the previous history of the person submitting the report in complying with deadlines established under the Commission's rules, the technical complications associated with assessing the extent of contamination at the site or identifying potential receptors, and the necessity for immediate action to eliminate an imminent threat to public health or the environment.

(d) The Department shall classify the risk of each known discharge or release as high, intermediate or low risk unless the discharge or release has been classified under Subparagraph (c)(3) of this Rule. For purposes of this Rule:

(1) "High risk" means that:

- (A) a water supply well, including one used for non-drinking purposes, has been contaminated by the release or discharge;
- (B) a water supply well used for drinking water is located within 1000 feet of the source area of a confirmed discharge or release;
- (C) a water supply well not used for drinking water is located within 250 feet of the source area of a confirmed discharge or release;
- (D) the groundwater within 500 feet of the source area of a confirmed discharge or release has the potential for future use in that there is no source of water supply other than the groundwater;
- (E) the vapors from the discharge or release pose a serious threat of explosion due to accumulation of the vapors in a confined space; or
- (F) the discharge or release poses an imminent danger to public health, public safety, or the environment.

(2) "Intermediate risk" means that:

- (A) surface water is located within 500 feet of the source area of a confirmed discharge or release and the maximum groundwater contaminant concentration exceeds the applicable surface water quality standards and criteria found in 15A NCAC 2B .0200 by a factor of 10;

- (B) in the Coastal Plain physiographic region as designated on a map entitled "Geology of North Carolina" published by the Department in 1985, the source area of a confirmed discharge or release is located in an area in which there is recharge to an unconfined or semi-confined deeper aquifer which the Department determines is being used or may be used as a source of drinking water;
 - (C) the source area of a confirmed discharge or release is within a designated wellhead protection area, as defined in 42 U.S.C. 300h-7(e);
 - (D) the levels of groundwater contamination for any contaminant except ethylene dibromide, benzene and alkane and aromatic carbon fraction classes exceed 50 percent of the solubility of the contaminant at 25 degrees Celsius or 1,000 times the groundwater standard or interim standard established in 15A NCAC 2L .0202, whichever is lower; or
 - (E) the levels of groundwater contamination for ethylene dibromide and benzene exceed 1,000 times the federal drinking water standard set out in 40 CFR 141.
- (3) "Low risk" means that:
- (A) the risk posed does not fall within the high or intermediate risk categories; or
 - (B) based on review of site-specific information, limited assessment or interim corrective actions, the Department determines that the discharge or release poses no significant risk to human health or the environment.

If the criteria for more than one risk category applies, the discharge or release shall be classified at the highest Paragraph (e) of this Rule.

(e) The Department may reclassify the risk posed by a release if warranted by further information concerning the potential exposure of receptors to the discharge or release or upon receipt of new information concerning changed conditions at the site. After initial classification of the discharge or release, the Department may require limited assessment, interim corrective action, or other actions which the Department believes will result in a lower risk classification. It shall be a continuing obligation of each responsible party to notify the Department of any changes that might affect the level of risk assigned to a discharge or release by the Department if the change is known or should be known by the responsible party. Such changes shall include, but shall not be limited to, changes in zoning of real property, use of real property or the use of groundwater that has been contaminated or is expected to be contaminated by the discharge or release, if such change could cause the Department to reclassify the risk.

(f) If the risk posed by a discharge or release is determined by the Department to be high risk, the responsible party shall comply with the assessment and cleanup requirements of Rule .0106(c), (g) and (h) of this Subchapter and 15A NCAC 2N .0706 and .0707. The goal of any required corrective action for groundwater contamination shall be restoration to the level of the groundwater standards set forth in 15A NCAC 2L .0202, or as closely thereto as is economically and technologically feasible. In any corrective action plan submitted pursuant to this Paragraph, natural attenuation shall be used to the maximum extent possible. If the responsible party demonstrates that natural attenuation prevents the further migration of the plume, the Department may approve a groundwater monitoring plan.

(g) If the risk posed by a discharge or release is determined by the Department to be an intermediate risk, the responsible party shall comply with the assessment requirements of 15A

NCAC 2L .0106(c) and (g) and 15A NCAC 2N .0706. As part of the comprehensive site assessment, the responsible party shall evaluate, based on site specific conditions, whether the release poses a significant risk to human health or the environment. If the Department determines, based on the site-specific conditions, that the discharge or release does not pose a significant threat to human health or the environment, the site shall be reclassified as a low risk site. If the site is not reclassified, the responsible party shall, at the direction of the Department, submit a groundwater monitoring plan or a corrective action plan, or a combination thereof, meeting the cleanup standards of this Paragraph and containing the information required in 15A NCAC 2L .0106(h) and 15A NCAC 2N .0707. Discharges or releases which are classified as intermediate risk shall be remediated, at a minimum, to a cleanup level of 50 percent of the solubility of the contaminant at 25 degrees Celsius or 1,000 times the groundwater standard or interim standard established in 15A NCAC 2L .0202, whichever is lower for any groundwater contaminant except ethylene dibromide, benzene and alkane and aromatic carbon fraction classes. Ethylene dibromide and benzene shall be remediated to a cleanup level of 1,000 times the federal drinking water standard set out in 40 CFR 141. Additionally, if a corrective action plan or groundwater monitoring plan is required under this Paragraph, the responsible party shall demonstrate that the groundwater cleanup levels are sufficient to prevent a violation of:

- (1) the rules contained in 15A NCAC 2B;
- (2) the standards contained in 15A NCAC 2L .0202 in a deep aquifer as described in Part (d)(2)(B) of this rule; and
- (3) the standards contained in 15A NCAC 2L .0202 at a location no closer than one year time of travel upgradient of a well within a designated wellhead protection area, based on travel time and the natural attenuation capacity of the subsurface materials or on a physical barrier to groundwater migration that exists or will be installed by the person making the request.

In any corrective action plan submitted pursuant to this Paragraph, natural attenuation shall be used to the maximum extent possible.

(h) If the risk posed by a discharge or release is determined by the Department to be a low risk, the Department shall notify the responsible party that no cleanup, no further cleanup or no further action will be required by the Department unless the Department later determines that the discharge or release poses an unacceptable risk or a potentially unacceptable risk to human health or the environment. No notification will be issued pursuant to this Paragraph, however, until the responsible party has completed soil remediation pursuant to Paragraph (i) of this Rule except as provided in Paragraph (r) of this Rule or as closely thereto as economically or technologically feasible. The issuance by the Department of a notification under this Paragraph shall not affect any private right of action by any party which may be affected by the contamination.

(i) Assessment and remediation of soil contamination shall be addressed as follows:

- (1) At the time that the Department determines the risk posed by the discharge or release, the Department shall also determine, based on site-specific information, whether the site is "residential" or "industrial/commercial." For purposes of this Rule, a site is presumed residential, but may be classified as industrial/commercial if the Department determines based on site-specific information that exposure to the soil contamination is limited in time due to the use of the site and does not involve exposure to children. For purposes of this Paragraph, "site" means both the property upon which the discharge or release has

occurred and any property upon which soil has been affected by the discharge or release.

- (2) The responsible party shall submit a report to the Department assessing the vertical and horizontal extent of soil contamination.
- (3) For a discharge or release classified by the Department as low risk, the responsible party shall submit a report demonstrating that soil contamination has been remediated to either the residential or industrial/commercial maximum soil contaminant concentration established by the Department pursuant to Paragraph (m) of this Rule, whichever is applicable.
- (4) For a discharge or release classified by the Department as high or intermediate risk, the responsible party shall submit a report demonstrating that soil contamination has been remediated to the lowest of:
 - (A) the residential or industrial/commercial maximum soil contaminant concentration, whichever is applicable, that has been established by the Department pursuant to Paragraph (m) of this Rule; or
 - (B) the "soil-to-groundwater" maximum soil contaminant concentration that has been established by the Department pursuant to Paragraph (m) of this Rule.

(j) A responsible party who submits a corrective action plan which proposes natural attenuation or to cleanup groundwater contamination to a standard other than a standard or interim standard established in 15A NCAC 2L .0202, or to cleanup soil other than to the standard for residential use or soil-to-groundwater contaminant concentration established pursuant to this Rule, whichever is lower, shall give notice to: the local Health Director and the chief administrative officer of each political jurisdiction in which the contamination occurs; all property owners and occupants within or contiguous to the area containing the contamination; and all property owners and occupants within or contiguous to the area where the contamination is expected to migrate. Such notice shall describe the nature of the plan and the reasons supporting it. Notification shall be made by certified mail concurrent with the submittal of the corrective action plan. Approval of the corrective action plan by the Department shall be postponed for a period of 30 days following receipt of the request so that the Department may consider comments submitted by interested individuals. The responsible party shall, within a time frame determined by the Department, provide the Department with a copy of the notice and proof of receipt of each required notice, or of refusal by the addressee to accept delivery of a required notice. If notice by certified mail to occupants under this Paragraph is impractical, the responsible party may give notice by posting such notice prominently in a manner designed to give actual notice to the occupants. If notice is made to occupants by posting, the responsible party shall provide the Department with a copy of the posted notice and a description of the manner in which such posted notice was given.

(k) A responsible party who receives a notice pursuant to Paragraph (h) of this Rule for a discharge or release which has not been remediated to the groundwater standards or interim standards established in Rule .0202 of this Subchapter or to the lower of the residential or soil-to-groundwater contaminant concentrations established under Paragraph (m) of this Rule, shall, within 30 days of the receipt of such notice, provide a copy of the notice to: the local Health Director and the chief administrative officer of each political jurisdiction in which the contamination occurs; all property owners and occupants within or contiguous to the area containing contamination; and all property owners and occupants within or contiguous to the

area where the contamination is expected to migrate. Notification shall be made by certified mail. The responsible party shall, within a time frame determined by the Department, provide the Department with proof of receipt of the copy of the notice, or of refusal by the addressee to accept delivery of the copy of the notice. If notice by certified mail to occupants under this Paragraph is impractical, the responsible party may give notice by posting a copy of the notice prominently in a manner designed to give actual notice to the occupants. If notice is made to occupants by posting, the responsible party shall provide the Department with a description of the manner in which such posted notice was given.

(l) To the extent feasible, the Department shall maintain in each of the Department's regional offices a list of all petroleum underground storage tank discharges or releases discovered and reported to the Department within the region on or after the effective date of this Rule and all petroleum underground storage tank discharges or releases for which notification was issued under Paragraph (h) of this rule by the Department on or after the effective date of this Rule.

(m) The Department shall publish, and annually revise, maximum soil contaminant concentrations to be used as soil cleanup levels for contamination from petroleum underground storage tank systems. Maximum soil contaminant concentrations will be established for residential, industrial/commercial and soil-to-groundwater exposures.

- (1) The following equations and references shall be used in establishing residential maximum soil contaminant concentrations. Equation 1 shall be used for each contaminant with an EPA carcinogenic classification of A, B1, B2, C, D or E. Equation 2 shall be used for each contaminant with an EPA carcinogenic classification of A, B1, B2 or C. The maximum soil contaminant concentration shall be the lowest of the concentrations derived from Equations 1 and 2.

(A) Equation 1: Non-cancer Risk-based Residential Ingestion Concentration

Soil mg/kg = $[0.2 \times \text{oral chronic reference dose} \times \text{body weight, age 1 to 6} \times \text{averaging time noncarcinogens}] / [\text{exposure frequency} \times \text{exposure duration, age 1 to 6} \times (\text{soil ingestion rate, age 1 to 6} / 106 \text{ mg/kg})]$.

(B) Equation 2: Cancer Risk-based Residential Ingestion Concentration

Soil mg/kg = $[\text{target cancer risk of } 10^{-6} \times \text{averaging time carcinogens}] / [\text{exposure frequency} \times (\text{soil ingestion factor, age adjusted} / 106 \text{ mg/kg}) \times \text{oral cancer slope factor}]$. The age adjusted soil ingestion factor shall be calculated by: $[(\text{exposure duration, age 1 to 6} \times \text{soil ingestion rate, age 1 to 6}) / (\text{body weight, age 1 to 6})] + [((\text{exposure duration, total} - \text{exposure duration, age 1 to 6}) \times \text{soil ingestion, adult}) / (\text{body weight, adult})]$.

- (C) The exposure factors selected in calculating the residential maximum soil contaminant concentrations shall be within the recommended ranges specified in the following references or the most recent version of these references:

- (i) EPA, 1990. Exposure Factors Handbook;
- (ii) EPA, 1991. Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual (Part B, Development of Risk Based Preliminary Remediation Goals);

- (iii) EPA Region III. Risk-based Concentration Tables (RBC Tables). Office of RCRA, Technical and Program Support Branch. Available at: <http://www.epa.gov/reg3hwmd/index.html>; and
 - (iv) EPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins Human Health Risk Assessment, including future amendments.
- (D) The following references or the most recent version of these references, in order of preference, shall be used to obtain oral chronic reference doses and oral cancer slope factors:
 - (i) EPA. Integrated Risk Information System (IRIS) Computer Database;
 - (ii) EPA. Health Effects Assessment Summary Tables (HEAST);
 - (iii) EPA Region III. Risk-based Concentration Tables (RBC Tables). Office of RCRA, Technical and Program Support Branch. Available at: <http://www.epa.gov/reg3hwmd/index.html>;
 - (iv) EPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins Human Health Risk Assessment, including future amendments; and
 - (v) Other appropriate, published health risk assessment data, and scientifically valid peer-reviewed published toxicological data.
- (2) The following equations and references shall be used in establishing industrial/commercial maximum soil contaminant concentrations. Equation 1 shall be used for each contaminant with an EPA carcinogenic classification of A, B1, B2, C, D or E. Equation 2 shall be used for each contaminant with an EPA carcinogenic classification of A, B1, B2 or C. The maximum soil contaminant concentration shall be the lowest of the concentrations derived from Equations 1 and 2.
 - (A) Equation 1: Non-cancer Risk-based Industrial/Commercial Ingestion Concentration

$$\text{Soil mg/kg} = [0.2 \times \text{oral chronic reference dose} \times \text{body weight, adult} \times \text{averaging time noncarcinogens}] / [\text{exposure frequency} \times \text{exposure duration, adult} \times (\text{soil ingestion rate, adult} / 106 \text{ mg/kg}) \times \text{fraction of contaminated soil ingested}].$$
 - (B) Equation 2: Cancer Risk-based Industrial/Commercial Ingestion Concentration

$$\text{Soil mg/kg} = [\text{target cancer risk of } 10^{-6} \times \text{body weight, adult} \times \text{averaging time carcinogens}] / [\text{exposure frequency} \times \text{exposure duration, adult} \times (\text{soil ingestion rate, adult} / 106 \text{ mg/kg}) \times \text{fraction of contaminated soil ingested} \times \text{oral cancer slope factor}].$$
 - (C) The exposure factors selected in calculating the industrial/commercial maximum soil contaminant concentrations shall be within the recommended ranges specified in the following references or the most recent version of these references:
 - (i) EPA, 1990. Exposure Factors Handbook;
 - (ii) EPA, 1991. Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual (Part B, Development of Risk Based Preliminary Remediation Goals);

- (iii) EPA Region III. Risk-based Concentration Tables (RBC Tables). Office of RCRA, Technical and Program Support Branch. Available at: <http://www.epa.gov/reg3hwmd/index.html>; and
 - (iv) EPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins Human Health Risk Assessment, including future amendments.
- (D) The following references or the most recent version of these references, in order of preference, shall be used to obtain oral chronic reference doses and oral cancer slope factors:
 - (i) EPA. Integrated Risk Information System (IRIS) Computer Database;
 - (ii) EPA. Health Effects Assessment Summary Tables (HEAST);
 - (iii) EPA Region III. Risk-based Concentration Tables (RBC Tables). Office of RCRA, Technical and Program Support Branch. Available at <http://www.epa.gov/reg3hwmd/index.html>;
 - (iv) EPA, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins Human Health Risk Assessment, including future amendments; and
 - (v) Other appropriate, published health risk assessment data, and scientifically valid peer-reviewed published toxicological data.
- (3) The following equations and references shall be used in establishing the soil-to-groundwater maximum contaminant concentrations:
 - (A) Organic Constituents:

Soil mg/kg = groundwater standard or interim standard x $[(.02 \times \text{soil organic carbon-water partition coefficient}) + 4 + (1.733 \times 41 \times \text{Henry's Law Constant (atm.-m}^3/\text{mole)})]$.

 - (i) If no groundwater standard or interim standard has been established under Rule .0202 of this Subchapter, the practical quantitation limit shall be used in lieu of a standard to calculate the soil-to-groundwater maximum contaminant concentrations.
 - (ii) The following references or the most recent version of these references, in order of preference, shall be used to obtain soil organic carbon-water partition coefficients and Henry's Law Constants:
 - (I) EPA, 1996. Soil Screening Guidance: Technical Background Document. (EPA/540/R95/128);
 - (II) EPA, 1986. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response (EPA/540/1-86/060);
 - (III) Agency for Toxic Substances and Disease Registry, "Toxicological Profile for [individual chemical]." U.S. Public Health Service;
 - (IV) Montgomery, J.H., 1996. Groundwater Chemicals Desk Reference. CRC Press, Inc;
 - (V) Sims, R.C., J.L. Sims and S.G. Hansen, 1991. Soil Transport and Fate Database, Version 2.0. EPA Robert S. Kerr Environmental Laboratory; and

(VI) Other appropriate, published, peer-reviewed and scientifically valid data.

(B) Inorganic Constituents:

Soil mg/kg = groundwater standard or interim standard x [(20 x soil-water partition coefficient for pH of 5.5) + 4 + (1.733 x 41 x Henry's Law Constant (atm.-m³/mole))].

(i) If no groundwater standard or interim standard has been established under Rule .0202 of this Subchapter, the practical quantitation limit shall be used in lieu of a standard to calculate the soil-to-groundwater maximum contaminant concentrations.

(ii) The following references or the most recent version of these references, in order of preference, shall be used to obtain soil-water partition coefficients and Henry's Law Constants:

(I) EPA, 1996. Soil Screening Guidance: Technical Background Document. (EPA/540/R95/128);

(II) Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture. Oak Ridge National Laboratory;

(III) Agency for Toxic Substances and Disease Registry, "Toxicological Profile for [individual chemical]." U.S. Public Health Service;

(IV) Sims, R.C., J.L. Sims and S.G. Hansen, 1991. Soil Transport and Fate Database, Version 2.0. EPA Robert S. Kerr Environmental Laboratory; and

(V) Other appropriate, published, peer-reviewed and scientifically valid data.

(n) Analytical procedures for soil samples required under this Rule, except as provided in Paragraph (s) of this rule, shall be as follows:

(1) soil samples collected from a discharge or release of low boiling point fuels, including, but not limited to gasoline, aviation gasoline and gasohol, shall be analyzed for volatile organic compounds and additives using EPA Method 8260, including isopropyl ether and methyl tertiary butyl ether;

(2) soil samples collected from a discharge or release of high boiling point fuels, including, but not limited to, kerosene, diesel, varsol, mineral spirits, naphtha, jet fuels and fuel oil no. 2, shall be analyzed for volatile organic compounds using EPA Method 8260 and semivolatile organic compounds using EPA Method 8270;

(3) soil samples collected from a discharge or release of heavy fuels shall be analyzed for semivolatile organic compounds using EPA Method 8270;

(4) soil samples collected from a discharge or release of used and waste oil shall be analyzed for volatile organic compounds using EPA Method 8260, semivolatile organic compounds using EPA Method 8270, polychlorinated biphenyls using EPA Method 8080, and chromium and lead, using procedures specified in Subparagraph (6) of this Paragraph;

- (5) soil samples collected from any discharge or release subject to this Rule shall be analyzed for alkane and aromatic carbon fraction classes using methods approved by the Director under Rule 2H .0805(a)(1) of this Chapter;
 - (6) analytical methods specified in Subparagraphs (1), (2), (3), and (4) of this Paragraph shall be performed as specified in the following references or the most recent version of these references: Test Methods for Evaluating Solid Wastes:Physical/Chemical Methods, November 1990, U.S. Environmental Protection Agency publication number SW-846; or in accordance with other methods or procedures approved by the Director under 15A NCAC 2H.0805(a)(1);
 - (7) other EPA-approved analytical methods may be used if the methods include the same constituents as the analytical methods specified in Subparagraphs (1), (2), (3), and (4) of this Paragraph and meet the detection limits of the analytical methods specified in Subparagraphs (1), (2), (3), and (4) of this Paragraph; and
 - (8) metals and acid extractable organic compounds shall be eliminated from analyses of soil samples collected pursuant to this Rule, if these compounds are not detected in soil samples collected during the construction of the source area monitoring well required under Subpart (c)(4)(F)(i) of this Rule.
- (o) Analytical procedures for groundwater samples required under this Rule shall be as follows:
- (1) groundwater samples collected from a discharge or release of low boiling point fuels, including, but not limited to, gasoline, aviation gasoline and gasohol, shall be analyzed for volatile organic compounds using Standard Method 6210D or EPA Methods 601 and 602, including xylenes, isopropyl ether and methyl tertiary butyl ether. Samples shall also be analyzed for ethylene dibromide using EPA Method 504.1 and lead using Standard Method 3030C preparation. 3030C metals preparation, using a 0.45 micron filter, must be completed within 72 hours of sample collection;
 - (2) groundwater samples collected from a discharge or release of high boiling point fuels, including, but not limited to, kerosene, diesel, varsol, mineral spirits, naphtha, jet fuels and fuel oil no. 2, shall be analyzed for volatile organic compounds using EPA Method 602 and semivolatile organic compounds plus the 10 largest non-target peaks identified using EPA Method 625;
 - (3) groundwater samples collected from a discharge or release of heavy fuels shall be analyzed for semivolatile organic compounds plus the 10 largest non-target peaks identified using EPA Method 625;
 - (4) groundwater samples collected from a discharge or release of used or waste oil shall be analyzed for volatile organic compounds using Standard Method 6210D, semivolatile organic compounds plus the 10 largest non-target peaks identified using EPA Method 625, and chromium and lead using Standard Method 3030C preparation. 3030C metals preparation, using a 0.45 micron filter, must be completed within 72 hours of sample collection;
 - (5) groundwater samples collected from any discharge or release subject to this Rule shall be analyzed for alkane and aromatic carbon fraction classes using methods approved by the Director under Rule 2H .0805(a)(1) of this Chapter;
 - (6) analytical methods specified in Subparagraphs (1), (2), (3) and (4) of this Paragraph shall be performed as specified in the following references or the most

recent version of these references: Test Procedures for the Analysis of Pollutants under the Clean Water Act, Federal Register Vol. 49 No. 209, 40 CFR Part 136, October 26, 1984; Standard Methods for the Examination of Water and Wastewater, published jointly by American Public Health Association, American Water Works Association and Water Pollution Control Federation; Methods for Determination of Organic Compounds in Drinking Water, U.S. Environmental Protection Agency publication number EPA-600/4-79-020; or in accordance with other methods or procedures approved by the Director under 15A NCAC 2H .0805(a)(1);

- (7) other EPA-approved analytical methods may be used if the methods include the same constituents as the analytical methods specified in Subparagraphs (1), (2), (3), and (4) of this Paragraph and meet the detection limits of the analytical methods specified in Subparagraphs (1), (2), (3), and (4) of this Paragraph; and
- (8) metals and acid extractable organic compounds shall be eliminated from analyses of groundwater samples collected pursuant to this Rule, if these compounds are not detected in the groundwater sample collected from the source area monitoring well installed pursuant to Subpart (c)(4)(F)(i) of this Rule.

(p) In accordance with 15A NCAC 2H .0804, laboratories are required to obtain North Carolina Division of Water Quality laboratory certification for parameters that are required to be reported to the State in compliance with the State's surface water, groundwater and pretreatment rules.

(q) This Rule shall not relieve any person responsible for assessment or cleanup of contamination from a source other than a commercial or noncommercial underground storage tank from its obligation to assess and clean up contamination resulting from such discharge or releases.

(r) If the risk posed by the discharge or release has been classified by the Department as Class AB under 1995 (Reg. Sess., 1996) c. 648, s. 1, the discharge or release is classified as high risk under this Rule unless and until the Department reclassifies the risk posed by the discharge or release. If the risk posed by the discharge or release has been classified by the Department as Class CDE under 1995 (Reg. Sess., 1996) c. 648, s. 1, the discharge or release is classified as low risk under this Rule unless and until the Department reclassifies the risk posed by the discharge or release. The responsible party shall notify the Department of any factors that might affect the level of risk assigned to Class AB or Class CDE discharges or releases by the Department. Responsible parties for Class AB discharges or releases for which a site assessment pursuant to Rule .0106 (c) and (g) of this Section has been submitted to the Department before the effective date of this Rule, shall continue to comply with notices previously received from the Department unless and until the Department determines that application of all or part of this Rule is necessary to protect human health or the environment or may result in a more cost effective assessment and cleanup of the discharge or release. If a site assessment pursuant to Rule .0106 (c) and (g) of this Section has not been submitted to the Department for a Class AB or Class CDE discharge or release before the effective date of this Rule, the responsible party shall comply with Paragraph (c) of this Rule unless the Department has issued a closure notice for the discharge or release. For discharges or releases classified as low risk under this Paragraph and for which a site assessment pursuant to Rule .0106 (c) and (g) of this Section has been submitted to the Department prior to the effective date of this Rule, the Department may issue a notification under Paragraph (h) of this Rule if the responsible party demonstrates that

soil contamination does not exceed contamination cleanup levels established (March 1997) in Paragraph (s) of this Rule.

(s) The Department may issue a notification under Paragraph (h) of this Rule for a discharge or release classified as low risk under Paragraph (r) of this Rule if a site assessment pursuant to Rule .0106(c) and (g) of this Section was submitted to the Department prior to the effective date of this Rule and the responsible party demonstrates that soil contamination from the discharge or release has been remediated to the final cleanup levels established under this Paragraph. If it has not already done so, a responsible party must submit all information necessary for the Department to establish a cleanup level under this Paragraph, including, but not limited to, the completed forms contained in Tables 1 and 2.

- (1) In establishing a cleanup level, the Department shall determine whether any of the following conditions apply to the discharge or release:
 - (A) groundwater is contaminated by the discharge or release;
 - (B) contaminated soil in the unsaturated zone is located less than five feet from the seasonal high water table, bedrock or transmissive indurated sedimentary units. Transmissive indurated sedimentary units shall include, but shall not be limited to shell limestone, fractured shale and sandstone; and
 - (C) vapors pose a serious threat of explosion or other public health concern due to the accumulation of the vapors in a confined space.
- (2) If any of the conditions specified in Subparagraph (1) of this Paragraph apply to the discharge or release, the final cleanup level for the discharge or release shall be:
 - (A) 10 mg/kg total petroleum hydrocarbons for discharges or releases of low boiling point fuels, including, but not limited to, gasoline, aviation gasoline, and gasohol;
 - (B) 40 mg/kg total petroleum hydrocarbons for discharges or releases of medium and high boiling point fuels, including, but not limited to, kerosene, diesel, varsol, mineral spirits, naphtha, jet fuels and fuel oil no. 2; and
 - (C) 250 mg/kg total petroleum hydrocarbons for discharges or releases of waste oil and heavy fuels, including, but not limited to fuel oil nos. 4, 5 and 6, motor oil and hydraulic fluid.
- (3) If the conditions specified in Subparagraph (1) of this Paragraph do not apply to the discharge or releases, the Department shall determine a final cleanup level in the following manner:
 - (A) the total site characteristics score shall be determined from Table 1 by recording and adding the five characteristic scores;
 - (B) the total site characteristics score shall be used to determine each applicable initial cleanup level on Table 2;
 - (C) using Table 3, the applicable Site Code shall be determined; and
 - (D) the final contamination cleanup level for the discharge or release shall be determined by multiplying each applicable initial cleanup level determined in Part (B) of this Subparagraph by 1 for Code A sites, 2 for Code B sites and 3 for Code C sites.

- (4) Any soil samples obtained to determine cleanup levels pursuant to this Paragraph shall be analyzed as follows:
- (A) soil samples collected from a discharge or release of low boiling point fuels including, but not limited to, gasoline, aviation gasoline and gasohol, shall be analyzed using EPA Method modified 8015 (California Method) with EPA Method 5030 preparation;
 - (B) soil samples collected from a discharge or release of medium or high boiling point fuels including, but not limited to, kerosene, diesel, varsol, mineral spirits, naphtha, jet fuels and fuel oil no. 2, shall be analyzed using EPA Method modified 8015 (California Method) with EPA Method 3550 preparation; and
 - (C) soil samples collected from a discharge or release of waste oil and heavy fuels, including, but not limited to fuel oil nos. 4, 5 and 6, motor oil and hydraulic fluid, shall be analyzed using EPA Method 9071 or another equivalent EPA-approved method that meets the same detection limits.
- (5) Analytical methods for any soil samples obtained to determine cleanup levels pursuant to this Paragraph shall be performed as specified in the following references or the most recent version of these references: Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, November 1990, U.S. Environmental Protection Agency Publication number SW-846 and Guidelines for Addressing Fuel Leaks, D.M. Eisenberg and others, 1985, California Regional Water Quality Control Board, San Francisco Bay Region.

Table 1
SITE CHARACTERISTICS EVALUATION

Characteristic	Condition	Rating	Score
1) Predominant grain size as classified in accordance with the Unified Soil Classification System or the U.S. Department of Agriculture Soil Classification System	Gravel	150	
	Sand	100	
	Silt	50	
	Clay	0	
2) Are preferential pathways for contaminant movement such as quartz veins, coarse-grained sediments, fractures and weathered igneous intrusions present in or below the contaminated soil?	Present and intersecting seasonal high water table	10	
	Present but not intersecting seasonal high water table	5	
	None Present	0	
3) Distance between the contaminated/non-contaminated soil interference and the seasonal high water table	5-10 feet	20	
	>10-40 feet	10	
	>40 feet	0	
4) Is the top of bedrock or transmissive indurated sediments located above seasonal high water table?	Yes	20	
	No	0	
5) Are artificial conduits present within the zone of contamination?	Present and intersecting seasonal high water table	150	
	Present but not intersecting seasonal high water table	10	
	Not Present	150	
Total Site Characteristics Score			

Table 2
CLEANUP LEVEL DETERMINATION

Initial Cleanup Level

Final Cleanup Level

**EPA Method 8015/5030 for Low Boiling Point Hydrocarbons
such as Gasoline, Aviation Fuels, Gasohol**

Total Site Characteristics Score	Initial Cleanup Level TPH (mg/kg)	Select Site Code*	Final Cleanup Level
>150	<10	Code A	
121 - 150	20	(Multiply initial cleanup level by 1)	1 x ____ = ____ mg/kg
91 - 120	40	Code B	
61 - 90	60	(Multiply initial cleanup level by 2)	2 x ____ = ____ mg/kg
31 - 60	80	Code C	
0 - 30	100	(Multiply initial cleanup level by 3)	3 x ____ = ____ mg/kg

EPA Method 8015/3550 for Medium and High Boiling Point Hydrocarbons
such as Kerosene, Diesel, Varsol, Mineral Spirits, Naptha

Total Site Characteristics Score	Initial Cleanup Level TPH (mg/kg)	Select Site Code*	Final Cleanup Level
>150	<40	Code A (Multiply initial cleanup level by 1)	1 x ____ = ____ mg/kg
121 - 150	80	Code B (Multiply initial cleanup level by 2)	2 x ____ = ____ mg/kg
91 - 120	160	Code C (Multiply initial cleanup level by 3)	3 x ____ = ____ mg/kg
61 - 90	240		
31 - 60	320		
0 - 30	400		

EPA Method 9071 for Heavy Fuels
such as Fuel Oil (#4,#5,#6), Motor Oil, Hydraulic Fluid, Waste Oil

Total Site Characteristics Score	Initial Cleanup Level TPH (mg/kg)	Select Site Code*	Final Cleanup Level
>150	<250	Code A (Multiply initial cleanup level by 1)	1 x ____ = ____ mg/kg
121 - 150	400	Code B (Multiply initial cleanup level by 2)	2 x ____ = ____ mg/kg
91 - 120	550	Code C (Multiply initial cleanup level by 3)	3 x ____ = ____ mg/kg
61 - 90	700		
31 - 60	850		
0 - 30	1000		

See Site Code Description, Table 3
TPH – Total Petroleum Hydrocarbons
mg/kg – milligram per kilogram

Table 3
SITE CODE DESCRIPTIONS

Code-A *Site meets both of the following criteria:*

1. Water supply well(s) are within 1500 feet of the release.
2. Public water supply is not available for connecting water supply well users.

Code-B *Site meets both of the following criteria:*

1. Water supply well(s) are within 1500 feet of the release.
2. Public water supply is available for connecting water supply well users, however, water supply wells are still being used.

Code-C *Site meets the following criterion:*

1. No known water supply well(s) are within 1500 feet of the release.

History Note: Authority G.S. 143-215.2; 143-215.3(a)(1); 143-215.94A; 143-215.94E; 143-215.94T; 143-215.94V;
143B-282; 1995 (Reg. Sess. 1996) c. 648, s. 1;
Temporary Adoption Eff. January 2, 1998;
Amended Eff. October 29, 1998.

SECTION .0200 - CLASSIFICATIONS AND GROUNDWATER QUALITY STANDARDS

15A NCAC 02L .0201 GROUNDWATER CLASSIFICATIONS

The classifications which may be assigned to the groundwaters will be those specified in the following series of classifications:

- (1) Class GA groundwaters; usage and occurrence:
 - (a) Best Usage. Existing or potential source of drinking water supply for humans.
 - (b) Conditions Related to Best Usage. This class is intended for those groundwaters in which chloride concentrations are equal to or less than 250 mg/l, and which are considered suitable for drinking in their natural state, but which may require treatment to improve quality related to natural conditions.
 - (c) Occurrence. In the saturated zone.
- (2) Class GSA groundwaters; usage and occurrence:
 - (a) Best Usage. Existing or potential source of water supply for potable mineral water and conversion to fresh waters.
 - (b) Conditions Related to Best Usage. This class is intended for those groundwaters in which the chloride concentrations due to natural conditions is in excess of 250 mg/l, but which otherwise may be considered suitable for use as potable water after treatment to reduce concentrations of naturally occurring substances.
 - (c) Occurrence. In the saturated zone.
- (3) Class GC groundwaters; usage and occurrence:
 - (a) Best Usage. The best usage of GC groundwaters is as a source of water supply for purposes other than drinking, including other domestic uses by humans.
 - (b) Conditions Related to Best Usage. This class includes those groundwaters that do not meet the quality criteria for GA or GSA groundwaters and for which efforts to improve groundwater quality would not be technologically feasible, or not in the best interest of the public. Continued consumption of waters of this class by humans could result in adverse health affects.
 - (c) Occurrence. Groundwaters of this class may be defined by the Commission pursuant to Section .0300 of this Subchapter on a case by case basis.

History Note: Authority G.S. 143-214.1; 143B-282(2);

Eff. June 10, 1979;

Amended Eff. October 1, 1993; August 1, 1989; September 1, 1984; December 30, 1983.

15A NCAC 02L .0202 GROUNDWATER QUALITY STANDARDS

(a) The groundwater quality standards for the protection of the groundwaters of the state are those specified in this Rule. They are the maximum allowable concentrations resulting from any discharge of contaminants to the land or waters of the state, which may be tolerated without creating a threat to human health or which would otherwise render the groundwater unsuitable for its intended best usage.

(b) The groundwater quality standards for contaminants specified in Paragraphs (g) and (h) of this Rule shall be as listed, except that:

- (1) Where the standard for a substance is less than the practical quantitation limit, the detection of that substance at or above the practical quantitation limit shall constitute a violation of the standard.
- (2) Where two or more substances exist in combination, the Director shall consider the effects of chemical interactions as determined by the Division of Public Health and may establish maximum concentrations at values less than those established in accordance with Paragraphs (c), (g), or (h) of this Rule. In the absence of information to the contrary, in accordance with Paragraph (d) of this Rule, the carcinogenic risks associated with carcinogens present shall be considered additive and the toxic effects associated with non-carcinogens present shall also be considered additive.
- (3) Where naturally occurring substances exceed the established standard, the standard shall be the naturally occurring concentration as determined by the Director.

(c) Except for tracers used in concentrations which have been determined by the Division of Public Health to be protective of human health, and the use of which has been permitted by the Division, substances which are not naturally occurring and for which no standard is specified shall not be permitted in detectable concentrations in Class GA or Class GSA groundwaters. Any person may petition the Director to establish an interim maximum allowable concentration for a substance for which a standard has not been established under this Rule. The petitioner shall submit relevant toxicological and epidemiological data, study results, and calculations necessary to establish a standard in accordance with Paragraph (d) of this Rule. Within three months after the establishment of an interim maximum allowable concentration for a substance by the Director, the Director shall initiate action to consider adoption of a standard for that substance.

(d) Groundwater quality standards for substances in Class GA and Class GSA groundwaters are established as the least of:

- (1) Systemic threshold concentration calculated as follows: $[\text{Reference Dose (mg/kg/day)} \times 70 \text{ kg (adult body weight)} \times \text{Relative Source Contribution (.10 for inorganics; .20 for organics)}] / [2 \text{ liters/day (avg. water consumption)}]$;
- (2) Concentration which corresponds to an incremental lifetime cancer risk of 1×10^{-6} ;
- (3) Taste threshold limit value;
- (4) Odor threshold limit value;
- (5) Maximum contaminant level; or
- (6) National secondary drinking water standard.

(e) The following references, in order of preference, shall be used in establishing concentrations of substances which correspond to levels described in Paragraph (d) of this Rule.

- (1) Integrated Risk Information System (U.S. EPA).
- (2) Health Advisories (U.S. EPA Office of Drinking Water).
- (3) Other health risk assessment data published by U.S. EPA.
- (4) Other appropriate, published health risk assessment data, and scientifically valid peer-reviewed published toxicological data.

(f) Groundwater quality standards specified in Paragraphs (g) and (h) of this Rule and interim maximum allowable concentrations established pursuant to Paragraph (c) of this Rule shall be reviewed on a triennial basis. Appropriate modifications to established standards shall be made in accordance with the procedure prescribed in Paragraph (d) of this Rule where modifications are considered appropriate based on data published subsequent to the previous review.

(g) Class GA Standards. Where not otherwise indicated, the standard refers to the total concentration in milligrams per liter of any constituent in a dissolved, colloidal or particulate form which is mobile in groundwater. This does not apply to sediment or other particulate matter which is preserved in a groundwater sample as a result of well construction or sampling procedures.

- (1) acetone: 0.7
- (2) acenaphthene: 0.08
- (3) acenaphthylene: 0.21
- (4) acrylamide (propenamide): 0.000008
- (5) anthracene: 2.1

- (6) arsenic: 0.05
- (7) atrazine and chlorotriazine metabolites: 0.0030
- (8) barium: 2.0
- (9) benzene: 0.001
- (10) benzo(a)anthracene (benz(a)anthracene): 0.0000479
- (11) benzo(b)fluoranthene: 4.79×10^{-5}
- (12) benzo(k)fluoranthene: 4.79×10^{-4}
- (13) benzo(g,h,i)perylene: 0.21
- (14) benzo(a)pyrene: 4.79×10^{-6}
- (15) boron: 0.315
- (16) bromodichloromethane: 0.00056
- (17) bromoform (tribromomethane): 0.00443
- (18) n-butylbenzene: 0.07
- (19) sec-butylbenzene: 0.07
- (20) tert-butylbenzene: 0.07
- (21) butylbenzyl phthalate: 0.10
- (22) cadmium: 0.00175
- (23) caprolactam: 3.5
- (24) carbofuran: 0.035
- (25) carbon disulfide: 0.7
- (26) carbon tetrachloride: 0.000269
- (27) chlordanes: 1.0×10^{-4}
- (28) chloride: 250.0
- (29) chlorobenzene: 0.05
- (30) chloroethane: 2.80
- (31) chloroform (trichloromethane): 0.07
- (32) chloromethane (methyl chloride): 2.6×10^{-3}
- (33) 2-chlorophenol: 0.00036
- (34) 2-chlorotoluene: 0.14
- (35) chromium: 0.05
- (36) chrysene: 0.00479
- (37) cis-1,2-dichloroethene: 0.07
- (38) coliform organisms (total): 1 per 100 milliliters
- (39) color: 15 color units
- (40) copper: 1.0
- (41) cyanide (free cyanide): 0.07
- (42) 2, 4-D (2,4-dichlorophenoxy acetic acid): 0.07
- (43) dibenz(a,h)anthracene: 4.7×10^{-6}
- (44) 1,2-dibromo-3-chloropropane: 2.5×10^{-5}
- (45) dichlorodifluoromethane (Freon-12; Halon): 1.4
- (46) p,p'-dichlorodiphenyl dichloroethane (DDD): 1.4×10^{-4}
- (47) p,p'-dichlorodiphenyltrichloroethane (DDT): 1.0×10^{-4}
- (48) 1,1-dichloroethane: 0.07
- (49) 1,2-dichloroethane (ethylene dichloride): 0.00038
- (50) 1,1-dichloroethylene (vinylidene chloride): 0.007
- (51) 1,2-dichloropropane: 0.00051
- (52) 1,3-dichloropropene (cis and trans isomers): 0.00019
- (53) dieldrin: 2.2×10^{-6}
- (54) di-n-butyl (or dibutyl) phthalate (DBP): 0.7
- (55) diethylphthalate (DEP): 5.0
- (56) di(2-ethylhexyl) phthalate (DEHP): 0.0025
- (57) 2,4-dimethylphenol (m-xenol): 0.14
- (58) di-n-octyl phthalate: 0.14
- (59) p-dioxane (1,4-diethylene dioxide): 0.007
- (60) dioxin: 2.2×10^{-10}
- (61) diphenyl (1,1- diphenyl): 0.35

- (62) dissolved solids (total): 500
- (63) disulfoton: 2.8×10^{-4}
- (64) diundecyl phthalate (Santicizer 711): 0.14
- (65) endosulfan II (beta-endosulfan): 0.0420
- (66) endrin: 0.002
- (67) endrin (total endrin: includes endrin, endrin aldehyde, and endrin ketone): 2.1×10^{-3}
- (68) epichlorohydrin (1-chloro-2,3-epoxypropane): 0.00354
- (69) ethylbenzene: 0.550
- (70) ethylene dibromide (EDB; 1,2-dibromoethane): 4.0×10^{-7}
- (71) ethylene glycol: 14.0
- (72) fluoranthene: 0.28
- (73) fluorene: 0.28
- (74) fluoride: 2.0
- (75) foaming agents: 0.5
- (76) gross alpha (adjusted) particle activity (excluding radium-226 and uranium): 15 pCi/l
- (77) heptachlor: 7.8×10^{-6}
- (78) heptachlor epoxide: 3.8×10^{-6}
- (79) heptane: 0.42
- (80) hexachlorobenzene (perchlorobenzene): 0.00002
- (81) hexachlorocyclohexane isomers (total hexachlorocyclohexane: includes alpha,beta,delta,gamma, and epsilon isomers): 1.9×10^{-5}
- (82) n-hexane: 0.42
- (83) indeno(1,2,3-cd)pyrene: 4.79×10^{-5}
- (84) iron: 0.3
- (85) isophorone: 0.0368
- (86) isopropylbenzene: 0.070
- (87) isopropyl ether (diisopropyl ether): 0.070
- (88) lead: 0.015
- (89) lindane: 2.0×10^{-4}
- (90) manganese: 0.05
- (91) mercury: 0.00105
- (92) metadichlorobenzene (1,3-dichlorobenzene): 0.170
- (93) methanol: 3.5
- (94) methoxychlor: 0.035
- (95) methylene chloride (dichloromethane): 0.0046
- (96) methyl ethyl ketone (MEK; 2-butanone): 4.20
- (97) 2-methylnaphthalene: 0.0140
- (98) 3-methylphenol (m-cresol): 0.0350
- (99) 4-methylphenol (p-cresol): 3.5×10^{-3}
- (100) methyl tert-butyl ether (MTBE): 0.2
- (101) naphthalene: 0.021
- (102) nickel: 0.1
- (103) nitrate: (as N) 10.0
- (104) nitrite: (as N) 1.0
- (105) N-nitrosodimethylamine: 7.0×10^{-7}
- (106) orthodichlorobenzene (1,2-dichlorobenzene): 0.024
- (107) oxamyl: 0.175
- (108) paradichlorobenzene (1,4-dichlorobenzene): 0.0014
- (109) pentachlorophenol: 0.00029
- (110) petroleum aliphatic carbon fraction class C5 - C8: 0.42
- (111) petroleum aliphatic carbon fraction class C9 - C18: 4.20
- (112) petroleum aliphatic carbon fraction class C19 - C36: 42.0
- (113) petroleum aromatics carbon fraction class C9 - C22: 0.210
- (114) pH: 6.5 - 8.5
- (115) phenanthrene: 0.21
- (116) phenol: 0.30

- (117) phorate: 1.4×10^{-3}
- (118) n-propylbenzene: 0.070
- (119) pyrene: 0.21
- (120) selenium: 0.05
- (121) silver: 0.0175
- (122) simazine: 0.004
- (123) styrene (ethenylbenzene): 0.1
- (124) sulfate: 250.0
- (125) tetrachloroethylene (perchloroethylene; PCE): 0.0007
- (126) 2,3,4,6-tetrachlorophenol: 0.210
- (127) toluene (methylbenzene): 1.0
- (128) toxaphene: 3.1×10^{-5}
- (129) 2, 4, 5,-TP (Silvex): 0.05
- (130) trans-1,2-dichloroethene: 0.10
- (131) 1,1,1-trichloroethane (methyl chloroform): 0.2
- (132) trichloroethylene (TCE): 0.0028
- (133) trichlorofluoromethane: 2.1
- (134) 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113): 210.0
- (135) 1,2,3- trichloropropane: 5.0×10^{-6}
- (136) 1,2,4-trimethylbenzene: 0.350
- (137) 1,3,5-trimethylbenzene: 0.350
- (138) vinyl chloride (chloroethylene): 1.5×10^{-5}
- (139) xylenes (o-, m-, and p-): 0.53
- (140) zinc: 1.05

(h) Class GSA Standards. The standards for this class shall be the same as those for Class GA except as follows:

- (1) chloride: allowable increase not to exceed 100 percent of the natural quality concentration.
- (2) total dissolved solids: 1000 mg/l.

(i) Class GC Waters.

- (1) The concentrations of substances which, at the time of classification exceed the standards applicable to Class GA or GSA groundwaters shall not be caused to increase, nor shall the concentrations of other substances be caused to exceed the GA or GSA standards as a result of further disposal of contaminants to or beneath the surface of the land within the boundary of the area classified GC.
- (2) The concentrations of substances which, at the time of classification, exceed the standards applicable to GA or GSA groundwaters shall not be caused to migrate as a result of activities within the boundary of the GC classification, so as to violate the groundwater or surface water quality standards in adjoining waters of a different class.
- (3) Concentrations of specific substances, which exceed the established standard at the time of classification, shall be listed in Section .0300 of this Subchapter.

*History Note: Authority G.S. 143-214.1; 143B-282(a)(2);
 Eff. June 10, 1979;
 Amended Eff. November 1, 1994; October 1, 1993; September 1, 1992; August 1, 1989;
 Temporary Amendment Eff. June 30, 2002;
 Amended Eff. August 1, 2002;
 Temporary Amendment Expired February 9, 2003;
 Amended Eff. April 1, 2005.*

Groundwater Standard Concentrations
Changes to 15A NCAC 2L .0202
(DENR Rulemaking # E-3258)

Substance	Former Concentration (mg/L)	Current Concentration (mg/L)
Acrylamide	0.00001	0.000008
Boron	0.32	0.315
Bromoform	0.00019	0.00443
Cadmium	0.005	0.00175
Carbofuran	0.036	0.035
Carbon Tetrachloride	0.0003	0.000269
Chlordane	2.7×10^{-5}	1.0×10^{-4}
Chloroform	0.00019	0.07
2-Chlorophenol	0.0001	0.00036
Cyanide	0.154	0.07 (as Free Cyanide) ■
1,2-Dichlorobenzene	0.62	0.024
1,3-Dichlorobenzene	0.62	0.170
1,4-Dichlorobenzene	0.075	0.0014
1,1-Dichloroethane	0.7	0.07
1,1-Dichloroethylene	0.007	0.007 (no change recommended)
1,2-Dichloropropane	0.00056	0.00051
Di(2-ethylhexyl) Phthalate	0.003	0.0025
1,4-Dioxane	0.007	0.007
Ethylbenzene	0.029	0.550
Ethylene Glycol	7.0	14.0
Fluoride	2.0	~~1.0~~ 2.0 ♣
Heptachlor	8.0×10^{-6}	7.8×10^{-6}
Heptachlor Epoxide	4.0×10^{-6}	3.8×10^{-6}
Heptane	2.1	0.42
Mercury	0.0011	0.00105
Methylene Chloride	0.005	0.0046
Methyl Ethyl Ketone	0.17	4.20
Pentachlorophenol	0.0003	0.00029
Radium (Combined Radium-226 and Radium-228)	5 pCi/L	Delete from Rule ♦
Silver	0.018	0.0175
trans-1,2- Dichloroethene	0.07	0.10
Zinc	2.1	1.05

Notes:

■ - **Free Cyanide** is now used to accurately reflect the health and toxicity information that forms the basis for this recommendation.

♦ - The former Groundwater Quality Standards for Radium was a combined total of **Radium-226 and Radium-228**. Based on comments from the State Health Director (Division of Environmental Health) and the Radiation Protection Commission, the EMC and Legislature approved the Groundwater Quality Standards for these radioisotopes be deleted from the rule.

♣ - **Fluoride** was proposed at 1.0 mg/L , but was rejected by the EMC because it was incorrectly calculated using the body weight of a child. Current 2L regulations specify calculations at an adult body weight only.

APPENDIX B

GUIDELINES FOR ASSESSMENT AND CORRECTIVE ACTION (2001 GUIDELINES) [SECTIONS 4.4, 4.7, 6.0 AND 7.0; TABLES 5, 6, 7, 10 AND 11]

**GUIDELINES FOR
ASSESSMENT AND CORRECTIVE ACTION**

**North Carolina
Underground Storage Tank Section**

Effective July 1, 2001

STATE of NORTH CAROLINA
DEPARTMENT of ENVIRONMENT and NATURAL RESOURCES
DIVISION of WASTE MANAGEMENT
UST SECTION

April 2001

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In delineating the horizontal and vertical extent of soil contamination, the responsible party must consider the residential or industrial/commercial maximum soil contaminant concentrations, whichever are applicable. For example, if the land use at a site has been classified as industrial/commercial, the responsible party will only be required to delineate soil contamination concentrations above the industrial/commercial maximum soil contaminant concentrations.

The SAR must provide a detailed proposal for remediating contaminated soil. An evaluation of the remedial options must be included in this report. The evaluation should describe the feasibility, limitations and costs of each option. The SAR must provide the basis for selecting the proposed remedy (see Appendix B, Report 8). The proposal must include detailed specifications of the proposed remedy, a plan for post-remediation sampling, a detailed cost estimate and an implementation schedule. For STF reimbursement, approval of the SAR by the regional office is required before you begin soil remediation.

REFERENCES

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McAllister, P.M. and C.Y. Chiang. 1994. *A practical approach to evaluating natural attenuation of contaminants*. Groundwater Monitoring Review. Spring 1994. Pp. 161-173.

NCDENR. 1996. *G3CTM Groundwater Contaminant Transport Model*. North Carolina Department of Environment and Natural Resources, Division of Water Quality, Groundwater Section, Raleigh, North Carolina.

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Wiedemeir, T.H., J.T. Wilson, D.H. Kampbell, R.N. Miller and J.E. Hansen. 1995. *Technical protocol for implementing intrinsic remediation with long-term monitoring for natural attenuation of fuel contamination dissolved in groundwater*. Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks Air Force Base, San Antonio, Texas.

Yeh, G.T., et al. 1993. *AT123D, version 1.22*. Oak Ridge National Laboratories, Oak Ridge, Tennessee. Distributed by Pennsylvania State University, University Park, Pennsylvania.

4.4 Soil Cleanup Requirements

In general, the requirements to cleanup soil contamination vary based on whether the release was reported to the Department before or after the effective date of the rule (15A NCAC 2L .0115, January 2, 1998), and whether a complete CSA was submitted before or after that date. The soil corrective action requirements are presented in the sections that follow.

A. Releases Reported before January 2, 1998: TPH-Based Corrective Action Levels

The soil corrective action levels specified in this section apply to all releases for which the following occurred prior to the effective date of the Rule - January 2, 1998:

- ☐ the release was reported to the Department, AND
- ☐ a responsible party submitted a complete CSA to the Department.

Please refer to Section 4.4B for all other releases.

For releases that are classified by the Department as AB, soil contamination must be remediated to the cleanup levels established in the March 1997 *Groundwater Section Guidelines for the Investigation and Remediation of Soil and Groundwater*. Alternatively, the Department may direct a responsible party to remediate soil contamination to the cleanup levels established in 15A NCAC 2L .0115 to protect human health and the environment or to provide a more cost effective remediation. For releases that are classified by the Department as CDE, the responsible party must remediate soil contamination to either the cleanup levels established in the March 1997 Guidelines or the Risk-Based Corrective Action Levels presented in Section 4.4B. If the responsible party expects to seek reimbursement from the STF (15A NCAC 2P .0402), the most cost-effective approach that has been pre-approved by the Department must be implemented.

1. TPH Action Levels

In accordance with the March 1997 Guidelines, the responsible party must cleanup soil contamination to a level at which the total petroleum hydrocarbon concentrations remaining in the soil at the site do not exceed:

- ☐ 10 milligrams per kilogram (mg/kg) for samples analyzed according to EPA 5030/Modified 8015 (California Method),
- ☐ 40 mg/kg for samples analyzed according to EPA 5030/Modified 8015 (California Method), and
- ☐ 250 mg/kg (oil and grease) for samples analyzed according to EPA Method 9071.

(Approved methods for soil contamination determination are listed in Table 6, p. T-8.)

However, the responsible party may cleanup soil contamination to a site-specific TPH action level using the Site Sensitivity Evaluation, if the CDE release only resulted in soil contamination and the following conditions are met:

- ☐ the release did not result in groundwater contamination;
- ☐ contaminated soil is located not less than five feet from the seasonal high water table, bedrock or transmissive indurated sedimentary units (shell limestone, fractured shale, sandstone, etc.);
- ☐ contaminated soil does not create a human exposure pathway via ingestion, absorption, or inhalation; and
- ☐ explosive vapors or vapors at levels that create a health concern are not present in confined spaces.

To establish the site-specific TPH action level, a Site Sensitivity Evaluation must be performed as described below.

2. Site Sensitivity Evaluation

The purpose of a SSE is to establish site-specific cleanup levels for soil contaminated with petroleum hydrocarbons. Before performing a SSE, the responsible party should obtain a

measurement of the depth to groundwater, assess whether groundwater is contaminated and define the extent of soil contamination.

To obtain a measurement of the depth to groundwater, and to assess whether or not the release has resulted in groundwater contamination, you may use a monitoring well, temporary well or a piezometer. They must be installed within the source area of the release and located in an estimated down-gradient direction. A groundwater sample must be obtained from this well or piezometer. It must be analyzed in accordance with the methods and procedures specified in Section 7.0. At sites with confined or restricted access, or where appropriate based on site conditions, a mechanical pushprobe may be utilized to obtain a groundwater sample instead of installing a well or piezometer.

3. Special Conditions for Non-Regulated USTs

For residential home heating oil (non-regulated) USTs, the requirements for installing a monitoring well may be waived if **all** of the following conditions apply:

- a. The UST system has either been removed or the UST system has been pumped of all materials and fluids;
- b. Petroleum-contaminated soil does not create a human exposure pathway via ingestion, absorption, or inhalation; and
- c. All properties within a 1,500 foot radius of the UST are served by public water.

4. Explanation and Procedures for Completing the SSE

The SSE should be completed by following this three-step approach:

STEP 1: Site Characteristics Evaluation (See Table 1, p. T-1)

Site-specific cleanup levels for *in situ* petroleum-contaminated soil are established by assessing the five site-specific characteristics presented in Table 1, p. T-1. Based on its relative potential to contaminate groundwater, a numeric "score" is generated for each characteristic. Characteristics with greater potential to contaminate groundwater are given a higher score. The overall potential to contaminate groundwater is represented by the "Total Site Characteristics Score". The Total Site Characteristics Score is obtained by summing the five site-specific characteristic scores. Record this total score in the bottom box of Table 1, p. T-1.

1) Grain Size Analysis - The main objective of this analysis is to estimate soil permeability, the potential for contaminant attenuation, and the presence of zones that may restrict contaminant migration. Samples obtained for the analysis of grain size should represent the predominant soil type five feet below the contamination zone. It should be located beneath the source, or near and hydraulically down gradient of the source. Retaining soil samples for future reference is advisable. The soil sample obtained for the analysis of the **predominant** grain size should be classified according to the Unified Soil Classification System (American Society for Testing and Materials designation D-2487) or the United States Department of Agriculture method for soil classification.

NOTE: *The SSE and soil sample classification must be performed by persons duly licensed by the appropriate North Carolina licensing board to provide such services.*

2) Relict structures, sedimentary structures, and/or textures present in the zone of contamination and underlying soil may increase soil permeability and may provide preferential pathways that may significantly increase the potential to contaminate groundwater. These

features may include quartz veins, fractures, or textures with coarse-grained sandy beds in silts and clays, weathered coarse-grained igneous intrusions, or similar features that may increase soil permeability.

3) Vertical separation between contaminated soil and the seasonal high water table - In defining depth to the seasonal high water table, a monitoring well, temporary well or piezometer must be installed within the source area of the release in an estimated downgradient direction. At sites with confined or restricted access, or where appropriate based on site conditions, a mechanical pushprobe may be utilized to obtain depth-to-groundwater instead of installing a well or piezometer.

While advancing soil borings in the area of known soil contamination, great care must be taken to prevent vertical migration of contamination. Any soil boring that intersects the water table must be abandoned with cement grout or must be properly completed as a groundwater monitoring well to avoid creating a preferential pathway.

4) Water table elevation relative to bedrock or transmissive indurated sedimentary units - Bedrock or transmissive indurated sedimentary units (shell limestone, fractured shale, sandstone, etc.) may cause preferential pathways of contaminate migration. The preferential pathways may significantly increase the potential to contaminate groundwater.

5) Artificial conduits present within the zone of contamination - Artificial conduits such as water lines, sewer lines, telephone cables or product dispensing piping, may enable contaminants to migrate vertically and horizontally. The potential to contaminate groundwater increases when these conduits intersect the seasonal high water table.

STEP 2: Establishing the Initial Cleanup Level (See Table 2, p. T-2)

For each analytical method shown in Table 2, match the Total Site Characteristics Score (from Step 1, Table 1) to the corresponding range in the left-hand column of Table 2. Circle the corresponding “initial” cleanup level in the adjacent column.

STEP 3: Establishing Final Cleanup Level (See Tables 2 & 3, pp. T-2 and T-3)

To obtain the “final” cleanup level, first identify the SSE code associated with the site (see Table 3: A, B, and C). Then for each analytical method, transpose the “initial” cleanup value obtained in Step 2 to the right column of Table 2, for the appropriate site code. Finally, multiply the initial cleanup level by 1 for Code A sites, 2 for Code B sites and 3 for Code C sites, depending upon the code associated with the site. This value, in parts per million, is the site-specific TPH corrective action level to which soil needed to be remediated.

EPA 5030/Modified 8015 (California Method)	EPA 3550/Modified 8015 (California Method)	EPA Method 9071
10 to 300 ppm TPH	40 to 1,200 ppm TPH	250 to 3,000 ppm O&G

B. Release Reported on or after January 2, 1998: Risk-Based Corrective Action Levels

The soil cleanup requirements presented in this section (referred to as the risk-based corrective action levels) apply to the following releases:

- ☐ Releases reported to the Department on or after January 2, 1998; AND

- ☐ Releases reported to the Department before January 2, 1998, for which a complete CSA was not submitted to the Department before January 2, 1998.

Please refer to Section 4.4A for all other releases.

1. Maximum Soil Contaminant Concentrations (See Table 4, p. T-5)

In accordance with 15A NCAC 2L .0115 (m), three categories of risk-based corrective action levels (maximum soil contaminant concentrations) have been established: residential, industrial/commercial and soil-to-groundwater. The residential maximum soil contaminant concentrations are based on protecting the health of children and adult residents that may be exposed to contaminated soil. The industrial/commercial maximum soil contaminant concentrations are based on protecting the health of an adult worker that may be exposed to contaminated soil for a limited period of time. The soil-to-groundwater maximum soil contaminant concentrations are based on protecting groundwater that may be impacted by contaminants leaching from soil.

The equations used by the Department to calculate the residential, industrial/commercial and soil-to-groundwater maximum soil contaminant concentrations are provided in Figures 5, 6, and 7, pp. F-5, 6 and 7. To develop the residential and industrial/commercial maximum soil contaminant concentrations, non-cancer and cancer risk-based ingestion concentrations were determined for each contaminant. The maximum soil contaminant concentration represents the lower of the non-cancer and cancer risk-based ingestion concentrations.

The exposure factors used in calculating the residential and industrial/commercial maximum soil contaminant concentrations were taken from the following references:

- ☐ EPA, 1990. *Exposure Factors Handbook*;
- ☐ EPA, 1991. *Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual (Part B, Development of Risk Based Preliminary Remediation Goals)*;
- ☐ EPA Region III. Risk-based Concentration Tables (RBC Tables). Office of RCRA, Technical and Program Support Branch. Available at <http://www.epa.gov/reg3hwmd/index.html>; and
- ☐ EPA, 1995. *Supplemental Guidance to RAGS: Region 4 Bulletins Human Health Risk Assessment*, including future amendments.

The oral chronic reference doses and oral cancer slope factors used in calculating the residential and industrial/commercial maximum soil contaminant concentrations were taken from the following references:

- ☐ EPA. Integrated Risk Information System (IRIS) Computer Database;
- ☐ EPA. Health Effects Assessment Summary Tables (HEAST);
- ☐ EPA Region III. Risk-based Concentration Tables (RBC Tables). Office of RCRA, Technical and Program Support Branch. Available at <http://www.epa.gov/reg3hwmd/index.html>;
- ☐ EPA, 1995. *Supplemental Guidance to RAGS: Region 4 Bulletins Human Health Risk Assessment*, including future amendments; and
- ☐ Other appropriate, published health risk assessment data, and scientifically valid peer-reviewed published toxicological data.

The soil organic carbon-water partition coefficients and Henry's Law Constants used to calculate the soil-to-groundwater maximum contaminant concentrations for the organic compounds were obtained from the following references:

- ▣ EPA, 1996. *Soil Screening Guidance: Technical Background Document*. (EPA/540/R95/128);
- ▣ EPA, 1986. *Superfund Public Health Evaluation Manual*. Office of Emergency and Remedial Response (EPA/540/1-86/060);
- ▣ Agency for Toxic Substances and Disease Registry, *Toxicological Profile for [individual chemical]*. U.S. Public Health Service;
- ▣ Montgomery, J.H., 1996. *Groundwater Chemicals Desk Reference*. CRC Press, Inc.;
- ▣ Sims, R.C., J.L. Sims and S.G. Hansen, 1991. Soil Transport and Fate Database, Version 2.0. EPA Robert S. Kerr Environmental Laboratory; and
- ▣ Other appropriate, published, peer-reviewed and scientifically valid data.

The soil-water partition coefficients and Henry's Law Constants used to calculate the soil-to-groundwater maximum contaminant concentrations for the inorganic compounds were taken from the following references:

- ▣ EPA, 1996. *Soil Screening Guidance: Technical Background Document*. (EPA/540/R95/128);
- ▣ Baes, C.F., III, R.D. Sharp, A.L. Sjoeren, and R.W. Shor, 1984. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*. Oak Ridge National Laboratory;
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- ▣ Sims, R.C., J.L. Sims and S.G. Hansen, 1991. Soil Transport and Fate Database, Version 2.0. EPA Robert S. Kerr Environmental Laboratory; and
- ▣ Other appropriate, published, peer-reviewed, and scientifically valid data.

2. Cleanup Requirements

Pursuant to 15A NCAC 2L .0115(h), soil must be remediated to maximum soil contaminant concentrations or as closely thereto as economically or technologically feasible. Economic and technological feasibility will only be considered in cases where traditional remediation technologies cannot be used, or where treatment or removal of contaminated soil will jeopardize the integrity of a permanent structure. Pavement is not considered a permanent structure. The soil cleanup requirements apply to the entire unsaturated soil column.

a) For high and intermediate risk releases, the responsible party must remediate contaminated soils to the lower of: residential or industrial/commercial maximum soil contaminant concentrations, whichever are applicable, or soil-to-groundwater levels.

b) For low risk releases, the responsible party must remediate contaminated soils to the residential or industrial/commercial maximum soil contaminant concentrations, whichever is applicable.

3. Public Notice

The responsible party who proposes to cleanup contaminated soil to a standard other than to the residential or soil-to-groundwater maximum soil contaminant concentration, whichever is lower, must comply with the public notice requirements of 15A NCAC 2L .0115(j). Refer to Section 4.6 for further guidance on public notices.

4.5 Groundwater Cleanup Requirements

The groundwater cleanup requirements for each site will depend on the timing of the release, the level of risk resulting from the release, and the date that the CSA report was submitted to the Department.

A. Releases Reported before January 2, 1998

NOTE: *A flowchart of the regulatory requirement for existing releases is provided as Figure 4, p. F-4.*

Complete CSA Reports Submitted before January 2, 1998

The groundwater cleanup requirements presented in this section apply to all releases for which the following occurred before the effective date of the rule - January 2, 1998:

- ☐ the release was reported to the Department, AND
- ☐ a responsible party submitted a complete CSA to the Department.

Refer to Section 4.5B for all other releases.

For releases that were classified by the Department as AB, the responsible party must restore groundwater to the standards and interim standards established by 15A NCAC 2L .0202. These standards may be obtained from the Groundwater Section at <http://gw.ehnr.state.nc.us>. For releases that were classified by the Department as CDE, no further cleanup of groundwater is required, provided the risk posed by a release does not meet any of the high or intermediate risk criteria specified in 15A NCAC 2L .0115. However, the responsible party must submit a Soil Cleanup Plan detailing proposed soil remediation activities, in accordance with Section 4.4A.

B. Releases Reported on or after January 2, 1998

NOTE: *A flowchart of the regulatory requirement for new releases is provided as Figure 3, p. F-3.*

1. CSA Reports Submitted On or After January 2, 1998

The groundwater cleanup requirements presented in this section apply to the following releases:

- ☐ releases reported to the Department on or after January 2, 1998; AND
- ☐ releases reported to the Department before January 2, 1998, for which a complete CSA was not submitted to the Department prior to January 2, 1998.

Refer to Section 4.5A for all other releases.

NOTE: *A party responsible for a release reported before January 2, 1998 must comply with the abatement measures in 15A NCAC 2L .0115(c). They must also submit a LSA Report in accordance with 15A NCAC 2L .0115(c)(4).*

For releases that result in a high risk, the responsible party must restore groundwater quality to the standards and interim standards established by 15A NCAC 2L .0202, or as closely thereto as is economically and technologically feasible.

For releases that result in an intermediate risk, the responsible party must restore groundwater quality to levels that are protective of surface water, wellhead protection areas and deeper Coastal Plain aquifers that are or could be used as a source for drinking water. Specifically, the responsible party must demonstrate that groundwater has been restored to levels that are sufficient to prevent a violation of the following:

- ▣ surface water standards and criteria contained in 15A NCAC 2B,
- ▣ groundwater quality standards and interim standards contained in 15A NCAC 2L .0202 for locations no closer than one year time of travel upgradient of a well within a designated wellhead protection area, and
- ▣ groundwater quality standards and interim standards contained in 15A NCAC 2L .0202 for a deep Coastal Plain aquifer that is, or could be, used as a source of drinking water.

If the responsible party can demonstrate that the restored groundwater will not result in a violation of these standards, the responsible party must restore groundwater quality to gross contamination levels. GCLs are presented in Table 9 (p. T-11), and are defined as follows:

- ▣ Levels of groundwater contamination for any contaminant except ethylene dibromide, benzene and aliphatic and aromatic carbon fraction classes that exceed 50 percent of the solubility of the contaminant at 25 degrees Celsius or 1,000 times the groundwater quality standard or interim standard established in 15A NCAC 2L .0202, whichever is lower; and
- ▣ Levels of groundwater contamination for ethylene dibromide and benzene that exceed 1,000 times the federal drinking water standard set out in 40 CFR 141.

2. Low Risk Releases

Groundwater corrective action is not required for releases that result in a low risk classification. If a release is classified as low risk after a Soil Contamination Report is submitted, the Department will notify the responsible party pursuant to 15A NCAC 2L .0115(h) that no further action is required. If a release is classified as low risk after the submittal of a LSA, the responsible party must submit a Soil Assessment Report that documents the extent of soil contamination and proposes a plan for soil remediation. Once this plan is approved, the responsible party must remediate soil to the applicable cleanup levels (see Section 4.4B) and submit a Soil Cleanup Report with Site Closure Request (Appendix B Report 13). The Soil Cleanup Report with Site Closure Request must document soil remediation activities and must contain a petition for site closure. The Department will then issue a notice of no further action.

If a release is classified as low risk after a CSA is submitted, the responsible party must submit a Soil Cleanup Plan (Appendix B Report 10) proposing appropriate soil remediation activities. Once this plan is approved and soil is remediated to applicable cleanup levels, the responsible party must submit a Soil Cleanup Report with Site Closure Request (Appendix B, Report 13). The Soil Cleanup Report with Site Closure Request must document soil cleanup activities and must contain a petition for site closure. The Department will then issue a notice of no further action.

C. Public Notice

- a) Pursuant to 15A NCAC 2L .0115(f) and .0115(g), and as described in 15A NCAC 2L .0106(c) and .0114(a), responsible parties of high and intermediate risk releases must submit a summary of the CSA report to the local Health Director and the chief administrative officer of the political jurisdiction in which the groundwater contamination occurs (See Section 4.6).

b) Pursuant to 15A NCAC 2L .0115(j), a responsible party who proposes to restore groundwater quality through natural attenuation, or to cleanup groundwater contamination to a standard other than the standards or interim standards established in 15A NCAC 2L .0202, must provide public notice, at the time a corrective action proposal is submitted to the Department as described in Section 4.6.

4.6 Public Notice Requirement and Formats

A. Comprehensive Site Assessment

Pursuant to 15A NCAC 2L .0115(f) and .0115(g), responsible parties of high and intermediate risk releases must provide a summary of the CSA report to the local Health Director and the chief administrative officer of the political jurisdiction in which the contamination occurs. This report must include a map of the contaminant plume with the location of all monitoring wells identified, the frequency of monitoring, a table of the constituents exceeding the groundwater quality standards, and interim standards including the analytical results and any actions taken to mitigate threats to human health. This summary report must be submitted by certified mail to the parties above no later than five working days after the CSA report is submitted to the Department.

B. Corrective Action

Pursuant to 15A NCAC 2L .0115(j), public notice is also required when:

- ☐ The responsible party submits a CAP proposing remediation by **natural attenuation**, or by a combination of active treatment and RNA;
- ☐ The responsible party submits a CAP proposing to cleanup groundwater contamination to an **alternate standard** (i.e., a standard other than the groundwater standard or interim standard established in 15A NCAC 2L .0202); or
- ☐ The responsible party submits a SAR or Soil Cleanup Plan proposing to cleanup soil contamination to an **alternate standard** (i.e., a standard other than the residential or soil-to-groundwater maximum soil contaminant concentration, whichever is lower).

For these proposed remedies, the responsible party must notify the following people:

- ☐ the local health director;
- ☐ the chief administrative officer (*Mayor, Chairman of the County Commissioners, County Manager, City Manager, or other official of equal or similar position*) of each political jurisdiction in which the contamination occurs;
- ☐ all property owners and occupants residing within or contiguous to the area containing contamination; and
- ☐ all property owners and occupants residing within or contiguous to the area where the contamination is expected to migrate.

This notice must be made by certified mail. The notice must describe the nature of the selected remedy, as well as the justification for implementing the chosen remedy.

It may be impractical to provide notice by certified mail to the occupants of apartment buildings, condominiums, office buildings, etc. In these cases, the responsible party may give

4.7 Site Closure

Site closure is the final act of the regulatory process related to a release.

NOTE: The responsible party should properly close any monitoring wells or injection wells used to investigate or remediate this incident in accordance with 15A NCAC 2C .0113 and .0214.

Appropriate documentation must be submitted to the Department in support of a petition for site closure. For a party responsible for a release that results in a high or intermediate risk, this documentation is a Site Closure Report.

NOTE: The number of groundwater sampling events that are needed to demonstrate that groundwater quality does not exceed or has been restored to the required cleanup level is site-specific and will be determined by the local regional office.

For a party responsible for a release that results in low risk, this documentation is a Soil Cleanup Report with Site Closure Request. Each report must document that contamination has been remediated to applicable cleanup levels, and must also incorporate a request for site closure. This petition should request that the Department issue a notice of no further action.

If a release has not been remediated to the standards or interim standards established under 15A NCAC 2L .0202, or to the lower of the residential or soil-to-groundwater maximum soil contaminant concentrations, the responsible party must provide public notice in accordance with 15A NCAC 2L .0115(k). See Section 4.6 for information on public notice requirements.

Site closure is conditional upon proper notice.

NOTES: *Even after the Department issues a no further action letter, 15A NCAC 2L .0115(e) places a continuing obligation on the responsible party, to notify the Department of any changes in site conditions that might affect the level of risk assigned to a release. Such changes may include but, are not limited to, changes in zoning of the property, changes in use of the property (e.g., conversion of a service station or convenience store to a residence/school/recreation area/daycare center, etc.) or changes in the use of the affected, or potentially affected groundwater (e.g., installation of an irrigation well within 250 feet of the source area of the release). If the site had a DWQ permit, the responsible party should request rescission of the permit within thirty days of receiving the no further action letter. Contact the DWQ Water Quality Section, Point Source Branch for NPDES permits, NPDES Unit and contact the DWQ Water Quality Section, Non-discharge Branch, Non-discharge Permitting Unit for non-surface discharge permits. Both units can be reached at (919) 733-5083.*

Furthermore, the enabling statute (Senate Bill 1012) for the risk-based rule (15A NCAC 2L .0115) allows the Department to reopen an incident if the Department later determines that a release poses an unacceptable or potentially unacceptable risk to human health or the environment.

6.0 Soil Sampling and Analysis Guidelines

The quantity and locations of the samples specified in the following guidance are intended to provide a good approximation of the extent of soil contamination. Additional samples should be taken from areas where contamination is known or suspected, at potential sources or along preferential pathways (e.g., underground utilities). All analyses are required to be performed using approved analytical methods. Laboratories used must be NC DWQ certified to run the approved methods.

6.1 Field Screening

Portable organic vapor analyzers (Flame Ionization Detectors, Photoionization Detectors) and immunoassay field test kits are useful tools for on-site sample screening and selecting samples for lab analysis. However, because of their lack of specificity, accuracy, reproducibility, quality assurance/quality control, etc., field-screening data will not be acceptable for confirming the presence, nature and extent of soil contamination. Final determination of soil contamination must be made by the laboratory analytical methods as specified in Tables 5, 6 and 7 (pp. T-7, 8 and 9).

6.2 Sample Preparation

The type of sample containers used depends on the type of analysis performed. First determine the type(s) of contaminants expected and the proper analytical method(s) established in Tables 5, 6, and 7 (pp. T-7, 8 and 9) (Methods for Soil Analyses).

The NC DWQ Laboratory Certification Program maintains a list of certified commercial laboratories. The list includes laboratory contact information and the analytical methods they are certified to perform. The list is available from the NC DWQ Chemistry Laboratory at 4405 Reedy Creek Road, Raleigh, NC 27607 or by calling (919) 733-3908. The Laboratory Certification Program plans to add this list to their webpage in the near future. The webpage address is <http://www.esb.enr.state.nc.us/lab/>. Table 8 (p. T-10) lists the typical collection requirements for the specified methods. Be sure to consult your selected laboratory for their specific needs and requirements before you sample.

Sampling kits for collection and transport may be purchased from some commercial laboratories. They include all the items needed (sample containers, shipping cartons, etc.) for collection and shipment of samples. If you use these services, carefully follow the instructions provided and do not discard any preservative that may have been added to the containers. If you do not choose to use a customized kit provided by your laboratory, use only new containers that are appropriate for the contaminants you are sampling. Check with the laboratory that will be running the analysis about appropriate sample containers and the preservation requirements for each method. **If proper sampling and QA/QC protocols are not followed, the DWM may consider your results invalid.**

All sample containers containing methanol must be on ice when shipped from the laboratory, before sample collection, and when shipped back to the laboratory after sample collection. The sample containers should be kept in a refrigerator from the time they are received until they are taken to the field for sample collection. In other words, all sample containers containing methanol must be kept cold from the time they leave the laboratory until the time they return to the laboratory. The reason for keeping the methanol cold at all times is to reduce the chances of

methanol vaporization, which may magnify the concentration of contaminants in the samples and subsequently lead to higher cleanup costs.

Collection devices which are not shipped with methanol (i.e., the EnCore sampler) do not need to be shipped on ice from the laboratory. However they should be put on ice before and after sample collection for shipping to the laboratory. Collecting the sample in a chilled collection device will reduce volatilization and provide a more accurate result of the amount of soil contamination.

The requirement for keeping all methanol jars cold from the time they leave the laboratory until the time they return to the laboratory introduces the question of how long jars containing methanol can be stored prior to sample collection. It is recommended that sample containers be ordered and received immediately before each sampling event. Do not store a supply of unused sample containers with methanol for long periods of time. Again, the concern with the stockpiling of sample containers with methanol is the volatilization of the methanol. This may magnify the contamination levels in the sample and subsequently cause higher cleanup costs.

It is recommended that samples be collected in sample containers containing methanol within 14 days of the date the jar was weighed in the laboratory. When the laboratories weigh the sample and record the weight on the vials, the date should also be recorded on the vials.

Label sample containers before you collect samples. Each sample label should include the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials and any other pertinent information for sample identification.

Prepare the storage and transport containers (ice chest, etc.) before taking any samples so that each sample can be immediately placed in a chilled environment.

6.3 Soil Sample Collection Procedures

Soil samples should be collected in a manner that causes the least disturbance of the internal structure of the soil and reduces its exposure to heat, sunlight and open air. Likewise, care should be taken to keep the samples from being contaminated by other material at the site, or from contaminating other samples taken from the site (i.e., the sample container should be clean and the outside should be kept uncontaminated).

When taking samples of potentially contaminated soil, care should be taken to reduce contact with skin or other body parts. The sample collector should wear disposable gloves. Gloves should be changed between samples to avoid cross-contamination. At a minimum, a clean, stainless steel spoon should be used to collect each sample. The spoon should be decontaminated between sampling events.

Ideally, samples should be collected from cores of the soil. Disturb primary samples as little as possible during acquisition. For practical reasons, however, often it may be necessary to collect samples from a backhoe bucket, hand auger or even a shovel. As long as an effort is made to reduce the loss of contaminants from, and cross contamination to the sample, any of these methods may be used.

When removed from the ground, each sample must be placed immediately in a proper container for the analysis to be performed. Refer to Table 8 (p. T-10), for the required sample containers and volume for each analytical method. As soon as the sample is collected, the container should be immediately capped, sealed and appropriately stored at 4 degrees Celsius (40 degrees Fahrenheit).

6.4 Laboratory Analytical Methods

When selecting analytical methods to determine soil contamination, refer to Tables 5, 6 and 7 (pp. T-7, 8 and 9). Releases of virgin gasoline and fuel oil (e.g., kerosene, diesel, etc.) will be assumed to be free of metals. Releases of used/waste oil or fuel oil blended with used oil (both motor oil and industrial oil) will be assumed to contain metals. Therefore, laboratory analysis for metals will be required.

A. Limited Site Assessment (Petroleum contaminated sites)

Soil sampling locations and frequency are provided in Section 4.3. All samples collected in the Phase I investigation must be analyzed using the methods (including MADEP VPH and EPH) specified in Table 5, p. T-7.

B. Other Assessment, Corrective Action, and Monitoring Activities

Samples must be analyzed in accordance with the methods specified in Tables 5, 6 and 7 (pp. T-7, 8 and 9). However, if metals and acid extractable organic compounds on the EPA Method 8270 parameter list are not detected in LSA samples, these parameters should not be analyzed for in subsequent investigation, corrective action or monitoring activities. It may also be possible to further reduce the parameters analyzed if certain other targeted contaminants are not detected in previous sampling events. For example, if only polycyclic aromatic hydrocarbons were detected in LSA samples using EPA Method 8270, it is not necessary to analyze and report any of the other base neutral organic compounds detected by EPA Method 8270 in subsequent sampling events. The responsible party should request that the laboratory report only the PAHs.

NOTE: The reporting limit ranges that are specified within each method of MADEP seem to be causing some confusion. Therefore, the UST Section is setting a reporting limit that is equivalent to the values at the top of the MADEP established range. The reporting limit for soil samples is 10 mg/kg.

C. Disposal or Treatment

Additional analytical methods may be required if contaminated soil is to be disposed or treated at a permitted facility. Contact the disposal facility for its specific requirements, and contact the UST central office at (919) 733-8486 for permit information. If TCLP metals exceed TCLP limits (see Table 13, p. T-16), then contact the Division of Waste Management's Hazardous Waste Section at (919) 733-2187 for storage, transport and disposal requirements.

6.5 Collecting and Preserving VOC and VPH Soil Samples

Collection and preservation requirements for soil samples analyzed for VOCs, including details on the use of EPA SW-846 Method 5035 are below. Modifications to Appendix 4 of the January 1998 Massachusetts Department of Environmental Protection Method for the Determination of Volatile Petroleum Hydrocarbons are also provided. An electronic copy of the MADEP VPH method is available on the Internet at www.state.ma.us/dep/bwsc/vph_eph.htm.

Collecting and Preserving VOC Soil Samples

Beginning July 1, 2001, EPA SW-846 Method 5035 will be required to preserve soil samples analyzed for VOCs by the constituent specific methods (EPA 8000-series methods).

EPA Method 5035 was developed to minimize the loss of volatile organic compounds from the field to analysis. One of the method's most significant elements is the preservation of soil samples containing VOCs with methanol prior to analysis. Methanol preservation has already been incorporated as a requirement in the MADEP VPH method. The methanol preservation options described under Collecting and Preserving VPH Soil Samples are also acceptable as options for EPA Method 5035 methanol preservation. When collecting soil samples from a petroleum UST site for both VPH and EPA 5035/8260 analysis, the methanol preserved VPH sample may also be analyzed as the "high concentration" EPA 5035/8260 sample. A single non-preserved sample collected for dry weight determination for VPH and EPA 5035/8260 may also be used for soil characterization, if the effervescence check is required.

Because methanol preservation introduces a dilution factor into the sample analysis, EPA Method 5035 recommends sodium bisulfate preservation for detecting VOCs at concentrations below 200 micrograms per kilogram (ug/kg). Currently, there are 11 VOCs with North Carolina maximum soil contaminant concentrations below 200 ug/kg (See Table 4, p. T-5). The 200 ug/kg cutoff that distinguishes "low concentration" from "high concentration" samples is based on the commonly used upper limit of the calibration range for EPA Method 8260. The "low concentration" sodium bisulfate preservation is not practical for samples containing concentrations of analytes over the calibration range of the determinative method. Because the purge-and-trap device used in Method 5035 is a closed-system, it is not possible to dilute the original sample when the observed concentration exceeds the calibration range of the method. The upper limit is both instrument and method dependent. Consult a certified laboratory before collecting samples to determine the relevant cutoff concentration for the specific determinative method you will use.

The following options are available at sites where the applicable maximum soil contaminant concentration is less than 200 ug/kg.

Option 1 Use methanol preservation if the laboratory can demonstrate that its reporting limits are at or below the cleanup standard of interest. The majority of the routine VOC soil samples can be analyzed using the "high concentration" methanol preservation technique, with the reporting limits ranging from 50 to 200 ug/kg. The laboratory must be able to document the validity of the reporting limit with Method Detection Limit studies, appropriate calibration and QA/QC procedures.

Option 2 Use sodium bisulfate or any other suitable low level preservation method with demonstrated effectiveness. (Since preservation with sodium bisulfate may result in poor sample purging efficiencies, acetone production and has limited effectiveness in reducing VOC losses due to volatilization, sodium bisulfate preservation is only recommended if expected VOC concentrations are likely to be less than 200 ug/kg, based on site conditions, site history and screening data.) **If sodium bisulfate preservation is performed in the field, consult a certified laboratory to ensure you use the correct sample containers and collection procedures. Sample size should be limited to 5 to 10 grams depending on soil type.**

NOTE: *Soil types with high concentrations of carbonate minerals may effervesce on contact with the acidic sodium bisulfate preservation solution. Samples suspected to contain high levels of carbonates require a test sample to check for effervescence. If a rapid or vigorous reaction occurs, discard the sample. Then, collect the samples in vials that do not contain the sodium bisulfate preservative solution and store at 4 degrees Celsius.*

Where field preservation is not preferred, or when there is a question as to which preservation method, "high level" methanol or "low level" sodium bisulfate, will be sufficient, you can collect samples using an EnCore™ sampler or an equivalent device. The sample must be extruded into methanol or sodium bisulfate within 48 hours of collection. This time limit requires careful coordination between field and laboratory personnel. Collect three samplers per sample location to allow one sample for high-level analysis/screening, one sample for low-level analysis and one for possible re-analysis. The samples should be taken from the same soil stratum and within as close proximity to one another as possible. Also collect a sample in a 40 or 60 ml VOA vial for dry weight determination and soil characterization (i.e., effervescence check for sodium bisulfate preservation) by the laboratory.

Collecting and Preserving VPH Soil Samples

Obtain undisturbed soil samples and preserve with methanol at a ratio of 1-mL methanol (purge and trap grade) per 1-gram soil. Samples should be collected in triplicate in 40mL or 60mL vials, two with the methanol preservative and one without, to allow for determination of soil moisture content and dry weight correction factors. The samples must be preserved with methanol. This is a critical part of the analytical method. Protect the vials and samples from exhaust fumes or other known airborne contamination at all times. The exact weight of the soil samples and volume of the methanol must be known by the laboratory. A methanol trip blank must also accompany each batch of samples.

Three sample collection options are provided in Appendix 4 of the MADEP VPH method. Options 1 and 2 are acceptable options with the modification below. Option 3 should be replaced, in its entirety, by Option 3 below. Follow the Shipping Methanol Preserved Samples section of Appendix 4 of the MADEP VPH method as written, without any modifications.

Modifications to Appendix 4 of MADEP VPH Method

Option 1 In-Field Methanol Preservation Technique (modifications to existing Option 1)

Steps 1, 2 and 3 are performed by the laboratory. Weigh containers and samples to within 0.01 gram in the laboratory. Protect prepared vials before and after sample collection by placing them in sealable plastic bags and storing them at 4 degrees Celsius. Collect samples in duplicate. A methanol trip blank is required.

Option 2 Use of a Sealed-Tube Sampling/Storage Device (modifications to existing Option 2)

Soil samples may be obtained in specially designed and approved air tight sampling devices, such as the EnCore™ sampler, provided the sampling devices are cooled and maintained at 4 degrees Celsius before and after sample addition. Collect samples in duplicate. Samples must be extruded and preserved in methanol in the laboratory within 48 hours of collection. Laboratories will need the EnCore™ Extrusion Tool to extrude the soil, or a similar device as specified by

other manufacturers for their airtight samplers. Check with the laboratory being used before collecting samples, to make sure that the necessary equipment is available to open the devices and to ensure that the 48-hour holding time can be met. Protect the sample containers and labels from moisture with sealable plastic bags.

Option 3 In-Field Methanol Preservation Technique with Field Weighing (Replaces existing Option 3 in Appendix 4 of MADEP VPH method)

Laboratories will provide samplers with labeled, pre-weighed sampling vials, including a methanol trip blank, that contain measured amounts of purge and trap grade methanol. When the laboratories weigh the sampling vials, they should record the date on the vial. The prepared vials will be maintained at 4 degrees Celsius.

Collect samples in duplicate. Add the appropriate amount of soil to the VOA sample vials (15 grams to a 40-mL vial, 25 grams to a 60-mL vial), weigh them, record weights on the labeled sample vials, then return all vials to the laboratory. Samplers must wear new disposable gloves throughout the sample collection procedure. They must change gloves between samples to avoid cross-contamination.

Laboratory Preparation of Vials

1. Add 15 mL of **purge-and-trap grade methanol** to duplicate 40-mL VOA vials with open top screw caps and Teflon-coated septa. Add 25 mL if using 60-mL VOA vials. Include a methanol trip blank and a glass jar, or other appropriate containers per sample set for dry weight determination.
2. Seal the vials with the screw caps and septum seals.
3. Affix a label to each vial. This eliminates the need to label the vials in the field and assures that the tare weight of the vial includes the label (the weight of any markings added to the label in the field is negligible).
4. Calibrate an electronic balance and weigh each prepared sample vial to within 0.01 gram. Record the tare weight and the date on the label. Store the prepared vials at 4 degrees Celsius and protect them with sealable plastic bags for transport to the field.

Shelf-life of methanol preserved bottles

The requirement for keeping all methanol vials cold from the time they leave the laboratory until the time they return to the laboratory introduces the question of how long vials containing methanol can be stored before sample collection. Sample containers should be ordered and received immediately before each sampling event. We recommend that you not store a supply of sample containers with methanol unused for long periods of time. The concern when stockpiling sample containers that contain methanol is the volatilization of the methanol. Volatilization may magnify the contamination levels in the sample and subsequently result in higher cleanup costs. We recommend that samples collected in containers holding methanol be used within 14 days of the date the vial was prepared and weighed in the laboratory. When the laboratories weigh the sample and record the weight on the vials, they should also record the date on the vials.

NOTE: *Vials containing methanol should be weighed a second time on the day that they are to be used. Vials found to have lost methanol (reduction in weight of ≥ 0.01 g if weighed in the laboratory or ≥ 0.2 g if weighed in the field) should not be used to collect samples.*

Sample Collection

Regardless of which sampling option is used (i.e., in-field methanol preservation with fill-line, EnCore™ sampler/sealed tube sampling/storage device with laboratory preservation, or in-field methanol preservation with field weighing) the desired ratio of methanol-to-soil should be 1-ml methanol to 1-gram soil, $\pm 25\%$. A soil sample with a minimum weight of 15 grams is required. The exact weight of the soil sample and the volume of methanol must be determined by the laboratory when calculating and reporting soil concentration data.

NOTE: *The 1:1 soil-to-solvent ratio appears to work well for solid samples (e.g., sandy soil) that do not expand to soak up the methanol when it is added. On the other hand, many samples, such as those with a high organic content, may expand and soak up all the methanol, making it impossible to remove the methanol extract from the sample container for purging purposes. If the solvent does not cover all of the soil, volatile analytes will escape into the headspace and not be captured in the aliquot of solvent removed from the vial for analysis. In all cases, the soil sample in the vial must be completely covered by methanol.*

Step 1: Obtain labeled and pre-weighed 40-mL or 60-mL VOA vials with open top screw caps that have Teflon-coated septa. Each vial should contain 15 mL or 25 mL of **purge-and-trap grade methanol** respectively. (Collect 15.0 grams of soil into a 40-mL vial, or 25.0 grams into a 60-mL vial.) Obtain enough to collect duplicate samples, a methanol trip blank, and an empty container per location to collect soil for calculating moisture content and dry weight.

Step 2: Transport the pre-labeled and weighed vials that contain the appropriate volume of methanol to the field in a cooler, which maintains a temperature of 4 degrees Celsius. Take precautions to avoid exposing the vials to exhaust fumes or other known airborne contaminants at all times. Use disposable gloves while collecting samples.

Step 3: Calibrate a field electronic balance to weigh 15.0 grams of soil, to the nearest 0.01 gram, for a 40-mL vial. The calibration check weight should approximate the expected combined weight of the closed sample vial containing methanol and the soil sample. Use a 10-30 mL disposable plastic syringe with the end cut off, or a special soil sampler, to obtain an undisturbed soil sample from freshly exposed soils. Collect soil samples within a few minutes, at most, from the time when the surface of the soil has been exposed to the atmosphere.

NOTE: *Collect trial samples with the syringe, weigh and note the length of the soil column in the syringe to determine the length of soil corresponding to 15.0 ± 0.5 grams. Discard all trial samples.*

Step 4: Collect a soil sample, open a sample vial, and immediately extrude the soil sample into the vial carefully to avoid splashing methanol out of the container. Use a clean brush or paper towel to quickly brush any soil off the vial threads, then immediately seal the vial with the septum and screw cap. Wipe off any soil adhering to the outside of the vial. Gently swirl the sample to break up any soil clumps, if necessary, but do so only until the soil is covered with methanol. **The soil sample must be completely covered by methanol.**

Step 5: Weigh the sealed vial containing the soil sample to ensure that 15.0 ± 0.5 grams of sample were added. Record the weight of the sealed vial, to within 0.01 gram, on the vial label. Obtain a duplicate sample in the same manner.

Step 6: Collect a soil sample in a vial without methanol so that the laboratory can calculate moisture content and dry weight.

NOTE: *Because water is completely miscible with methanol, naturally occurring moisture contained in the soil sample may result in under-reporting of the true, dry weight VOC concentrations. In general, every percent of moisture (by weight) present in a soil sample will result in a negative bias of about 1 percent. It is the responsibility of the data user to determine the significance of this effect on a site-specific basis. However, moisture contents less than 25% by weight are generally not considered a significant concern. No data adjustments are to be done by the laboratory relative to this issue, although laboratories may reference this phenomenon in the case narrative as a reason for low surrogate recoveries, when appropriate.*

Step 7: First, place each vial in a separate sealable plastic bag immediately after collection to protect against leakage during transport. Then, quickly place each sample container in a cooler in an upright position. Transport the samples to the analytical laboratory maintaining a temperature of 4 degrees Celsius, and use appropriate chain-of-custody procedures and forms. The samples must be analyzed within 28 days of collection.

Shipping Sample Containers/Collection Devices on Ice

All sample containers containing methanol must be on ice when shipped from the laboratory, before sample collection, and when shipped back to the laboratory after sample collection. The sample containers should be kept in a refrigerator from the time they are received until they are taken to the field for sample collection. In other words, all sample containers containing methanol must be kept cold from the time they leave the laboratory until the time they return to the laboratory. The reason for keeping the methanol cold at all times is to reduce methanol vaporization, which may magnify the concentration of contaminants in the samples and subsequently increase cleanup costs.

The collection devices which are not shipped with methanol (i.e., the En Core™ sampler) do not need to be shipped on ice from the laboratory, but should be put on ice before and after sample collection for shipping to the laboratory. Collecting the sample in a chilled collection device will reduce volatilization and provide a more accurate result of the amount of contamination in the soil.

NOTE: *Prepared vials and samples must be shipped according to U.S. Department of Transportation Regulations, Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179). Available on the Internet at <http://www.access.gpo.gov/nara/cfr/cfr-table-search.html>.*

(No modifications to Appendix 4 of the MADEP VPH method.)

SHIPPING METHANOL PRESERVED SAMPLES

NOTE: *Methanol is a toxic and flammable liquid, and must be handled with appropriate care. Use in a well-vented area and avoid inhaling methanol vapors. The use of protective gloves is recommended when handling or transferring methanol. Vials of methanol should always be*

stored in a cooler with ice at all times. Vials should be kept away from sources of ignition such as extreme heat or open flames.

Shipping of Hazardous Materials

Methanol is considered a hazardous material by the US Department of Transportation and the International Air Transport Association. Shipments of methanol between the field and the laboratory must conform to the rules established in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and the most current edition of the IATA Dangerous Goods Regulations. Review these documents or consult with your shipping company for complete details. Both are available on the Internet at <http://www.access.gpo.gov/nara/cfr/cfr-table-search.html> and <http://www.iata.org/cargo/dg/index.htm>, respectively.

Small Quantity Exemption

The volumes of methanol recommended in the VPH method fall under the small quantity exemption of 49 CFR Section 173.4. To qualify for this exemption, all of the following conditions must be met:

- ▣ The maximum volume of methanol in each sample container must not exceed 30 ml.
- ▣ The sample container must not be full of methanol.
- ▣ The sample container must be securely packed and cushioned in an upright position, and must be surrounded by a sorbent material capable of absorbing spills from leaks or broken sample containers.
- ▣ The package weight must not exceed 64 pounds.
- ▣ The volume of methanol per shipping container must not exceed 500 ml.
- ▣ The packaging and shipping container must be strong enough to hold up to the intended use.
- ▣ The package must not be opened or altered while in transit, and
- ▣ The shipper must mark the shipping container as required when shipping dangerous goods in acceptable quantities. The shipper must provide the statement,
"This package conforms to conditions and limitations specified in 49 CFR 173.4".

Shipping Papers

All shipments must be accompanied by shipping papers which include the following:

Proper Shipping Name:	Methyl Alcohol
Hazardous Class:	Flammable Liquid
Identification Number:	UN1230
Total Quantity:	(ml methanol/container x the number of containers)
Emergency Response Info:	Methanol MSDS attached
Emergency Response Phone:	provide appropriate number
Shipping Exemption:	DOT-E 173.118, Limited Quantity

Labeling & Placarding

Labeling and placarding is not required for valid small quantity exemptions (per 49 CFR Section 173.118).

6.6 Sampling Stockpiled Soil

Sampling of the stockpile should be performed immediately before applying for a permit or before soil disposal. Samples should be collected and handled as described in Section 6.3. The analytical methods for soil analysis are specified in Table 14, p. 17. Check with the disposal facility concerning analytical requirements for disposal.

A. Number of Samples

The sampling protocol that follows is designed to determine the average contamination level in the stockpile. The number of samples required is based on the volume of the stockpiled soil. One composite sample must be taken and analyzed for each 200 cubic yards of the stockpile. The volume of the stockpile can be determined by either calculating from the specific geometry of the pile and/or the excavation, or by approximating from the general geometry of the pile as specified in Figure 12, p. F-15. If the volume is approximated, use the maximum dimensions as indicated by the sketches for the different shapes of stockpiles in Figure 12. Once the volume is determined, lay out a grid that divides the pile into square blocks with equal surface area.

A composite soil sample is composed of six primary soil samples. To achieve one composite sample, three primary soil samples must be collected from each of two randomly selected borings. These two selected borings must be performed for each 200 cubic yard grid block of stockpiled soil. Primary samples should be collected from borings as shown in Figure 13, p. F-16. This will result in a total of six primary samples (one composite) from each 200 cubic yard grid block of stockpiled soil. For soil sample collection procedures, see Section 6.3.

B. Primary Samples

Primary samples that are to be analyzed must be mixed into a composite sample by a DWQ approved laboratory under controlled conditions and by a qualified laboratory technician. Each composite sample must consist of a mixture of at least six primary samples of equal size. Mixing should be performed quickly, but in a manner that effectively combines the primary samples so that all portions of the mixture can be reasonably considered to contain nearly equal portions of each component primary sample. Because homogenization will, by its very nature, allow some loss of the most volatile petroleum constituents, care should be taken to perform the mixing under the best available environmental conditions to minimize this loss. Each composite sample should be analyzed in accordance with the methods listed in Table 14, p. 17.

6.7 Analytical Requirements for Disposal/Treatment of Contaminated Soil

Contaminated soil must be disposed of properly or treated at a permitted facility. The analytical requirements will be determined by the facility and the permit. The approved methods for soil analysis are presented in Table 14, p. T-17. To dispose of contaminated soil, it may also be necessary to analyze soil samples for the toxicity characteristic using EPA Methods 1311 or the toxicity characteristic leaching procedure. If any contaminant exceeds the regulatory limits established for TCLP, the contaminated soil must be stored, transported and disposed of as a hazardous waste. The TCLP regulatory limits are provided in Table 13, p. T-16. Contact the Division of Waste Management's Hazardous Waste Section at (919) 733-2178 for more information.

There is a provision in EPA 1311 (TCLP) that allows use of a total waste analysis to demonstrate that a waste does not exhibit the toxicity characteristic. The following formula may be used to make this determination for a contaminant. Table 13 (p. T-16) provides the maximum

concentration of contaminants for the toxicity characteristic. **This equation is not to be used to establish cleanup levels.**

$$M = C/20 \quad \text{where:}$$

M = maximum theoretical leachate concentration (mg/L);
 C = concentration of analyte in the solid (mg/kg) (total contaminant concentration);
 and
 mg/L = ppm = mg/kg.

6.8 Sample Storage and Transport

If necessary add prescribed preservatives before filling the sample containers. After filling the containers, seal them firmly to prevent headspace and store them for transport in a manner that will prevent breakage. The samples should be kept at a temperature of approximately 4° Celsius following collection. Add ice, if necessary, and transport to a DWQ-certified laboratory as soon as possible. Avoid unnecessary handling of sample containers. Avoid heating (room temperature or above, including exposure to sunlight) or freezing of the sample containers. Reduce the time between sample collection and delivery to a laboratory whenever possible. Be sure that the analytical holding times (see Table 8, p. T-10) of your samples are met.

Be sure that the sample containers are labeled with the sample location, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials, and any other pertinent information for sample identification. The labels should contain a unique identifier (e.g., soil boring number) that can be traced to the chain-of-custody form.

A chain-of-custody form must be completed to accompany the samples to the laboratory. The COC must include the following:

- 1) each sample identification number, the number of sample containers and sampling location;
- 2) signature of the sample collector;
- 3) the date and time of sample collection;
- 4) the analytical method to be performed;
- 5) the sample type (i.e., composite, grab, water or soil);
- 6) the regulatory agency (i.e., NCDENR/DWM – UST Section);
- 7) signatures of all persons relinquishing and receiving custody of samples; and
- 8) the dates and times of custody transfers.

6.9 Laboratory Reports

Results of analyses must be included in the appropriate report, or as specified by a permit. Submit them to the appropriate regional office, or to the person specified in a permit, if you are doing compliance monitoring. The laboratory reporting forms for the MADEP VPH and EPH methods are located in Figures 14 and 15 (pp. F-17 and F-18) and should be used by the laboratories to report results to the responsible parties. These forms should be included in the reports submitted to the UST Section. The forms are available for download, in Excel format, from <http://ust.enr.state.nc.us>. Using these forms will allow the information to be easily identifiable to the consultants and UST Section staff. It will also promote consistency in the data

review. All compounds analyzed using a certified method must be reported. A laboratory report should include the following, all of which should be submitted to the Department in the appropriate reports:

1. NC DWQ Laboratory Certification Number, Contact and phone number.
2. Client/Facility name & address.
3. Date of report preparation.
4. Chain-of-Custody form.
5. Case Narrative. (It should be written on laboratory letterhead and signed by the laboratory supervisor or his/her designee. It should include a detailed description of all problems encountered in the analysis and a discussion of possible reasons for any QA/QC criteria outside acceptance limits.)
6. Summary of Analytical Results, including:
 - Client's sample identification and the corresponding laboratory identification,
 - Sample matrix,
 - Dates of and methods of analysis, preparation and/or extraction,
 - Weight or volume of sample used for analysis/extraction/digestion,
 - Dilution or concentration factor for the samples,
 - Percentage of moisture in the soil samples,
 - Definitions of any data qualifiers,
 - Method Detection Limit and Reporting Limit (Practical Quantitation Limit), and
 - Analytical results.
7. Summary of QA/QC Results, including:
 - Method Blank results and field or trip blank results if applicable,
 - Surrogate recoveries,
 - Laboratory QC Check sample results with percent recoveries and control limits,
 - Laboratory duplicate results with relative percent difference, and
 - Matrix spike/matrix spike duplicate results (if performed on your sample).

NOTES: *For target analytes with maximum soil contaminant concentrations or groundwater quality standards below laboratory reporting limits, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and flagged as estimated. The most sensitive of the approved methods must be used to determine compliance or noncompliance with the standards established in 15A NCAC 2L .0202. The reporting limit concentration must be indicated for all target analytes, and must be supported by the inclusion of a calibration standard at this concentration in the calibration curve. In addition, the laboratory reporting forms require that units be included with all reported values. The units used must be noted on the form. The concentrations for soil results should be reported in mg/kg (ppm) and results for aqueous samples should be reported in ug/L (ppb).*

There has been some confusion on the reporting of the aliphatic and aromatic petroleum hydrocarbon ranges in the MADEP VPH and EPH methods. The reported ranges should be the unadjusted ranges. In other words, the target analytes should NOT be subtracted from the range value, as was previously indicated on the laboratory forms. The reported ranges should exclude the concentrations of any surrogate(s), internal standards and/or concentrations of other ranges that elute within a specified range. The updated Laboratory Report Forms for the MADEP VPH and EPH methods are included in Figures 14 and 15 (pp. F-17 and F-18) of this document. They are also available in electronic format from the web page at <http://ust.enr.state.nc.us>.

When samples are analyzed by both VPH and EPH methods, the laboratory will report results for all six analytical hydrocarbon fractions. Figure 16 (p. F-19) is included as guidance for combining VPH and EPH results for comparison to the MSCCs. Combine the VPH C9-C10 aromatic results and EPH C11-C22 aromatic results to calculate the total for the C9-C22 aromatic fraction. Combine the VPH C9-C12 aliphatic results and EPH C9-C18 aromatic results to calculate the total for the C9-C18 aliphatic fraction. To determine if cleanup of soil contamination is necessary, compare these to the appropriate MSCCs for the toxicologically defined hydrocarbon fractions. The reporting limit, not to be confused with regulatory limits such as MSCC or TCLP values, of the methods for each of the collective aliphatic and aromatic fractional ranges is approximately 2-10 mg/kg in soil. Occasionally, the concentration of one of the hydrocarbon fractions to be combined is less than the reporting limit and greater than the method detection limit. If the addition of the concentration for this fraction causes the total to exceed the MSCC, contact the central office at 919-733-8486 for guidance.

The target analyte concentrations must still be reported for the constituent-specific methods (e.g., EPA 8260, EPA 8270).

REFERENCES

American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1992. *Methods for Determining Organic Compounds in Drinking Water*. Standard Methods for the Examination of Water and Wastewater. U.S. EPA publication number EPA-600/4-79-020 or the most recent edition.

Arizona Department of Health Services. Information Update #52. *EPA 5035 Implementation*. November 1998. Available on the Internet at <http://www.hs.state.az.us/lab/license/updates/>.

International Air Transport Association. *Dangerous Goods Regulations*. Issued annually. Available on the Internet at <http://www.iata.org/cargo/dg/index.htm>.

Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure. State of California Leaking Underground Fuel Tank Task Force, October 1989.

Massachusetts Department of Environmental Protection. *Method for the Determination of Extractable Petroleum Hydrocarbons*. January 1998. Available on the Internet at http://www.state.ma.us/dep/bwsc/vph_eph.htm.

Massachusetts Department of Environmental Protection. *Method for the Determination of Volatile Petroleum Hydrocarbons*. January 1998. Available on the Internet at http://www.state.ma.us/dep/bwsc/vph_eph.htm.

Massachusetts Department of Environmental Protection. *Preservation Techniques for Volatile Organic Compound (VOC) Soil Sample Analyses*. Available on the Internet at http://www.state.ma.us/dep/bwsc/vph_eph.htm.

U.S. EPA. *Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods*. U.S. EPA publication number SW-846. Third Edition, June 1997. Available on the Internet at <http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm>.

U.S. EPA. 1999. *Test Procedures for the Analyses of Pollutants under the Clean Water Act*. Federal Register Vol. 49, No. 209, 40 CFR Part 136, October 26, 1984 or the most recent edition.

U.S. EPA 500 Series - *Methods for the Determination of Organic Compounds in Drinking Water*, U.S. EPA - 600/4-88/039.

U.S. EPA 600 Series -Federal Register, latest EPA approval edition of 40 CFR Part 136. Copies available from Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, telephone (202) 512-1800.

U.S. EPA Office of Solid Waste. Memorandum. *Clarification Regarding Use of SW-846 Methods*. August 1998.

Std. Methods 6000 Series -*Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 18th Edition, 1992 or latest EPA-approved edition.

7.0 Groundwater Sampling and Analysis Guidelines

Groundwater samples are collected to investigate, assess and monitor the concentration of dissolved constituents. Follow proper sampling procedures when collecting samples to obtain representative results. To properly assess the groundwater contaminant plume, first install sampling points (monitoring wells, etc.), collect groundwater samples and then perform specific laboratory analyses. All monitoring wells should be constructed in accordance with 15A NCAC 2C .0100 and sampled as outlined in this section.

7.1 Field Screening

Several methods are commercially available for screening groundwater samples in the field for contamination. However, because of the lack of specificity, accuracy, precision, reproducibility, etc., associated with field screening methods, they are not approved for the determination of groundwater contamination.

One common method of screening is the pushprobe technology. Pushprobes (e.g., Direct Push, Push Probing, Geoprobings, Direct Point Sampling, Hydraulic Probe Sampling, Hydrocone, Geocone, etc.) are considered rapid assessment tools. That are designed to aid in the assessment of contaminated soil and groundwater. This technology has the potential for saving money by strategically locating and reducing the number of future monitoring wells.

To determine the site-specific feasibility of this technology, the consultant should evaluate the depth of groundwater and soil permeability by performing the first phase of assessment activities (e.g., installation of soil borings, monitoring wells, etc.). If this information is already available or the consultant is confident in using the pushprobe technology for the first phase of assessment this evaluation may not be necessary. It may be difficult to recover samples in certain geological settings such as a site with a shallow groundwater table and sandy soil, which is typical of the Coastal Plains physiographic region. Using this technology on a site with poor site-specific conditions could result in failed attempts. For purposes of the STF, failed attempts to perform this technology will not be reimbursed; certain performance requirements apply (see STF Reasonable Rate Document for more information, which is available from the UST Section Web site at <http://ust.enr.state.nc.us> or, for a fee, the UST Section Central Office; see Figure 1, p. F-1.).

For sites with moderate to large plumes, it may be feasible to use a DWQ-certified mobile laboratory to perform on-site soil and groundwater analyses while performing the probe survey. However, a non-mobile DWQ-certified laboratory may be sufficient for small quantity sampling. Regardless of which type of laboratory is selected, a DWQ certified laboratory must perform the specific soil and groundwater analytical methods required.

NOTE: *For purposes of STF reimbursement, in situ soil gas sampling will not be reimbursable. Instead, use only DWQ approved analytical methods for soil and groundwater. If a mobile laboratory is used, it must be certified by DWQ. To acquire a list of all DWQ certified mobile laboratories, along with the methods for which they are certified, please call the NC DWQ Chemistry Laboratory at (919) 733-3908.*

7.2 Sample Preparation

The type of sample containers used depends on the type of analysis performed. First, determine the type(s) of contaminants expected and the proper analytical method(s) established in Tables 10 and 11, pp. T-13 and T-14 (Methods for Groundwater Analyses).

The NC DWQ Laboratory Certification Program generates a list of certified commercial laboratories. The list includes laboratory contact information and the analytical methods they are certified to perform. A copy of the list may be obtained from the NC DWQ Chemistry Laboratory at 4405 Reedy Creek Road, Raleigh, NC 27607, or requested by calling (919) 733-3908. The Laboratory Certification Program plans to add this list to their web page in the near future. The Web page address is <http://www.esb.enr.state.nc.us/lab/>. Table 12 (p. T-15) lists the typical collection requirements for the specified methods. Be sure to consult with your selected laboratory for its specific needs and requirements prior to sampling.

Sampling kits for sample collection and transport may be purchased from some commercial laboratories and include all the items needed (sample containers, shipping cartons, etc.) for collection and shipment of samples. If you use these services, carefully follow the instructions provided and do not discard any preservative that may have been added to the containers. If you do not choose to use a customized kit provided by your laboratory, use only new containers of the appropriate type for the contaminants for which you are sampling. Check with the laboratory that will be running the analysis about appropriate sample containers and preservation requirements for each method. **If proper sampling and QA/QC protocols are not followed, the Department may consider your results invalid.**

Label sample containers prior to sample collection. Each sample label should include the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials and any other pertinent information for sample identification.

Prepare the storage and transport containers (ice chest, etc.) before taking any samples so that each collected sample can be placed in a chilled environment immediately after collection.

All sampling equipment (bailers, tubing, containers, etc.) must be selected based on its chemical compatibility with the source being sampled (e.g., water supply well, monitoring well) and the contaminants potentially present. All sampling equipment should be thoroughly decontaminated and transported in a manner that does not allow it to become contaminated. Arrangements should be made ahead of time for decontamination of any sampling or measuring equipment that will be reused when taking samples from more than one well. Field decontamination of sampling equipment will be necessary before sampling each well to minimize the risk of cross contamination. Decontamination procedures should be included in reports as necessary.

7.3 Groundwater Sample Collection Procedures

Wells must be purged of all standing water in the well, pump, etc, because standing water is not representative of the groundwater within the aquifer. To determine how much water should be purged, a calculation needs to be performed using the amount of water in the well and the well diameter (calculation provided in Section 7.3B).

A. Water Supply Wells

Water supply wells are sampled to ensure that groundwater used for human consumption is not contaminated. Samples should be collected using the existing pump system. Samples should be collected as close to the well head as possible. Generally this will be the first spigot on the line. Occasionally, water samples may have to be collected from inside a building or house.

Before sample collection, water within the delivery system must be adequately purged. The system should be flushed at the maximum flow rate the spigot will allow for at least 10 - 15 minutes. Longer running times may be required for large diameter wells or if the well uses a large capacity water tank (e.g., pressure tank). When collecting samples for VOCs, the flow rate must be reduced to a minimum to avoid aerating the sample. Also, if collecting the sample from a kitchen or bathroom faucet, the aerator (screen) must be removed prior to sample collection.

Additional information about the construction of the well should be collected. Include the following, as available: depth of well, use of well, well diameter, well yield, screened interval (if applicable), depth to pump (if submersible), depth of casing and static water level.

NOTE: *Sampling of water supply wells will not be considered a substitute for monitoring well sampling.*

1. Uncontaminated Water Supply Wells

Initially, residential or public water supply wells which are located within a 500-foot radius of the source area of the release should be sampled. If the closest wells become impacted by the release, then the next closest wells should be sampled and so forth. To ensure State Trust Fund reimbursement, care must be used when sampling beyond impacted wells, unless otherwise approved by the regional office. Sampling and reporting the results for each uncontaminated well should be repeated semi-annually or as otherwise specified by the appropriate regional office.

If contamination is detected, copies of the lab report must be submitted to the well user, well owner, appropriate Department regional office, and the local health department. Questions regarding effects to the health of individuals should be directed to the local health department or the NC Occupational and Environmental Epidemiology Branch at (919) 733-3410.

If no contamination is detected, the analytical results need to be submitted to only the person utilizing the well and to the appropriate regional office.

2. Contaminated Water Supply Wells

If analysis of samples extracted from a residential or public water supply well has previously indicated contamination, and the NC Occupational and Environmental Epidemiology Branch has determined the well is still useable to some degree, samples should be collected at the frequency advised by the state's toxicologist. A summary of historical analytical results may be requested with each laboratory analysis submitted to the toxicologist. If the toxicologist does not recommend a time interval for re-sampling, the well should be sampled semi-annually or as otherwise specified by the appropriate regional office.

NOTE: *Toxicological evaluations should be forwarded to the well user and the local health department. Sampling should be discontinued once the toxicologist advises the water is not suitable for further use, once an alternate water supply has been provided to the affected party, or as otherwise required by the regional office.*

3. Reduction of Sampling Activities

Re-sampling of contaminated water supply wells that are still suitable for limited use and uncontaminated water supply wells will occur at a frequency established by the regional office once an active groundwater remediation system is in place to minimize further migration of the plume. Unless otherwise specified, sampling will be conducted on an annual basis.

Sampling may be eliminated altogether for those water supply wells located adjacent to an array of shallow and/or deep monitoring wells, sufficient to detect plume movement and provide for the protection of human health. However, contact the local regional office before you eliminate any sampling efforts.

4. Sampling Methodology

Samples should be analyzed in accordance with groundwater analytical methods specified in other sections of this guidance document.

5. Alternate Water

a) Petroleum contaminated UST site

Pursuant to 15A NCAC 2L .0106(b), any person conducting or controlling an activity which results in the discharge of a waste or hazardous substance or oil to the groundwaters of the State, or in proximity thereto, shall take immediate action to terminate and control the discharge, mitigate any hazards resulting from exposure to the pollutants, and notify the Department of the discharge. This includes providing alternate water to households with contaminated water supplies. Provision of alternate water shall be determined by whether the analytical results show concentrations greater than the appropriate water quality standards or the state toxicologist determines that the water supply presents a health risk. Depending on the level of contamination present, bottled water, a point-of-entry carbon filtration system, or other alternatives may be required. If the responsible party does not immediately provide alternate water to the well owners, the UST Section must be notified so that UST Section staff may initiate the process of supplying alternate water for each affected household. The State must recover costs expended for such activities from the person(s) identified as the responsible party. Options for providing a safe source of alternate drinking water may be discussed with the regional office.

b) Non-petroleum contaminated UST site

The Department may require responsible parties to provide alternate water to households with contaminated water supplies. Depending on the level of contamination present, bottled water, a point-of-entry carbon filtration system or other alternatives may be necessary. Options for providing a safe source of alternate drinking water may be discussed with the regional office.

6. Abandoning Wells or Making Connection to Municipal Water

The purpose of connecting water supply well users to municipal water is intended to eliminate a contaminated source of drinking water or eliminate the risk of water supply contamination. The appropriate regional office should be contacted prior to the abandonment of wells or connection to municipal water supplies.

NOTE: *The provisions for protection of human health described above must be followed until a permanent alternate water supply has been provided to each residence.*

B. Monitoring Wells

1. Measuring Water Levels

A pre-established point of known elevation on the highest point of the well casing should be used for each consecutive water level measurement. Water level measurements should be measured to the nearest hundredth of an inch before any sampling activities. Measurements taken with an electric water level meter will directly indicate the depth to water by emitting an audible and/or visible alarm. When using a steel tape to collect water levels, record the holding mark and the wet level mark from the tape. The difference between the holding mark and the wet level mark is the depth to water. Subtracting the elevation of the measuring point from the depth to water will yield head.

All water level measuring equipment must be decontaminated prior to each water level taken. If water levels are taken at multiple contaminated wells, begin with the least contaminated well and work toward the most contaminated well.

2. Purging the Well

Wells must be adequately purged prior to sample collection to ensure representation of the aquifer formation water rather than stagnant well water. This may be achieved by purging the well until the field parameters of pH, specific conductivity and temperature stabilize; by purging three well volumes from the well; or by one fully dry purge. *[Stabilization is defined as three consecutive readings (within 5%) taken at least five minutes apart.]*

The volume of water contained in a well may be mathematically derived or approximated by multiplying the length of well section which contains water (in feet) by one of the following conversion factors based on the diameter of the well casing.

[Total well depth (ft) – Depth to water (ft)] x Well diameter conversion (gal/ft) = 1 well Volume (gals)

2" diameter casing = 0.16 gallons per foot
 3" diameter casing = 0.37 gallons per foot
 4" diameter casing = 0.65 gallons per foot
 6" diameter casing = 1.5 gallons per foot
 8" diameter casing = 2.6 gallons per foot
 10" diameter casing = 4.1 gallons per foot
 12" diameter casing = 5.9 gallons per foot

Water samples must be collected within 24 hours of purging. If pumping or bailing of the well effectively removes all water in the well, a sample may be collected after recovery (provided that recovery is within 24 hours of purging).

NOTE: *Muddy or severely turbid samples may be an indication of improper well construction. Therefore, the analytical results for these samples may not be accepted by the regional office or reimbursed by the STF.*

3. Handling Purged Water

All contaminated purged water must be disposed of in an environmentally sound manner. Contact the appropriate regional office for disposal procedures (see Appendix D).

C. Sample Collection

To prevent accidental contamination during sampling, spread clean plastic sheeting around the well to protect sampling equipment from the ground surface and wear a new pair of disposable gloves for each well sampled.

After wells are purged, collect samples using a positive-displacement bladder pump or bailer. To avoid cross-contamination, **do not** use any equipment in more than one well without proper decontamination prior to reuse. Do not use vacuum systems to collect groundwater samples for volatile contaminants. Documentation of decontamination and sampling procedures must be incorporated into all appropriate reports, see Appendix B.

1. Pumps

To purge standing well water and to avoid having silt locking the pump, place the pump a few feet below the top of the water column. Never set the pump on the bottom of the well. When pumps of any type are used for sampling, the flow rate must be adjusted low enough to fill the sampling jar effectively. When collecting samples for volatile contaminants, a flow rate of less than 100 ml/min ($\frac{1}{2}$ cup/min) is required to fill a VOA vial without aerating the sample. Fill the VOA vial slowly to avoid volatilization of contaminants. Also, pour enough to create an upper meniscus above the top of the vial; this will help to prevent leaving air space in the sample vial when it is closed. A gentle tap on the side of the vial may be necessary to loosen any small bubbles. Replace the cap and invert the vial - no bubbles should be present. If a bubble is present do not try to open the vial and eliminate the bubbles more than twice.

2. Bailers

When sampling with a bailer, lower the bailer slowly into the well to avoid aeration of the water or agitation of particulate matter within the well. Retract the bailer slowly and gently empty the sample into the appropriate container until the correct volume has been collected. If collecting a volatile sample, fill the VOA vial slowly to avoid volatilization of contaminants. Also, pour enough to create an upper meniscus above the top of the vial; this will help to prevent leaving air space in the sample vial when it is closed. A gentle tap on the side of the vial may be necessary to loosen any small bubbles. Replace the cap and invert the vial - no bubbles should be present. If a bubble is present do not try to open the vial and eliminate the bubbles more than twice.

3. MADEP VPH and EPH: Aliphatics/Aromatics (Petroleum releases only)

The volatile samples that will be analyzed by the MADEP VPH method should be collected in duplicate without agitation or headspace in 40mL vials preserved with HCl, similar to the procedure used in sampling for EPA 601/602. The semi-volatile samples that will be analyzed using MADEP EPH method should be collected in a one liter amber bottle preserved with HCl. Refer to Table 12 (p. T-15).

7.4 General Decontamination Procedures

Decontamination procedures should be based on the composition (type) of sampling equipment being used and the type(s) of suspected or known contaminants. All equipment used in the field must be thoroughly decontaminated between consecutive measurements or sampling events to prevent cross-contamination. Decontamination procedures must be submitted with appropriate reports.

A. Bailer lines

To minimize the possibility of cross-contamination, braided nylon or cotton cord should not be reused, even if cleaned. Teflon coated wire, single strand stainless wire or other monofilament line can be reused, if thoroughly cleaned between use.

B. Pumps

The inside and outside of pumps and reusable hoses/lines must be cleaned or replaced between use. Ensure that hoses, lines and exposed gaskets are either constructed of non-reactive materials or replaced between use.

7.5 Sample Storage and Transport

Add any prescribed preservatives before filling the sample containers if necessary. After filling the containers, seal firmly to prevent leakage and store samples for transport in a manner that will prevent breakage. The samples must be kept at a temperature of approximately 4 ° Celsius following collection. Add ice, if necessary, and transport to the DWQ certified laboratory of your choice as soon as possible. Avoid unnecessary handling of sample containers. Small sample containers which require cooling (VOAs, etc.), should be placed in self-sealing bags before being submerged in ice. Avoid heating (room temperature or above, including exposure to sunlight) or freezing of the sample containers. Reduce the time between sample collection and delivery to a laboratory whenever possible and be sure that the analytical hold times (Table 12, p. T-15) of your samples are met.

Be sure that the sample containers are labeled with the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials and any other pertinent information for sample identification. The labels should contain an unique identifier (i.e., unique well numbers) that can be traced to the chain-of-custody form.

A chain-of-custody form must be completed and accompany the samples to the laboratory. The COC must include the following:

- 1) each sample identification number, the number of sample containers and sampling location/well number,
- 2) signature of the sample collector,
- 3) the date and time of sample collection,
- 4) the analytical method to be performed,
- 5) the sample type (i.e., composite, grab, water or soil),
- 6) the regulatory agency (i.e., NCDENR/DWM – UST Section),
- 7) signatures of all persons relinquishing and receiving custody of samples, and
- 8) the date and times of custody transfers.

7.6 Laboratory Analytical Methods

When selecting analytical methods to determine groundwater contamination, refer to Tables 10 and 11 (pp. T-13 and T-14). Releases of virgin gasoline and fuel oil (e.g., kerosene, diesel, etc.) are assumed to be free of metals, or at concentrations less than the allowable limits. Releases of used oil, waste oil or fuel oil blended with used oil (both motor oil and industrial oil) will be assumed to contain metals and laboratory analysis for metals will be required.

A. Limited Site Assessment (Petroleum USTs only)

Groundwater sampling locations are provided in Section 4.3. The groundwater samples collected from the source area monitoring well during the Phase I investigation must be analyzed using the methods specified in Table 10 (p. T-13). For the Phase II investigation, metals and the acid extractable organic compounds should be eliminated from the analytical requirements if these parameters were not detected in the Phase I analyses.

NOTE: The reporting limit ranges that are specified within each method of MADEP seem to be causing some confusion. Therefore, the UST Section has set a reporting limit that is equivalent to the values at the top of the MADEP established range. The reporting limit for aqueous samples is 100 ug/L.

B. 45 Day Report (Non-petroleum USTs)

Groundwater sampling locations are described in Section 5.0. The groundwater samples collected from the monitoring wells must be analyzed using appropriate methods from Table 11 (p. T-14).

C. Further Assessment, Corrective Action, and Monitoring Activities

Samples must be analyzed in accordance with the methods specified in Tables 10 and 11 (pp. T-13 and T-14). However, if metals and acid extractable organic compounds are not detected in the LSA or 45 Day Report samples, these parameters need not be analyzed in subsequent investigation, corrective actions, or monitoring activities. It may also be possible to further reduce the parameters to be analyzed if certain other targeted contaminants were not detected in previous sampling events. For example, if only polycyclic aromatic hydrocarbons were detected in initial samples, it is not necessary to continue analysis and reporting any of the other base neutral organic compounds detected in subsequent sampling events. The responsible party should request that the laboratory report only the PAHs.

7.7 Laboratory Reports

Results of analyses must be included in the appropriate report or as specified by a permit and submitted to the appropriate regional office or to the person specified in a permit if doing compliance monitoring. The laboratory reporting forms for the MADEP VPH and EPH methods are located in Figures 14 and 15 (pp. F-17 and F-18) and should be used by the laboratories to report results to the responsible parties. These forms should be included in the reports submitted to the UST Section. The forms are available for download, in Excel format, from <http://ust.enr.state.nc.us>. Using these forms will allow the information to be easily identifiable to the consultants and UST Section staff. It will also promote consistency in the review of the data. All compounds analyzed using a certified method must be reported. A laboratory report should include the following, all of which should be submitted to the Department in the appropriate reports:

1. NC DWQ Laboratory Certification Number, Contact and phone number
2. Client/Facility name & address
3. Date of report preparation
4. Chain-of-Custody form
5. Case Narrative (It should be written on laboratory letterhead and signed by the laboratory supervisor or his/her designee. It should include a detailed description of all problems

encountered in the analysis and a discussion of possible reasons for any QA/QC criteria outside acceptance limits.

6. Summary of Analytical Results, including:
 - Client's sample identification and the corresponding laboratory identification,
 - Sample matrix,
 - Dates of and methods of analysis, preparation and/or extraction,
 - Weight or volume of sample used for analysis/extraction/digestion,
 - Dilution or concentration factor for the samples,
 - Definitions of any data qualifiers,
 - Method Detection Limit and Reporting Limit (Practical Quantitation Limit), and
 - Analytical results.
7. Summary of QA/QC Results, including:
 - Method Blank results and field or trip blank results, if applicable,
 - Surrogate recoveries,
 - Laboratory QC check sample results with percent recoveries and control limits,
 - Laboratory duplicate results with relative percent difference, and
 - Matrix spike/matrix spike duplicate results (if performed on your sample).

The target analyte concentrations must still be reported for the constituent-specific methods. The updated Laboratory Report Forms for the MADEP VPH and EPH methods are included in Figures 14 and 15 (pp. F-17 and F-18) of this document. They are also available in electronic format from the Web page at <http://ust.enr.state.nc.us>.

NOTES: *For target analytes with maximum soil contaminant concentrations or groundwater quality standards below laboratory reporting limits, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and flagged as estimated. The most sensitive of the approved methods must be used to determine compliance or noncompliance with the standards established in 15A NCAC 2L .0202. The reporting limit concentration must be indicated for all target analytes, and must be supported by the inclusion of a calibration standard at this concentration in the calibration curve. In addition, the laboratory reporting forms require that units be included with all reported values. The units used must be noted on the form. The concentrations for soil results should be reported in mg/kg (ppm) and results for aqueous samples should be reported in ug/L (ppb).*

There has been some confusion on the reporting of the aliphatic and aromatic petroleum hydrocarbon ranges in the MADEP VPH and EPH methods. The reported ranges should be the unadjusted ranges. In other words, the target analytes should NOT be subtracted from the range value, as was previously indicated on the laboratory forms. The reported ranges however should exclude the concentrations of any surrogate(s), internal standards and/or concentrations of other ranges that elute within a specified range.

When samples are analyzed by both VPH and EPH methods, the laboratory will report results for all six analytical hydrocarbon fractions. Figure 17 (p. F-20) is included as guidance for combining VPH and EPH results for comparison to the groundwater standards. Combine the VPH C9-C10 aromatic results and EPH C11-C22 aromatic results to calculate the total for the C9-C22 aromatic fraction. Combine the VPH C9-C12 aliphatic results and EPH C9-C18 aromatic results to calculate the total for the C9-C18 aliphatic fraction. Compare these to the appropriate groundwater standards for the toxicologically defined hydrocarbon fractions. The

reporting limit (RL) of the methods for each of the collective aliphatic and aromatic fractional ranges is approximately 50-100 ug/L in water. Do not confuse this limit with regulatory limits such as GCL or Groundwater Quality Standard values. Occasionally, the concentration of one of the hydrocarbon fractions to be combined is less than the reporting limit, but greater than the method detection limit. If the addition of the concentration for this fraction causes the total to exceed the groundwater standard, contact the central office at (919) 733-8486 for guidance.

Sample filtration in the field is not permitted for any analyses and the analytical results of field-filtered samples will not be accepted by the Department. The Standard Method 3030C, Preliminary Treatment for Acid-Extractable Metals, will be the only accepted preparation method for metals analyses. This method does include laboratory filtration, which should only be performed by qualified laboratory personnel. The sample must be acidified in the field with 5-ml of concentrated nitric acid per liter of sample and submitted to the laboratory for preparation within 72 hours of collection. A 0.45-micron filter must be used for laboratory filtration following the acid extraction.

REFERENCES

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International Air Transport Association. *Dangerous Goods Regulations*. Issued annually. Available on the Internet at <http://www.iata.org/cargo/dg/index.htm>.

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Massachusetts Department of Environmental Protection. *Method for the Determination of Extractable Petroleum Hydrocarbons*. January 1998. Available on the Internet at http://www.state.ma.us/dep/bwsc/vph_eph.htm.

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U.S. EPA. *Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods*. U.S. EPA publication number SW-846. Third Edition, June 1997. Available on the Internet at <http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm>.

U.S. EPA. 1999. *Test Procedures for the Analyses of Pollutants under the Clean Water Act*. Federal Register Vol. 49, No. 209, 40 CFR Part 136, October 26, 1984 or the most recent edition.

U.S. EPA 500 Series - *Methods for the Determination of Organic Compounds in Drinking Water*, U.S. EPA - 600/4-88/039.

U.S. EPA 600 Series -Federal Register, latest EPA approval edition of 40 CFR Part 136. Copies available from: Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, telephone (202) 512-1800.

U.S. EPA Office of Solid Waste. Memorandum. *Clarification Regarding Use of SW-846 Methods*. August 1998.

Std. Methods 6000 Series -*Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association and Water Pollution Control Federation, 18th Edition, 1992 or latest EPA-approved edition.

Table 4
Maximum Soil Contaminant Concentrations

Constituent	CAS#	Residential Soil Cleanup Levels (mg/kg)	Industrial/ Commercial Soil Cleanup Levels (mg/kg)	Soil-to-Water Maximum Contaminant Concentration (Soil mg/kg)
Acenaphthene	83-32-9	940	24000	8
Acenaphthylene	208-96-8	469	12264	11
Acetone	67-64-1	1564	40880	3
Aliphatics, C5-C8	N/A	939	24528	72
Aliphatics, C9-C18	N/A	9386	245280	3255
Aliphatics, C19-C36	N/A	93860	#	##
Anthracene	120-12-7	4600	122000	995
Aromatics, C9-C22	N/A	469	12264	34
Barium	7440-39-3	1095	28616	848
Benzene	71-43-2	22	200	0.0056
Benzo(a)anthracene	56-55-3	0.88	8	0.34
Benzo(b)fluoranthene	205-99-2	0.88	8	1
Benzo(g,h,i)perylene	191-24-2	469	12264	6720
Benzo(k)fluoranthene	207-08-9	9	78	12
Benzo(a)pyrene	50-32-8	0.088	0.78	0.091
Benzoic Acid	65-85-0	62571	1635200	112
Bis(chloroethyl)ether (BCEE)	111-44-4	0.58	5.2	0.0002
Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	46	410	6.67
n-Butylbenzene	104-51-8	156	4088	4
sec-Butylbenzene	135-98-8	156	4088	3
tert-Butylbenzene	104-51-8	156	4088	3
Carbon disulfide	75-15-0	1564	40880	4
Chloroform (trichloromethane)	67-66-3	100	938	0.001
Chloromethane (methyl chloride)	74-87-3	49	440	0.02
Chromium (Total)	7440-50-8	47	1226	27
Chromium III	16065-83-1	23460	613200	27
Chromium VI	18540-29-9	47	1226	27
Chrysene	218-01-9	88	780	38
Dibenz(a,h)anthracene	53-70-8	0.088	0.78	0.17
Dibenzofuran	132-64-9	62	1635	4.7
Dibromochloromethane	124-48-1	7	68	0.002
1,2-Dibromoethane (EDB)	106-93-4	0.0075	0.067	0.00000197
1,2-Dichlorobenzene	95-50-1	1400	36000	7
1,3-Dichlorobenzene	541-73-1	1400	36000	24
1,4-Dichlorobenzene	106-46-7	27	240	1
1,1-Dichloroethane	75-34-3	1560	40000	4
1,2-Dichloroethane (ethylene dichloride)	107-06-2	7	63	0.0018

Constituent	CAS#	Residential Soil Cleanup Levels (mg/kg)	Industrial/ Commercial Soil Cleanup Levels (mg/kg)	Soil-to-Water Maximum Contaminant Concentration (Soil mg/kg)
1,2-Dichloroethene (cis)	156-59-2	156	4000	0.35
1,2-Dichloroethene (trans)	156-60-5	320	8200	0.38
1,1-Dichloroethylene	75-35-4	1	10	0.045
1,2-Dichloropropane	78-87-5	9	84	0.0029
1,3-Dichloropropene (cis and trans)	542-75-6	4	33	0.0009
2,4-Dimethylphenol	105-67-9	312	8176	0.9
Ethyl Acetate	141-78-6	14078	367920	11
Ethylbenzene	100-41-4	1560	40000	0.24
Fluoranthene	206-44-0	620	16400	276
Fluorene	86-73-7	620	16400	44
Hexachlorobutadiene	87-68-3	3.1	73	0.26
2-Hexanone (Methyl n-butyl ketone)	591-78-6	625	16352	1.9
Indeno(1,2,3-cd)pyrene	193-39-5	0.88	8	3
Isopropyl benzene (Cumene)	98-82-8	1564	40880	2
Isopropyl ether (diisopropyl ether)	108-20-3	156	4088	0.37
Lead	7439-92-1	400	400	270
Methanol	67-56-1	7821	204400	14
Methyl ethyl ketone (2-Butanone)	78-93-3	9385	245280	0.7
Methyl tert-butyl ether (MTBE)	1634-04-4	156	4088	0.92
Methylene chloride	75-09-2	85	763	0.02
2-Methylnaphthalene	91-57-6	63	1635	3
Naphthalene	91-20-3	63	1635	0.58
Phenanthrene	85-01-8	469	12264	60
n-Propylbenzene	103-65-1	156	4088	2
Pyrene	129-00-0	469	12264	286
Silver	7440-22-4	78.2	2044	0.23
Styrene (ethenylbenzene)	100-42-5	3128	81760	2.24
1,1,2,2-Tetrachlorethane	79-34-5	3	28	0.001
Tetrachloroethylene(PCE, perchloroethylene)	127-18-4	12	110	0.0074
1,2,4-Trichlorobenzene	120-82-1	156	4088	2.6
Trichloroethylene (TCE)	79-01-6	58	520	0.0183
1,2,4-Trimethylbenzene	95-63-6	782	20440	8
1,3,5-Trimethylbenzene	108-67-8	782	20440	7
Toluene	108-88-3	3200	82000	7
Xylenes (mixed)	1330-20-7	32000	200000	5

Health based level > 100%

Considered immobile

Table 5
Analytical Methods for Petroleum Contaminated Soil

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	1) EPA 5035 sample preparation and 8260* with IPE & MTBE AND 2) MADEP VPH: Aliphatics/Aromatics	Any amount above the MDL
2. Medium/High Boiling Point Fuels: jet fuels, kerosene, diesel, varsol, mineral spirits, naphtha, fuel oil #2, etc.	1) EPA 5035 sample preparation and 8260* with IPE & MTBE, 2) MADEP VPH: Aliphatics/Aromatics, 3) EPA 8270**, AND 4) MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
3. Heavy Fuels: #4, #5, #6 fuel oils; motor oil; hydraulic fluid; etc.	1) EPA 8270** AND 2) MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
4. Used / Waste Oil	1) EPA 5035 sample preparation and 8260* with IPE & MTBE, 2) MADEP VPH: Aliphatics/Aromatics, 3) EPA 8270**, 8081 (pesticides)***, 8082 (PCBs)*** 4) MADEP EPH: Aliphatics/Aromatics, AND 5) EPA 3050 or 3051 Preparation: Total Metals (Chromium and Lead)	Any amount above the MDL

* EPA Method 8021 may be used in place of EPA Method 8260, if MDLs are equivalent or lower.

** Plus ten largest peaks identified. Once contaminants have been initially identified by GC/MS methods, more economical compound specific methods may be used.

*** PCBs and pesticides are not required for service station/garage waste oil.

NOTES: 1) Other EPA approved comparable methods, which have similar costs, the same constituents and equivalent or lower detection limits, may be used if analyses are conducted by a NC DWQ certified laboratory that is certified for the method. 2) Report all results on a "dry weight" basis. 3) Submit copies of original laboratory reports. 4) Method Detection Limits and Reporting Limits: For target analytes with Maximum Soil Contaminant Concentrations below laboratory reporting limits, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and flagged as estimated. The reporting limit concentration must be indicated for all target analyte,s and must be supported by the inclusion of a calibration standard at this concentration in the calibration curve.

Table 6
Analytical Methods for Petroleum-Contaminated Soil
for Releases Reported before June 1, 1998
(i.e., the March 1997 Approved Methods)

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	5030 sample preparation with a modified 8015 (California GC-FID Method).	Any amount above the MDL
2. Medium/High Boiling Point Fuels: jet fuels, kerosene, diesel, varsol, mineral spirits, naphtha, fuel oil #2, etc.	5030 AND 3550 sample preparation with a Modified 8015 (California GC-FID Method).	Any amount above the MDL
3. Heavy Fuels: #4, #5, #6 fuel oils; motor oil; hydraulic fluid; etc.	EPA Method 9071 - (Oil & Grease)	Any amount above the MDL
4. Used / Waste Oil	1. EPA Method 8021 or 8260 (Volatiles) AND 2. EPA Method 9071 (Oil & Grease)* AND 3. EPA 3050 or 3051 Preparation: Total Metals (Chromium and Lead)	Any amount above the MDL

* If 9071 concentration is > 250 ppm, then run 8270 for semi-volatiles with PCBs. (PCBs are not required for service station/ garage waste oil).

NOTES: 1) Other EPA approved comparable methods, which have similar costs, the same constituents and equivalent or lower detection limits, may be used if analyses are conducted by a NC DWQ certified laboratory that is certified for the method. 2) Report all results on a "dry weight" basis. 3) Submit copies of original laboratory reports. 4) Method Detection Limits and Reporting Limits: For target analytes with Maximum Soil Contaminant Concentrations below laboratory reporting limits, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and flagged as estimated. The reporting limit concentration must be indicated for all target analytes, and must be supported by the inclusion of a calibration standard at this concentration in the calibration curve.

Table 7
Analytical Methods for Non-Petroleum Contaminated Soil
(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Metals	EPA 3050B or 3051 Preparation: Total Metals (site specific)	Any amount above the MDL
2. Halogenated Solvents	EPA Method 8021 or 8260, using 5035 sample preparation	Any amount above the MDL
3. Non-Halogenated Solvents	EPA Method 8021 or 8260 (8015 if appropriate for known solvent), using 5035 sample preparation	
4. Non-Petroleum - Unknown	EPA Method 8260 (volatiles) using 5035 sample preparation, 8270 (semi-volatiles), 8081 (pesticides) and 8082 (PCBs), AND EPA 3050B or 3051 Preparation: Total Metals (RCRA Metals: Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium and Silver)	Any amount above the MDL
5. Pesticides	Contact NC Dept. of Agriculture & Consumer Services/ Pesticide Section (919) 733-3556 AND NC DENR / UST Section at (919) 733-8486	Any amount above the MDL
6. For substances not covered in 1 through 5	Contact NC DENR / UST Section (919) 733-8486	Any amount above the MDL

NOTES: 1) Other EPA approved comparable methods, which have the same constituents and equivalent or lower detection limits, may be used if analyses are conducted by a NC DWQ certified laboratory that is certified for the method. 2) Report all results on a "dry weight" basis. 3) Submit copies of original laboratory reports. 4) Method Detection Limits and Reporting Limits: For target analytes with Maximum Soil Contaminant Concentrations below laboratory reporting limits, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and flagged as estimated. The reporting limit concentration must be indicated for all target analytes, and must be supported by the inclusion of a calibration standard at this concentration in the calibration curve.

Table 8
Sample Containers and Preservatives for Soil Analyses
(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Method	Container	Preservative	Holding Times
EPA 5030/Modified 8015 (California Method)	4-oz glass jar with Teflon-lined septa screw cap	Cool to 4°C	14 days
MADEP VPH	Duplicate VOA vials with Teflon-lined screw caps (for 40-mL vials; add 15g soil , for 60mL vials; add 25g soil) VOA vial w/o preservative*	Cool to 4°C AND Methanol preservation (field OR laboratory)	28 days
	Duplicate Encore samplers or equivalent VOA vial w/o preservative*	Cool to 4°C AND Complete laboratory preservation within 48 hours	
EPA 5035/8260 EPA 5035/8021 EPA 5035/8015	Triplicate VOA vials with Teflon-lined screw caps (for 40-mL vials; add 15g soil , for 60mL vials; add 25g soil) VOA vial w/o preservative* Triplicate Encore samplers or equivalent VOA vial w/o preservative*	Cool to 4°C AND Sodium Bisulfate** or Methanol preservation (field OR laboratory) Cool to 4°C AND Complete laboratory preservation within 48 hours	14 days
EPA 3550/Modified 8015 (California Method) EPA 8270 EPA 8081 EPA 8082	8-oz glass jar with Teflon-lined screw cap	Cool to 4°C	Extract within 14 days and analyze extracts within 40 days of extraction.
MADEP EPH	4-oz (120-mL) wide-mouth amber glass jar with Teflon-lined screw cap	Cool to 4°C	Extract within 7 days and analyzed extracts within 40 days of extraction.
Total Metals	4-oz polyethylene or glass jar	Cool to 4°C	6 months

* Use for dry weight determination and for soil characterization (i.e., effervescence check) of low concentration samples suspected to contain carbonate minerals.

** If low level sodium bisulfate or equivalent preservation is required, check with the laboratory that will be doing the analysis for any other requirements. Sample size should be limited to 5 to 10 grams, depending on soil type. See Section 6 for additional details.

Table 9
Gross Contamination Levels for Groundwater

Compound	CAS #	North Carolina Groundwater Quality Standards* (GWQS) (ug/l)	Gross Contamination Levels for Groundwater (GCL) (ug/l)	BASIS
Acenaphthene	83-32-9	80	2120	SOL
Acenaphthylene	208-96-8	210	1965	SOL
Acetone	67-64-1	700	700000	STD
Anthracene	120-12-7	2100	2100	STD
Barium	7440-39-3	2000	2000000	STD
Benzene	71-43-2	1	5000	DWSTD
Benzo(a)anthracene	56-55-3	0.05	22	SOL
Benzo(b)fluoranthene	205-99-2	0.047	0.6	SOL
Benzo(g,h,i)perylene	191-24-2	210	210	STD
Benzo(k)fluoranthene	207-08-9	0.47	0.47	STD
Benzoic acid	65-85-0	28000	1450000	SOL
Benzo(a)pyrene	50-32-8	0.0047	1.5	SOL
Bis(2-chloroethyl)ether (BCEE)	111-44-4	0.031	31	STD
Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	3	3000	STD
n-Butylbenzene	104-51-8	70	6900	SOL
sec-Butylbenzene	135-98-8	70	8500	SOL
tert-Butylbenzene	104-51-8	70	15000	SOL
Carbon disulfide	75-15-0	700	700000	STD
Chlorodibromomethane	124-48-1	0.41	410	STD
Chloroform (trichloromethane)	67-66-3	0.00019	190	STD
Chloromethane (Methyl Chloride)	74-87-3	2.6	2600	STD
Chromium	7440-50-8	50	50000	STD
Chrysene	218-01-9	5	5	STD
Dibenz(a,h)anthracene	53-70-3	0.0047	0.25	SOL
Dibenzofuran	132-64-9	28	28000	STD
1, 2- Dibromoethane (EDB)	106-93-4	0.0004	50	DWSTD
1, 2-Dichlorobenzene	95-50-1	620	72500	SOL
1, 3-Dichlorobenzene	541-73-1	620	61500	SOL
1, 4-Dichlorobenzene	106-46-7	75	39500	SOL
1, 1-Dichloroethane	75-34-3	700	700000	STD
1, 2-Dichloroethane (ethylene dichloride)	107-06-2	0.38	380	STD
1, 1-Dichloroethylene	75-35-4	7	7000	STD
1, 2-Dichloroethene (cis)	156-59-2	70	70000	STD
1, 2-Dichloroethene (trans)	156-60-5	70	70000	STD
1, 2-Dichloropropane	78-87-5	0.56	560	STD
1, 3-Dichloropropene (cis and trans)	542-75-6	0.2	200	STD
2,4-Dimethylphenol	105-67-9	140	140000	STD

Compound	CAS #	North Carolina Groundwater Quality Standards* (GWQS) (ug/l)	Gross Contamination Levels for Groundwater (GCL) (ug/l)	BASIS
Ethyl Acetate	141-78-6	2600	2600000	STD
Ethylbenzene	100-41-4	29	29000	STD
Fluoranthene	206-44-0	280	280	STD
Fluorene	86-73-7	280	950	SOL
Hexachloro-1,3-butadiene	87-68-3	0.44	440	STD
2-Hexanone (Methyl n-Butyl Ketone)	591-78-6	280	280000	STD
Indeno(1,2,3-cd)pyrene	193-39-5	0.047	31	SOL
Isopropyl benzene	98-82-8	70	25000	SOL
Isopropyl ether (Diisopropyl ether)	108-20-3	70	70000	STD
Lead	7439-92-1	15	15000	STD
Methanol	67-56-1	3500	3500000	STD
Methyl Ethyl Ketone (MEK)	78-93-3	170	170000	STD
2-Methylnaphthalene	91-57-6	28	12500	SOL
Methyl tert-butyl ether (MTBE)	1634-04-4	200	200000	STD
Methylene chloride	75-09-2	5	5000	STD
Naphthalene	91-20-3	21	15500	SOL
Phenanthrene	85-01-8	210	410	SOL
n-Propylbenzene	103-65-1	70	30000	SOL
Pyrene	129-00-0	210	210	STD
Silver	7440-22-4	0.018	18000	STD
Styrene (ethenylbenzene)	100-42-5	0.1	100000	STD
1,1,2,2-Tetrachloroethane	79-34-5	0.17	170	STD
Tetrachloroethylene (PCE)	127-18-4	0.7	700	STD
Toluene	108-88-3	1000	257500	SOL
1,2,4-Trichlorobenzene	120-82-1	70	9500	SOL
Trichloroethylene (TCE)	79-01-6	2.8	2800	STD
1,2,4-Trimethylbenzene	95-63-6	350	28500	SOL
1,3,5-Trimethylbenzene	108-67-8	350	25000	SOL
Vinyl chloride	75-01-4	0.015	15	STD
Xylenes (mixed)	1330-20-7	530	87500	SOL

SOL – 50% of the solubility at 25 degrees Celsius

DWSTD – 1,000 x federal drinking water standard (40 CFR 141)

STD – 1,000 x North Carolina groundwater quality standard (15A NCAC 2L .0202)

* Includes interim Groundwater Quality Standards

Table 10
Analytical Methods for Petroleum Contaminated Groundwater
(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	1) MADEP VPH: Aliphatics/Aromatics, 2) Lead (Std. Methods 3030C* Prep.) AND 3) Std. Method 6210D with IPE & MTBE OR Std. Method 6230D with IPE & MTBE OR EPA Methods 601 and 602 with IPE, MTBE, EDB** and Xylenes	Any amount above the MDL
2. Medium/High Boiling Point Fuels: kerosene, diesel, varsol, mineral spirits, naphtha, jet fuels, fuel oil #2, etc.	1) 602 with Xylenes 2) MADEP VPH: Aliphatics/Aromatics 3) EPA Method 625 plus 10 largest non-target peaks identified AND 4) MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
3. Heavy Fuels: #4, #5, #6 fuel oil; motor oil; hydraulic fluid; etc.	1) 625 plus 10 largest non-target peaks identified AND 2) MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
4. Used / Waste Oil	1) Std. Method 6210D 2) MADEP VPH: Aliphatics/Aromatics 3) 625 plus 10 largest non-target peaks identified 4) MADEP EPH: Aliphatics/Aromatics AND 5) Metals (Standard Methods 3030C* prep.): lead and chromium	Any amount above the MDL

* Conditions: 1) Total holding time is 72 hours after collection,
2) Use 0.45 micron filter for laboratory filtration.

** For identifying EDB, use EPA Method 504.1, initially and at closure.

NOTES: 1) Other EPA approved comparable methods, which have the same constituents, costs and equivalent or lower detection limits, may be used if analyses are conducted by a NC DWQ certified laboratory that is certified for the method. 2) All MDLs must be performed at or below the standards as outlined in 15A NCAC 2L. 3) Once contaminants have been initially identified by GC/MS methods, more economical compound specific methods may be used.

Table 11**Analytical Methods for Non-Petroleum Contaminated Groundwater**

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Metals	Standard Methods 3030C*prep: (site specific metals)	Any amount above the MDL
2. Solvents: a. Halogenated/Non-Halogenated b. Ethylene Glycol c. Formaldehyde	a. Standard Methods 6230D or 6210D b. EPA 8015 c. Chromatropic Acid Method	Any amount above the MDL
3. Non-Petroleum - Unknown	1) EPA 624 or Std. Method 6210D, 2) EPA 625 plus 10 largest non-target peaks identified AND 3) Metals (Standard Methods 3030C*prep): RCRA Metals (Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium and Silver)	Any amount above the MDL
4. Pesticides	Contact NC Dept. of Agriculture & Consumer Services/ Pesticide Section at (919) 733-3556 AND NC DENR / UST Section at (919) 733-8486	Not Applicable
5. For substances not covered in 1 - 4	Contact NC DENR / UST Section at (919) 733-8486	Not Applicable

* Conditions: 1) Total holding time is 72 hours after collection,
2) Use 0.45 micron filter for laboratory filtration.

NOTES: 1) Other EPA approved comparable methods, which have the same constituents and equivalent or lower detection limits, may be used if analyses are conducted by a NC DWQ certified laboratory that is certified for the method.. 2) All MDLs must be performed at or below the standards as outlined in 15A NCAC 2L. 3) Sample filtration in the field is not permitted for any analyses, and the analytical results of the field-filtered samples will not be accepted by the Department. 4) Once contaminants have been identified by GC/MS methods, more economical compound specific methods may subsequently be used.

Table 12**Sample Containers and Preservatives for Groundwater Analyses**

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Sample Type/Method	Container	Preservative	Holding Times
EPA 601/602 EPA 624 SM 6210D SM 6230D MADEP VPH	Duplicate 40-mL VOA vials with Teflon-lined septa screw cap	Add 3 to 4 drops of 1:1 HCl Cool to 4°C	14 days
MADEP EPH	1-L amber glass with Teflon-lined screw cap	Add 5-mL of 1:1 HCl (to pH <2) Cool to 4°C	Samples must be extracted within 14 days and extracts analyzed within 40 days.
EPA 625	1-L amber glass with Teflon-lined screw cap	Cool to 4°C	Samples must be extracted within 7 days and extracts analyzed within 40 days.
SM 3030C (Metals)	500-mL polyethylene or glass jar	Add 5-mL of 1:1 HNO ₃ (to pH<2) Cool to 4°C Submit to lab within 48 hours of collection	3030C prep within 72 hours of collection and analyze within 6 months of prep.

* Check with the laboratory that will be doing the analysis for any other requirements.

APPENDIX C

GROUNDWATER SECTION GUIDELINES FOR THE INVESTIGATION AND REMEDICATION OF SOIL AND GROUNDWATER (2000 GUIDELINES) [SECTIONS 5.0, 6.0, 8.0 AND 9.0; TABLES 1, 2 AND 5]

GROUNDWATER SECTION GUIDELINES FOR THE INVESTIGATION AND REMEDIATION OF SOIL AND GROUNDWATER

STATE of NORTH CAROLINA
DEPARTMENT of ENVIRONMENT and NATURAL RESOURCES
DIVISION of WATER QUALITY
GROUNDWATER SECTION
<http://gw.ehnr.state.nc.us>
July 2000

5.0 Cleanup Requirements for Contaminated Soil

The goal of soil restoration is to ensure that groundwater contamination does not occur or continue to occur. Table 1 outlines the required analytical methods for contaminated soil. In response to the need for a simple method for contaminant identification and to lower the cost of analysis, the Groundwater Section has chosen to use the TPH analyses for suspected or known petroleum contamination. The TPH Action Levels are as follows:

Analytical Method	Action Level
EPA Method 8015/5030	10 ppm TPH
EPA Method 8015/3550	40 ppm TPH
EPA Method 9071 (Oil & Grease)	250 ppm Oil & Grease

In the event petroleum contaminated soil is located near the groundwater, the Regional Office may require analyses in addition to or in lieu of TPH. These additional requirements are outlined in Table 2, however you should contact the appropriate Regional Office to determine if they are necessary. *Please note that the use of a Site Sensitivity Evaluation (SSE) has been discontinued.*

Soil cleanup levels have been established for some commonly encountered compounds. The soil-to-groundwater maximum soil contaminant concentrations were established to protect groundwater from the leaching of contaminants in soil. Residential maximum soil contaminant concentrations have also been developed to protect the health of children and adult residents that may be exposed to contaminated soil. The soil-to-groundwater levels are generally much lower than the residential levels. **Contaminated soil must be cleaned up to the residential or soil-to-groundwater maximum contaminant concentrations, whichever are lower.** Contaminated soil clean-up levels are provided in Table 3. *The most recent version of these cleanup levels may be downloaded from the Internet from the following web site address – <http://gw.ehnr.state.nc.us>.*

The equations used by the Department to calculate the soil-to-groundwater maximum soil contaminant concentrations are provided in Figure 3. The soil organic carbon-water partition coefficients, soil-water partition coefficients and Henry's Law Constants used to calculate the soil-to-groundwater maximum contaminant concentrations for organic and inorganic compounds were obtained from the following references:

- EPA, 1996. Soil Screening Guidance: Technical Background Document. (EPA/540/R95/128);
- EPA, 1986. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response (EPA/540/1-86/060);
- Agency for Toxic Substances and Disease Registry, "Toxicological Profile for [individual chemical]." U.S. Public Health Service;
- Montgomery, J.H., 1996. Groundwater Chemicals Desk Reference. CRC Press, Inc.;
- Sims, R.C., J.L. Sims and S.G. Hansen, 1991. Soil Transport and Fate Database, Version 2.0. EPA Robert S. Kerr Environmental Laboratory; and
- Baes, C.F., III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. Oak Ridge National Laboratory;
- Other appropriate, published, peer-reviewed and scientifically valid data.

Table 1
Required Analyses for Contaminated Soil

(Laboratories must be certified by the North Carolina DWQ to perform the following methods)

Suspected Contaminants	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	5030 sample preparation with a modified 8015 (California GC-FID Method).	Any Amount Above the MDL
2. Medium/High Boiling Point Fuels: jet fuels, kerosene, diesel, varsol, mineral spirits, naphtha, fuel oil #2, etc.	5030 AND 3550 sample preparation with a Modified 8015 (California GC-FID Method).	Any Amount Above the MDL
3. Heavy Fuels: #4, #5, #6 fuel oils; motor oil; hydraulic fluid; etc.	EPA Method 9071 - (Oil & Grease)	250 ppm
4. Used / Waste Oil	1. EPA Method 8021 or 8260 (Volatiles) AND 2. EPA Method 9071 (Oil & Grease) AND 3. EPA 8082 (PCB's) AND 4. EPA 3050 or 3051 Preparation: Total Metals (Chromium and Lead)	250 ppm for Oil and Grease AND Any Amount Above the MDL for others
5. Metals	Total Metals	Any Amount Above the MDL
6. Halogenated Solvents	EPA Method 8021 or 8260	Any Amount Above the MDL
7. Non-Halogenated Solvents	EPA Method 8021 or 8260 (8015 if appropriate for known solvent)	
8. Non-Petroleum – Unknown	8260 (volatiles), 8270 (semi-volatiles), 8081 (pesticides), 8082 (PCBs) AND Total Metals	Any Amount Above the MDL
9. Pesticides	Contact NC Dept of Agriculture/Pesticide Section (919) 733-3556 AND GW Section Regional Office	Any Amount Above the MDL
10. Substances not covered above	Contact Groundwater Section Regional Office	Any Amount Above the MDL

NOTES: (1) Report all results on a "dry weight" basis, (2) Submit copies of original lab reports, (3) For analytical methods associated with a Corrective Action Plan under .0106(k) or (l), see the 2L "Implementation Guidance", (4) Other comparable EPA-approved methods which target the same constituents as the listed methods and have equivalent or lower detection limits may be used if analyses are conducted by a DWQ-certified laboratory and prior approval is obtained from the appropriate Regional Office. (5) **Additional analytical methods may be required if contaminated soil is to be disposed of or treated at a permitted facility. Contact the disposal facility for its specific requirements.**

Abbreviations

GC-FID = Gas Chromatograph and Flame Ionization Detector
MDL = Method Detection Limit

EPA = Environmental Protection Agency
PCBs = Polychlorinated biphenyls

Table 2
Additional Analyses for Petroleum-Contaminated Soil
(May be required by GW Section depending on site-specific conditions)

(Laboratories must be certified by the North Carolina DWQ to perform the following methods)

Suspected Contaminants	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	EPA 8260 or 8021 with IPE & MTBE	Any Amount Above the MDL
2. Medium/High Boiling Point Fuels: jet fuels, kerosene, diesel, varsol, mineral spirits, naphtha, fuel oil #2, etc.	1. EPA 8260 or 8021 AND 2. EPA 8270	Any Amount Above the MDL
3. Used / Waste Oil	1. EPA 8260 or 8021 (volatiles) AND 2. EPA Method 9071 (Oil & Grease) AND 3. EPA 8082 (PCBs) AND 4. EPA Method 3050 or 3051 Preparation: Total Metals (Chromium and Lead)	250 ppm for Oil & Grease AND Any amount above the MDL for other analytes

NOTES: (1) Report all results on a "dry weight" basis, (2) Submit copies of original lab reports (3) For analytical methods associated with a Corrective Action Plan under .0106(k) or (l), see the 2L "Implementation Guidance. (4) Other comparable EPA-approved methods which target the same constituents as the listed methods and have equivalent or lower detection limits may be used if analyses are conducted by a DWQ-certified laboratory and prior approval is obtained from the appropriate Regional Office. (5) Additional analytical methods may be required if contaminated soil is to be disposed of or treated at a permitted facility. Contact the disposal facility for its specific requirements.

Abbreviations

EPA = Environmental Protection Agency
MDL = Method Detection Limit
PCBs = Polychlorinated biphenyls

IPE = Isopropyl ether
MTBE = Methyl tertiary butyl ether

Cleanup levels for soil contaminated by non-petroleum products not listed in Table 3 will be based on site-specific information. The responsible party must determine a cleanup level that is protective of human health and that will not result in a violation of the groundwater quality standards or interim standards established in 15A NCAC 2L .0202. Naturally occurring background levels may be considered in determining a cleanup level for metals in soil.

The appropriate Regional Office will consider all reasonable proposals for cleanup levels. The methods used to determine appropriate cleanup levels must be well documented. This documentation should include information and references on the strengths and limitations of the methods, technical articles, and case studies (if available).

The use of a suitable contaminant transport model will likely be necessary to demonstrate that the concentration of a contaminant in soil will not result in a violation of groundwater standards. Whenever possible, site-specific data including depth of contamination, depth to the water table, depth to bedrock, and soil characteristics such as permeability, organic carbon fraction, bulk density, etc. should be incorporated into the model.

Biodegradation may be factored into a transport model only if a contaminant is capable of being degraded under the conditions present at the site. Biodegradation may be considered only if site-specific evidence is provided demonstrating that it is occurring.

If selecting a computer transport model, the user should consider the track record of the program. A well-documented modeling package that has been field tested by a number of workers and documented in the literature is recommended. In addition, the user should select a model with inherent assumptions that are appropriate for the site conditions. The minimum documentation required for modeling includes:

- Name, version and developer of the model;
- Type of site for which the model is applicable;
- Critical conceptual assumptions and estimates of input values;
- Calibration process;
- Range of values used and the results of sensitivity analyses on critical data inputs; and
- Graphical representation and narrative explanation of the modeling results.

NOTE: *All assumptions and estimated values, including biodegradation rates, must be conservative (predict reasonable-worst case scenario) and must be well documented.*

REFERENCES

Eisenberg, D.M., and others, 1985, Guidelines for Addressing Fuel Leaks, California Regional Quality Control Board San Francisco Bay Region, 43 pp.

US EPA 1990, Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, US EPA SW-846, Third Edition, November, 1990.

US EPA 1984, Federal Register, October 26, 1984, 40 CFR part 136.

US EPA 1990. Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods. U.S. EPA publication number SW-846. Third Edition, November 1990, or most recent edition.

Table 3
Contaminated Soil Clean-Up Levels

Compound	CAS #	Soil-to-Groundwater (mg/kg)*
Acenaphthene	83-32-9	8
Acenaphthylene	208-96-8	11
Acetone	67-64-1	2.81
Anthracene	120-12-7	995
Barium	7440-39-3	848
Benzene	71-43-2	0.0056
Benzo(a)anthracene	56-55-3	0.34
Benzo(b)fluoranthene	205-99-2	1
Benzo(g,h,i)perylene	191-24-2	6720
Benzo(k)fluoranthene	207-08-9	12
Benzo(a)pyrene	50-32-8	0.091/0.088**
Benzoic acid	65-85-0	112
Bis(chloroethyl)ether (BCEE)	111-44-4	0.0002
n-Butylbenzene	104-51-8	4
Sec-Butylbenzene	135-98-8	3
Tert-Butylbenzene	104-51-8	3
Carbon disulfide	75-15-0	4
Chloromethane (methyl chloride)	74-87-3	0.02
Chromium III	16065-83-1	27
Chromium VI	18540-29-9	27
Chrysene	218-01-9	38
Dibenzo(a,h)anthracene	53-70-8	0.17/0.088**
Dibenzofuran	132-64-9	4.7
Dibromochloromethane	124-48-1	0.002
1, 2-Dibromoethane (ethylene dibromide; EDB)	106-93-4	0.00000197
1, 2-Dichlorobenzene	95-50-1	7
1, 3-Dichlorobenzene	541-73-1	24
1, 4-Dichlorobenzene	106-46-7	1
1, 1-Dichloroethane (1,1-DCA)	75-34-3	4
1, 2-Dichloroethane (ethylene dichloride; 1,2-DCA)	107-06-2	0.0018
1, 2-Dichloroethene (cis) (cis-1,2-DCE)	156-59-2	0.35
1, 2-Dichloroethene (trans) (trans-1,2-DCE)	156-60-5	0.38
1, 1-Dichloroethylene (1,1-DCE)	75-35-4	0.045

Compound	CAS #	Soil-to-Groundwater (mg/kg) *
1, 2-Dichloropropane	78-87-5	0.0029
1, 3-Dichloropropene (cis and trans)	542-75-6	0.0009
2, 4-Dimethylphenol	105-67-9	0.9
Ethyl acetate	141-78-6	11
Ethylbenzene	100-41-4	0.24
Fluoranthene	206-44-0	276
Fluorene	86-73-7	44
Hexachlorobutadiene	87-68-3	0.26
2-Hexanone	591-78-6	1.9
Indeno(1,2,3-cd)pyrene	193-39-5	3
Isopropyl benzene (cumene)	98-82-8	2
Isopropyl ether (diisopropyl ether)	108-20-3	0.37
Lead	7439-92-1	270
Methanol	67-56-1	14
Methyl ethyl ketone (2-Butanone; MEK)	78-93-3	0.69
Methyl tert-butyl ether (MTBE)	1634-04-4	0.92
Methylene chloride	75-09-2	0.02
2-Methylnaphthalene	91-57-6	3
Naphthalene	91-20-3	0.58
Phenanthrene	85-01-8	60
n-Propylbenzene	103-65-1	2
Pyrene	129-00-0	286
1,1,2,2-Tetrachlorethane	79-34-5	0.001
Tetrachloroethylene (PCE)	127-18-4	0.0074
1,2,4-Trichlorobenzene	120-82-1	2.6
1,2,4-Trimethylbenzene	95-63-6	8
1,3,5-Trimethylbenzene	108-67-8	7
Toluene	108-88-3	7
Xylenes (mixed)	1330-20-7	5

Notes * If the maximum soil contaminant concentration is less than the method detection limit, the maximum soil contaminant concentration should be set at the level of the method detection limit.
** Residential Level

Figure 3
**Transport Model for Calculation of Soil-To-Groundwater
Maximum Contaminant Concentrations**

$$C_{\text{soil}} = C_{\text{gw}} \left[k_s + \frac{(\theta_w + \theta_a H')}{P_b} \right] df$$

<u>Parameters</u>	<u>Parameter Values</u>	<u>Units</u>
C _{soil} Maximum Soil Contaminant	not applicable	mg/kg - soil
C _{gw} Applicable Groundwater Target Concentration	chemical-specific	mg/L - water
df Dilution factor	20	unitless
k _s Soil-water partition coefficient for organic constituents k _s = k _{oc} f _{oc} for inorganic constituents k _s = k _d	chemical-specific	L/kg
k _{oc} Soil organic carbon-water partition coefficient	chemical-specific	L/kg
f _{oc} Fraction of organic carbon in subsurface vadose soil	.001 (0.1%)	kg/kg
k _d Soil-water partition coefficient for inorganics	chemical-specific(pH=5.5)	L/kg
θ _w Water-filled soil porosity - vadose soil	0.3	L _{water} /L _{soil}
θ _a Air-filled soil porosity - vadose soil	0.13	L _{air} /L _{soil}
P _b Dry bulk density	1.5	kg/L
H' Henry's Law constant - dimensionless	chemical-specific	unitless
<i>where: H' = Henry's Law constant (atm-m³/mole) x conversion factor of 41.</i>		

6.0 Soil Sampling Guidelines and Analytical Requirements

The quantity and locations of samples specified in this guidance document are intended to be the minimum required to define the extent of soil contamination. Additional samples should be taken when contamination is known or suspected at potential sources or along preferential pathways (e.g., underground utilities).

Determination of soil contamination must be made by the laboratory analytical methods presented in Tables 1 and 2. All analyses are required to be performed using DWQ-approved analytical methods and the laboratories used must be DWQ-certified to run the approved methods. A current list of NC Certified Laboratories may be obtained from the Division of Water Quality, Laboratory Section at (919) 733-3908.

6.1 Field Screening

Portable organic vapor analyzers (Flame Ionization Detectors [FIDs], Photoionization Detectors [PIDs]) and immunoassay field test kits are useful tools for on-site sample screening and sample selection for laboratory analysis. However, because of the lack of specificity, accuracy, precision, and quality assurance/quality control (QA/QC), field screening data will not be acceptable for confirming the presence, nature or extent of soil contamination; only laboratory results will be acceptable.

6.2 Sample Preparation

The type of sample containers used depends on the type of analysis needed. First determine the type(s) of contaminants expected and the proper analytical method(s) as established in Tables 1 and 2. Then refer to Table 4 for typical container, preservation and storage information. Be sure to consult with your selected laboratory for its specific needs and requirements prior to sampling.

Always select a DWQ-certified laboratory to perform the required soil analyses, and ask the laboratory about any specific sample handling procedures required by the analytical methods. Sample containers, volumes, procedures, and preservation vary among methods. In addition, different laboratories may require different amounts of sample to conduct the analyses.

Sampling kits for sample collection and transport may be purchased from some commercial laboratories. They include all the items needed (sample containers, labels, shipping cartons, etc.) for sample collection and shipment. If you use these services, carefully follow the instructions provided and do not discard any preservative that may have been added to the containers. If you do not choose to use a customized kit provided by your laboratory, use only new containers of the appropriate type for the contaminants for which you are sampling. Check with the laboratory that will be running the analysis about appropriate sample containers and preservation requirements for each method. **If proper sampling and QA/QC protocols are not followed, your results may not be valid.**

Label sample containers prior to sample collection. Each sample label should include the sample location and/or well number, sample identification, the date and time of collection, the analyses to be performed, the preservative added (if any), the sampler's initials, and any other pertinent information

for sample identification. Also prepare the storage and transport containers (ice chest, etc.) prior to taking any samples so that each collected sample can be placed in an environment chilled to approximately 4° C immediately after collection.

6.3 Soil Sample Collection Procedures

Soil samples should be collected under the responsible charge of a professional engineer or licensed geologist if soil contamination is suspected or identified. Soil samples should be collected in a manner that causes the least disturbance of the internal structure of the soil and reduces the exposure to heat, sunlight and open air. Likewise, care should be taken to keep the samples from being contaminated by other material at the site or from contaminating other samples taken from the site (i.e., the sample container should be clean and the outside should be kept uncontaminated).

When collecting samples of potentially contaminated soil, care should be taken to prevent contact with skin or other parts of the body. Disposable gloves should be worn by the sample collector and should be changed between samples to avoid cross-contamination. At a minimum, a clean, stainless steel split spoon sampler should be used to collect each sample and it should be decontaminated between sampling events.

Ideally, samples should be collected from cores of the soil. For practical reasons, however, it may be necessary to collect samples from a backhoe bucket, hand auger, or even a shovel. As long as an effort is made to reduce the loss of contaminants from the sample, any of these methods may be used. Samples for volatile organic compound (VOC) analysis should be collected with minimal handling and agitation.

Immediately upon removal from the ground, each sample must be placed in a proper container for the analysis to be performed. The sample should fill the entire volume of the container, leaving no headspace unless the method requires otherwise. Refer to Table 4 for the required sample containers and volume for each analytical method. If necessary, add preservative prior to filling sample jars. As soon as the sample is collected the container should be immediately capped, sealed and stored at 4° C (40°F).

Soil samples collected to document excavation clean-up success should be taken in undisturbed material below the area of excavation. A sufficient number of samples should be collected to demonstrate all contamination has been removed in both horizontal and vertical directions.

Sample containers must be labeled with the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials, and any other pertinent information for sample identification. The labels should contain a unique identifier (e.g., unique well numbers) that can be traced to the chain-of-custody form.

6.4 Sample Storage and Transport

Store samples for transport in a manner that will prevent breakage. The samples should be kept at a temperature of approximately 4°C following collection. Add ice, if necessary, and transport to a DWQ-certified laboratory as soon as possible. Avoid unnecessary handling of sample containers. Avoid heating (room temperature or above, including exposure to sunlight) or freezing of the sample

containers. The time between sampling and delivery to a laboratory should be kept to a minimum, and be sure that the analytical holding times of the samples are met (see Table 4).

A chain-of-custody (COC) form must accompany the samples to the laboratory. All blanks on the laboratory form should be completed.

Table 4
Container and Preservation Protocol for Soil Analyses

(Laboratories must be certified by the North Carolina DWQ to perform the following methods)

Sample Type/Method	Container	Preservative	Holding Times
EPA 9071 (Oil & Grease)	4-oz glass jar	Cool to 4°C	28 days
EPA 5030/TPH California Method EPA 8260 EPA 8021 EPA 8015	4-oz glass jar with Teflon-lined septa screw cap	Cool to 4°C	14 days
EPA 3550/TPH California Method EPA 8270 EPA 8081 EPA 8082	8-oz glass jar with Teflon-lined screw cap	Cool to 4°C	Samples must be extracted within 14 days and extracts analyzed within 40 days.
Total Metals TCLP Metals	4-oz polyethylene or glass jar	Cool to 4°C	6 months

NOTE: Check with the laboratory that will be doing the analysis for any other requirements.

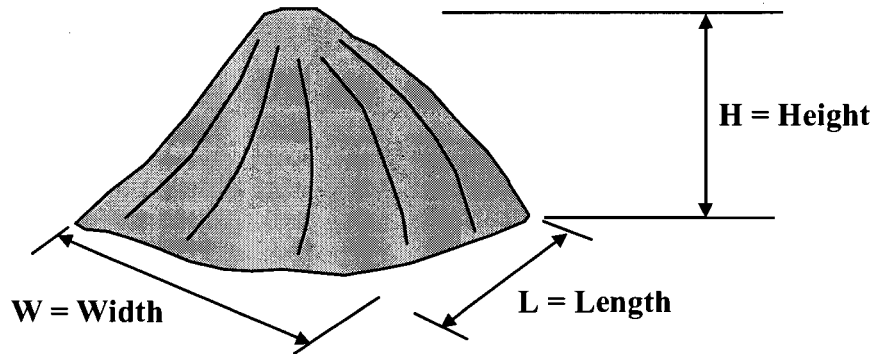
6.5 Sampling Stockpiled Soil

The stockpile should be sampled prior to applying for a permit for disposal. Samples should be collected and handled as described in Section 6.3 and 6.4. Check with the disposal facility concerning analytical requirements for disposal.

Collect one sample for each 200 cubic yards of the stockpile. The volume of the stockpile can be determined by either calculating the specific geometry of the pile or the excavation, or by approximating the general geometry of the pile as specified in Figure 4. If the volume is approximated, use the maximum dimensions as indicated by the sketches for the different shapes of stockpiles in Figure 4. Once the volume is determined, lay out a grid that divides the pile into square blocks with equal surface area. At least one (1) composite sample must be collected from each grid (See Figure 5).

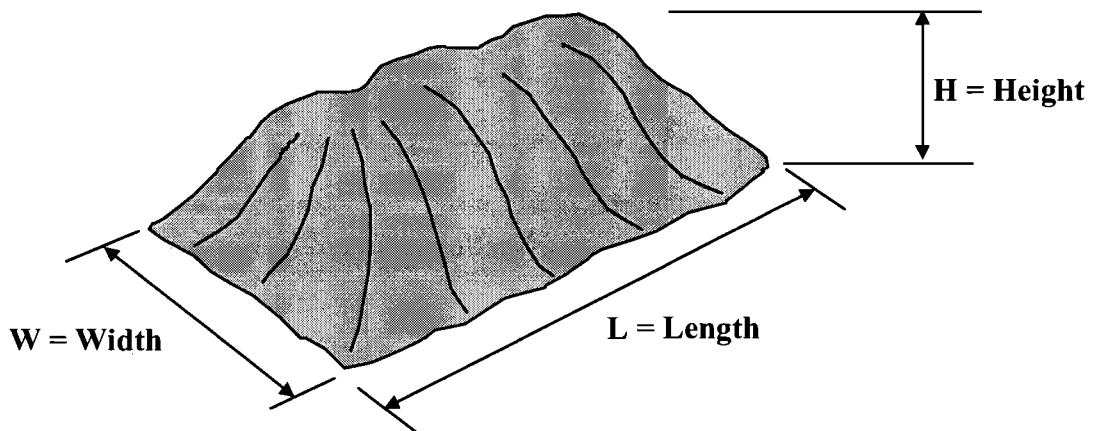
Figure 4
Volumes of Stockpiles

$$L > W > H$$



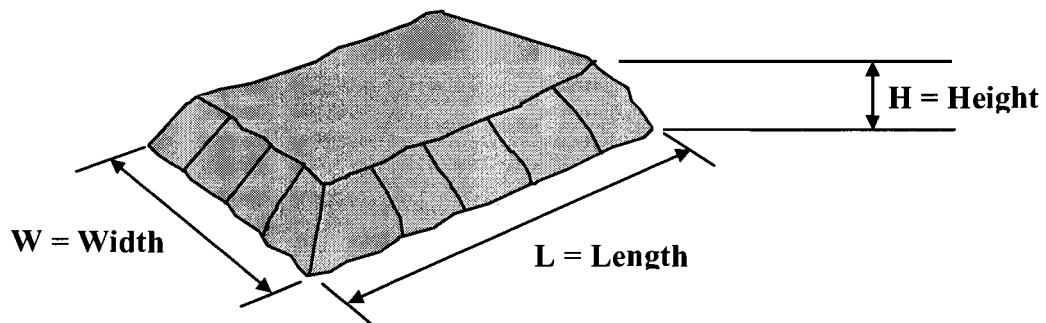
Conical Stockpiles:

$$\text{Volume} = \alpha \times H \times L \times W$$



Rectangular Stockpiles - pointed crest:

$$\text{Volume} = 2 \times H \times L \times W$$

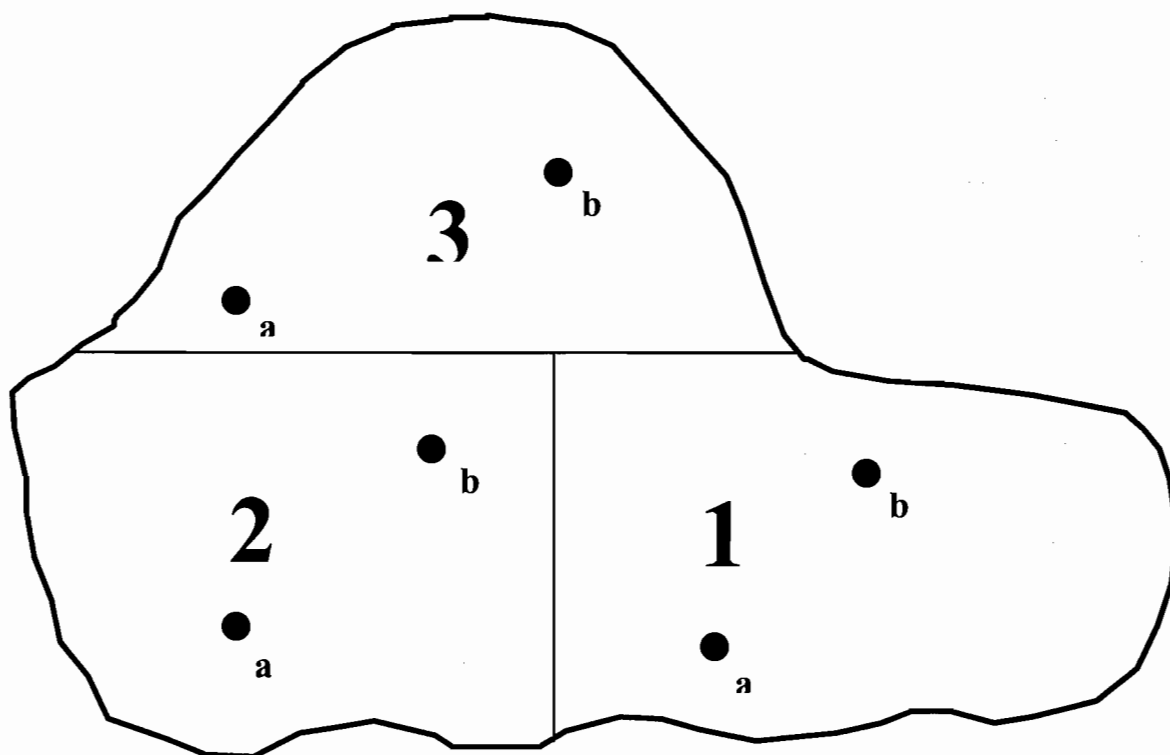


Rectangular Stockpiles - flat topped:

$$\text{Volume} = H \times [(L \times W) - (2 \times H \times W)]$$

Note: These equations have been simplified for ease of calculation.

Figure 5
Soil Stockpile Sampling Map (Example)



Stockpile Type: Rectangle, Flat Topped

$$\text{Volume} = 4 \times [(21 \times 11) - (2 \times 4 \times 11)] = 572 \text{ cubic yards}$$

where: Height (maximum) = 12 feet = 4 yards
 Length (maximum) = 63 feet = 21 yards
 Width (maximum) = 33 feet = 11 yards

<u>Composite Samples</u>	<u>3 Primary Samples per core</u>	<u>Sample Depths</u>
1	core 1a	1', 4', 7'
	core 1b	1', 5', 8'
2	core 2a	2', 6', 10'
	core 2b	1', 4', 7'
3	core 3a	1', 3', 5'
	core 3b	2', 5', 8'

Note: Each composite sample contains six primary samples, three from core "a" and three from core "b".

6.6 Analytical Requirements for Disposal of Contaminated Soil

Contaminated soil must be disposed of properly or treated at a permitted facility. The analytical requirements will be determined by the facility and the permit. For disposal of contaminated soil, it may also be necessary to analyze soil samples for the toxicity characteristic using EPA Methods 1311, the toxicity characteristic leaching procedure (TCLP). If any contaminant exceeds the regulatory limits established for TCLP, the contaminated soil must be stored, transported and disposed of as a hazardous waste. The TCLP regulatory limits are provided in Table 8. Contact the DWM Hazardous Waste Section at (919) 733-2178 for more information.

There is a provision in EPA 1311 (TCLP) that allows use of a total waste analysis to demonstrate that a waste does not exhibit the toxicity characteristic. The following formula may be used to make this determination for a contaminant. **This equation is not to be used to establish cleanup levels.**

$$\begin{aligned} M &= C/20 \quad \text{where:} \\ M &= \text{maximum theoretical leachate concentration (mg/L);} \\ C &= \text{concentration of analyte in the solid (mg/kg), (total concentration);} \\ &\quad \text{and} \\ &\quad \text{mg/L} = \text{ppm} = \text{mg/kg.} \end{aligned}$$

6.7 Laboratory Reports

Analytical results must be compiled in the appropriate report or as specified by a permit and submitted to the appropriate Regional Office. All compounds analyzed using a certified method must be reported. The laboratory report should include the following, all of which should be submitted to the Regional Office in appropriate reports:

- Laboratory Certification Number
- Facility Name
- Date of Report Preparation
- Chain-of-Custody
- Analytical Result Summary sheets including QA/QC information
- Laboratory Chronicle and Methodology including holding time checks
- Summary of Calibration Information (date calibrated, ranges, etc.)
- Blank Results (method, field, trip, etc.)
- Method Detection Limits

7.0 Cleanup Requirements for Groundwater

Contaminated groundwater must be cleaned up to the levels of the interim standards and the standards established in 15A NCAC 2L .0202. Final determination of groundwater contamination must be made by the laboratory analytical methods presented in Table 5. Any constituent, not specifically listed in 2L .0202, detected above the laboratory MDL and is not naturally occurring, is considered a violation of the GW standard.

8.0 Groundwater Sampling Guidelines

Groundwater samples are collected to investigate, assess, and monitor the concentration of dissolved constituents. To properly assess a groundwater contaminant plume, the investigator should install monitoring wells, collect groundwater samples and perform specific laboratory analyses. All nearby water supply wells should also be sampled, but may not be acceptable to properly assess the contaminant plume. The number and location of sampling points will depend upon specific site conditions and the goals of the investigation. All wells must be constructed in accordance with 15A NCAC 2C .0100 by a NC Certified Well Contractor and sampled as outlined in this section. Follow proper sampling procedures to obtain representative samples.

8.1 Field Screening

Several methods are commercially available for screening groundwater samples in the field for contamination. However, because of the lack of specificity, accuracy and precision associated with field screening methods, they are not approved for the determination of groundwater contamination.

For sites with moderate to large plumes, it may be feasible to use a DWQ-certified mobile laboratory to perform on-site soil and groundwater analyses while performing a probe survey. As with any laboratory, a mobile laboratory must be DWQ-certified to perform the specific soil and groundwater analytical methods required.

One common method of screening is the pushprobe technology. Pushprobes (e.g., Direct Push, Push Probing, Geoprobings, Direct Point Sampling, Hydraulic Probe Sampling, Hydrocone, Geocone, etc.) are considered rapid assessment tools that are designed to assess the extent of contaminated soil and groundwater. This technology may enable the strategic placement and limit the number of monitoring wells. Use of this technology for installation of monitoring wells may be limited due to site specific geological considerations. Wells installed using this technology must meet the “NC Well Construction Standards” and must be installed by a NC Certified Well Driller.

8.2 Sample Preparation

Always select a DWQ-certified laboratory to perform the required groundwater analyses, and ask the laboratory about any specific sample handling procedures required by the analytical method(s). The DWQ Chemistry Laboratory has a list of laboratories that are certified to run particular analyses. Contact the laboratory at 4405 Reedy Creek Road, Raleigh, North Carolina 27607 or (919) 733-3908 for this list.

First determine the type(s) of contaminants expected and the proper analytical method(s) for the contaminants as established in Table 5. The type of sample containers to be used depends on the type of analysis needed. Table 6 lists the typical container, preservation and storage requirements for the specified groundwater analytical methods, however, consult with your selected laboratory for their specific needs and requirements prior to sampling. **If proper sampling and QA/QC protocols are not followed, the DWQ may not consider your results valid.**

Label sample containers prior to sample collection. Each sample label should include the sample location and/or well number, sample identification, the date and time of collection, the analyses to be performed, the preservative added (if any), the sampler's initials, and any other pertinent information for sample identification. Prepare the storage and transport containers (ice chest, etc.) prior to taking any samples so that each collected sample can be placed in an environment chilled to 4°C immediately after collection.

All sampling equipment (bailers, tubing, containers, etc.) must be selected based on the materials' chemical compatibility with the contaminants potentially present and the source being sampled (e.g., water supply well, monitoring well). All sampling equipment should be thoroughly decontaminated and transported in a manner that does not allow it to become contaminated. Arrangements should be made ahead of time for decontamination of any sampling or measuring equipment that will be reused when taking samples from more than one well. Field decontamination of sampling equipment will be necessary before sampling each well to minimize the risk of cross contamination. Decontamination procedures should be included in reports as necessary.

Table 5
Required Analyses for Contaminated Groundwater

(Laboratories must be certified by the North Carolina DWQ to perform the following methods)

Suspected Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	1. Std. Method 6230D* or 6210D* with IPE & MTBE OR EPA Methods 601 and 602 with IPE, MTBE, EDB* and Xylenes AND 2. Lead (Std. Methods 3030C**prep.)	Any Amount Above the MDL
2. Medium/High Boiling Point Fuels: kerosene, diesel, varsol, mineral spirits, naphtha, jet fuels, fuel oil #2, etc.	1. 602 with Xylenes, AND 2. EPA Method 625***plus 10 largest non-target peaks identified	Any Amount Above the MDL
3. Heavy Fuels: #4, #5, #6 fuel oil; motor oil; hydraulic fluid; etc.	1. 625*** plus 10 largest non-target peaks identified	Any Amount Above the MDL
4. Used/Waste Oil	1. Std. Method 6210D AND 2. 625*** plus 10 largest non-target peaks identified AND 3. Metals (Standard Methods 3030C** prep): Lead and chromium.	Any Amount Above the MDL
5. Metals	1. Metals (Standard Methods 3030C** prep):	Any Amount Above the MDL
6. Solvents: a. Halogenated/Non- Halogenated b. Ethylene Glycol c. Formaldehyde	a. 6230D or 6210D b. GC-FID c. Chromatropic Acid Method	Any Amount Above the MDL
7. Non-Petroleum – Unknown	1. Std. Method 6210D*** AND 2. 625***plus 10 largest non-target peaks identified, AND 3. Metals (Standard Methods 3030C** prep)	Any Amount Above the MDL
8. Pesticides	Contact NC Dept. of Agriculture/Pesticide Section at (919) 733-3556 AND Groundwater Section Regional Office	Not Applicable
9. Substances not covered above	Contact Groundwater Section Regional Office	Not Applicable

- * For identifying EDB, use EPA Method 504.1 initially and at closure.
- ** Total holding time from collection to laboratory filtering is 72 hours.
- *** Once contaminants have been identified by GC/MS methods, more economical compound specific methods may be used. (For example, if no "Acids" were detected by GC/MS Method 625, subsequently analyze by 625 for "Base/Neutrals" only, or use GC Method 610.)

NOTES: (1) *Sample filtration in the field is not permitted for any analyses, and the analytical results of the field-filtered samples will not be accepted by the Department.* (2) *Other comparable EPA-approved methods which target the same constituents and have equivalent or lower detection limits may be used if analyses are conducted by a DWQ-certified laboratory and prior approval is obtained from the appropriate Regional Office.* (3) *For additional analytical methods associated with a Corrective Action Plan under .0106 (k) or (l), see the 2L "Implementation Guidance".* (4) *All MDLs must be at or below the standards as outlined in 15A NCAC 2L if possible.* (5) *For established sites under permit or with existing CAP approval, other analytical methods historically used at the site will be accepted provided the detection limits and list of analytes are similar.*

REFERENCES

American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1992. *Methods for Determining Organic Compounds in Drinking Water*. Standard Methods for the Examination of Water and Wastewater. U.S. EPA publication number EPA-600/4-79-020 or the most recent edition.

EPA 500 Series - "Methods for the Determination of Organic Compounds in Drinking Water," US EPA - 600/4-88/039.

EPA 600 Series -Federal Register, latest EPA approval edition of 40 CFR Part 136.

Copies available from: Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 telephone 202-512-1800.

Std. Methods 6000 Series -"Standard Methods for the Examination of Water and Wastewater," American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 18th Edition, 1992 or latest EPA-approved edition.

U.S. EPA. 1984. *Test Procedures for the Analyses of Pollutants under the Clean Water Act*. Federal Register Vol. 49, No. 209, 40 CFR Part 136, October 26, 1984 or the most recent edition.

Table 6
Container and Preservation Protocol for Groundwater Analyses

(Laboratories must be certified by the North Carolina DWQ to perform the following methods)

Sample Type/Method	Container	Preservative	Holding Times
EPA 601/602 SM 6210D SM 6230D	Duplicate 40-mL VOA vials with Teflon-lined septa screw cap	Add 3 to 4 drops of 1:1 HCl or approx. .25g NaHSO ₄ to pH<2* Cool to 4°C	14 days
EPA 625	1-L amber glass with Teflon-lined screw cap	Cool to 4°C	Samples must be extracted within 7 days and extracts analyzed within 40 days.
SM 3030C (Metals)	500-mL polyethylene or glass jar	Add 5-mL of 1:1 HNO ₃ (to pH<2) Cool to 4°C Submit to lab within 48 hours of collection	3030C prep within 72 hours of collection and analyze within 6 months of prep.

NOTES: (1) Check with the laboratory that will be doing the analysis for any other requirements, (2) *Some VOA vials may be purchased with preservative already added.

8.3 Groundwater Sample Collection Procedures

A. Water Supply Wells

Water supply well samples should be collected using the existing pump system and should be collected as close to the well head as possible, preferably at the wellhead or at the first spigot on the line. Occasionally, water samples may have to be collected from inside a building or house.

Prior to sample collection, water within the delivery system must be purged. The system should be flushed at the maximum flow rate the spigot will allow, for at least 10 - 15 minutes. Longer running times may be required for large diameter wells or if the well uses a large-capacity water tank (pressure tank). When collecting samples for volatile organic compounds, the flow rate must be reduced after purging to a minimum to avoid aerating the sample during collection.

Information about the construction of the well should be collected. Include the following, as available: depth of well, use of well, well diameter, well yield, screened interval, depth to submersible pump, depth of casing, and static water level.

If residential or public water supply wells are identified within 1500 feet of the discharge, the most imminently threatened should be sampled. If the closest wells are impacted by the release, then more distant wells should be sampled. Copies of the lab report should be submitted to the well user, well owner, appropriate DWQ Regional Office, and the local health department. Questions regarding effects on the health of individuals should be directed to the local health department or the NC Division of Epidemiology at (919) 733-3410. Samples should be analyzed in accordance with groundwater analytical methods specified in Table 5.

Schedules for continued monitoring of threatened water supply wells should be discussed with the appropriate Regional Office.

The groundwater rules (15A NCAC 2L .0106(d)) require responsible parties to provide alternate water to households with contaminated water supplies. Depending on the level of contamination present, municipal water, bottled water, a point-of-entry carbon filtration system, or other alternatives may be necessary. Options for providing a safe source of drinking water should be discussed with the Regional Office.

NOTES: (1) *The appropriate Regional Office should be contacted prior to the abandonment of water supply wells and the connection to municipal water supplies, (2) Water supply wells will not be considered a substitute for monitoring wells.*

B. Monitoring Wells

A pre-established point of known elevation on the highest point of each well casing should be used for every water level measurement. Water level measurements should be measured to the nearest hundredth of a foot prior to any sampling activities.

Measurements made with an electric water level meter will directly indicate the depth to water by emitting an audible and/or visible alarm. When using a steel tape to measure water levels, record the holding mark and the wet level mark from the tape. Do not use colored chalk or other substances on steel tapes. The difference between the holding mark and the wet level mark is the depth to water.

Subtracting the elevation of the static water level from the elevation of the measuring point yields head. If the volume of the well is unknown, subtract the depth to water from the total well depth (feet below the top of casing) in order to determine the length of well section which is filled with water. This length will be used to determine the purge volume.

To avoid cross contamination, all water level measuring equipment must be decontaminated prior to each water level measurement. If water levels must be measured at multiple contaminated wells, begin with the least contaminated well and work toward the most contaminated well.

Wells must be adequately purged prior to sample collection to ensure representation of the aquifer formation water rather than stagnant well water. This may be achieved by purging the well until such time as the field parameters (pH, specific conductivity, and temperature) stabilize, by purging a minimum of three well volumes from the well, or one fully dry purge. Low flow sampling technologies are acceptable as long as the appropriate techniques are employed. See the listed reference publications or the Groundwater Section website for additional information.

The volume of water contained in a well may be mathematically derived or approximated by multiplying the length of well section containing water (in feet) by one of the following conversion factors based on the diameter of the well casing.

$$[\text{total well depth (ft)} - \text{depth to water (ft)}] \times [\text{well diameter conversion (gal/ft)}] = 1 \text{ well volume (gals)}$$

Well Diameter Conversion Table

2" diameter casing	= 0.16 gallons per foot
3" diameter casing	= 0.37 gallons per foot
4" diameter casing	= 0.65 gallons per foot
6" diameter casing	= 1.5 gallons per foot
8" diameter casing	= 2.6 gallons per foot
10" diameter casing	= 4.1 gallons per foot
12" diameter casing	= 5.9 gallons per foot

Water samples must be collected within 24 hours of purging. If pumping or bailing the well effectively removes all water within the well, a sample may be collected after recovery, provided that recovery is within 24 hours of purging. **All contaminated purged water must be disposed of in an environmentally sound manner. (see Section 12).**

NOTE: *Muddy or severely turbid samples may be an indication of improper well construction. Analysis from such samples may not be accepted by the Regional Office.*

C. Sample Collection

To prevent accidental contamination during sampling, spread clean plastic sheeting around the well to protect sampling equipment from touching the ground and wear a new pair of disposable gloves.

After wells are purged, collect samples using a positive-displacement bladder pump or bailer. To avoid cross contamination, do not use any equipment in more than one well without proper decontamination prior to reuse. Do not use vacuum systems to collect groundwater samples for volatile contaminants. Documentation of decontamination and sampling procedures must be incorporated into all appropriate reports.

To purge standing well water and to avoid silt locking when sampling by pump, place the pump a few feet below the top of the water column and never set the pump on the bottom of the well. When pumps of any type are used for sampling, the flow rate must be adjusted low enough to fill the sampling jar effectively.

When sampling with a bailer, lower the bailer slowly into the well to avoid aeration of the water or agitation of particulate matter within the well. Retract the bailer slowly and gently empty the sample into the appropriate container until the correct volume has been collected.

When collecting samples for volatile contaminants using a pump or a bailer, a flow rate of less than 100 mL/min (½ cup/min) is required to fill a VOA vial without aerating the sample. Fill the VOA vial slowly to avoid volatilization of contaminants. Also, pour enough water to create an upper

meniscus above the top of the vial; this will help to prevent having air space in the sample vial when it is closed. A gentle tap on the side of the vial may be necessary to loosen any small bubbles. Replace the cap and invert the vial - no bubbles should be present. If a bubble is present do not try more than twice to open the vial and eliminate the bubbles. Collect a new sample if necessary.

8.4 General Decontamination Procedures

Decontamination procedures should be based on the type of sampling equipment being used and the suspected or known contaminants. All equipment used in the field must be thoroughly decontaminated between consecutive measurements to prevent cross-contamination. Documentation of decontamination procedures must be submitted with appropriate reports. Contact the appropriate Regional Office for specific decontamination procedures.

A. Bailer lines

To minimize the possibility of cross-contamination, braided nylon or cotton cord should not be reused, even if cleaned. Teflon coated wire, single strand stainless wire, or other monofilament line can be reused if decontaminated between each use.

B. Pumps

The inside and outside of pumps and reusable hoses/lines must be decontaminated or replaced between use. Ensure that hoses, lines, and exposed gaskets are either constructed of non-reactive materials or replaced between each use.

8.5 Sample Storage and Transport

If necessary, add prescribed preservatives before filling the sample containers. After filling the containers, seal firmly to prevent leakage and store samples for transport in a manner that will prevent breakage. The samples must be kept at a temperature of approximately 4°C following collection. Add ice, if necessary, and promptly transport to a DWQ-certified laboratory. Avoid unnecessary handling of sample containers. Small sample containers which require cooling, such as VOAs, should be placed in self-sealing bags prior to being submerged in ice. Avoid heating (room temperature or above, including exposure to sunlight) or freezing the sample containers. Keep the time between sample collection and delivery to a laboratory to a minimum and be sure that the analytical holding times of your samples are met (see Table 6).

Sample containers must be labeled with the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, any preservative added, the sampler's initials, and any other pertinent information for sample identification. The labels should contain a unique identifier (i.e., unique well numbers) that can be traced to the chain-of-custody form.

A chain-of-custody (COC) form must accompany the samples to the laboratory. All blanks on the laboratory form should be completed.

8.6 Laboratory Analytical Methods

The laboratory analyses for potentially contaminated groundwater are listed in Table 5. Due to the complex chemical composition of most petroleum and other groundwater contaminants, the methods listed apply to initial analysis of groundwater for a variety of potential contaminants. It is important to note that once actual contaminant compounds have been identified, there may be less expensive analyses available for investigative and monitoring purposes. Questions regarding analytical methods for site monitoring should be directed to the appropriate Regional Office.

Results of analyses must be compiled in the appropriate report and submitted to the attention of the Regional Groundwater Supervisor at the appropriate Regional Office within 30 days of sample collection, or as specified in your permit if doing compliance monitoring. All compounds analyzed using a certified method must be reported.

8.7 Laboratory Reports

Results of analyses must be compiled in the appropriate report or as specified by a permit and submitted to the appropriate Regional Office. All compounds analyzed using a certified method must be reported. The laboratory report must include the following, all of which should be submitted to the Regional Office in the appropriate reports:

- Laboratory Certification Number
- Facility Name
- Date of Report Preparation
- Chain-of-Custody
- Analytical Result Summary sheets including QA/QC information
- Laboratory Chronicle and Methodology including holding time checks
- Summary of Calibration Information (date calibrated, ranges, etc.)
- Blank Results (method, field, trip, etc.)
- Method Detection Limits

REFERENCES

Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures; by Puls, Robert W. and Barcelona, Michael J., Office of Research and Development, Washington, DC, December 1995; EPA/540/S-95/504.

Groundwater Sampling – A Workshop Summary, Dallas, Texas, November 30 – December 2, 1993; Office of Research and Development, Washington, DC, January, 1995; EPA/600/R-94/205.

Field Comparison of Micro-purging vs. Traditional Groundwater Sampling; by Kearl, Peter M., et al.; in, Groundwater Monitoring Review, Fall 1994, pp. 183-190.

Low-Flow Purging Reduces Management of Contaminated Groundwater; by, Schilling, Keith E.; Environmental Protection, December 1995, pp. 24-26.

9.0 Site Closure

Site Closure is the termination of regulatory oversight activities related to a discharge. It may occur when information is provided to document that site remediation has achieved the cleanup levels or standards specified by the regulatory agency. 15A NCAC 2L .0106(m) and .0113 outline the procedures for discontinuance of remedial action for sites which have a documented violation of the groundwater standards. See the Groundwater Section Revised 2L Implementation Guidance Document and Policy (GW Section website) for criteria and information required for proposing site closure under 2L .0106 (m).

Sites that have been undergoing active remediation can also show that groundwater has been remediated to below groundwater standards. Responsible parties may petition the Department for closure after verification of compliance with standards. Analytical results of groundwater samples collected over four consecutive quarters documenting no contamination above the 15A NCAC 2L standards or interim standards while a remediation system is operational, **and** four quarters after a remediation system has been shut down are generally required.

Closure of sites with soil contamination may be approved by the appropriate Regional Office when documentation is provided that indicates that no soil contaminated in excess of the appropriate action or cleanup levels remains in the ground.

APPENDIX D

UST SECTION GUIDELINES FOR SAMPLING (2003 GUIDELINES FOR SAMPLING)

UST SECTION GUIDELINES FOR SAMPLING

**STATE of NORTH CAROLINA
DEPARTMENT of ENVIRONMENT and NATURAL RESOURCES
DIVISION of WASTE MANAGEMENT
UNDERGROUND STORAGE TANK SECTION**

Version 1.2 September 1, 2003

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1.0 Purpose and Application of the Guidelines

The purpose of this document is to provide guidance on the sampling process for environmental monitoring associated with underground storage tank systems. Questions concerning the information presented in this document should be directed to the UST Section Central Office at 919-733-8486. Questions concerning a specific site should be directed to the UST Section Regional Office that is responsible for the county in which the site is located. The address, telephone number, and jurisdiction of each regional office are presented in Figure 1.

Requirements for environmental monitoring are described in 15A NCAC 2B .0500, 15A NCAC 2H .0200 and 15A NCAC 2L .0110. Specific guideline documents for each type of monitoring activity are to be used in conjunction with the UST Section "Guidelines for Sampling." These documents are the "Guidelines for Tank Closure," "Guidelines for Assessment and Corrective Action" and "Guidelines for Ex Situ Petroleum Contaminated Soil Remediation." The guidelines and rules are available in hard copy from the Central or Regional Offices. Electronic versions of the guidelines are available for download from the Division of Waste Management web site at <http://wastenot.enr.state.nc.us/>. Electronic versions of the rules can be found on the Office of Administrative Hearings (OAH) web page at http://ncrules.state.nc.us/ncadministrativ_/default.htm.

2.0 Definitions

The definitions provided here are for guidance purposes. To read the exact language contained in the rules and regulations, please consult the statute citations provided.

Department Refers to the North Carolina Department of Environment and Natural Resources.

Division Refers to the Division of Waste Management.

Discharge shall mean, but shall not be limited to, any emission, spillage, leakage, pumping, pouring, emptying or dumping of oil or other hazardous substances into waters of the State or into waters outside the territorial limits of the state which affect lands, waters or uses related thereto within the territorial limits of the state, or upon land in such proximity to waters that oil or other hazardous substances is reasonably likely to reach the waters, but shall not include amounts less than quantities which may be harmful to the public health or welfare as determined pursuant to G.S. 143-215.77A; provided, however, that this Article shall not be construed to prohibit the oiling of driveways, roads or streets for reduction of dust or routine maintenance; provided further, that the use of oil or other hazardous substances, oil-based products, or chemicals on the land or waters by any state, county, or municipal government agency in any program of mosquito or other pest control, or their use by any person in accepted agricultural, horticultural, or forestry practices, or in connection with aquatic weed control or structural pest and rodent control, in a manner approved by the State, county, or local agency charged with authority over such uses, shall not constitute a discharge; provided, further, that the use of a pesticide regulated by the North Carolina Pesticide Board in a manner consistent with the labeling required by the North Carolina Pesticide Law shall not constitute a "discharge" for purposes of this Article. The word "discharge" shall also include any discharge upon land, whether or not in proximity to waters, which is intentional, knowing or willful (G.S. 143-215.77 (4)).

Ex Situ Soil Soil that has been excavated.

Free Product Any accumulation of a substance of greater than or equal to 1/8 inch in contact with groundwater or perched on the water table, with a density less than or greater than water, and existing as a non-aqueous phase liquid (i.e., not dissolved in water).

Groundwater means those waters in the saturated zone of the earth as defined in 15A NCAC 2L (15A NCAC 2H .0203(18)).

Hazardous Waste means a solid waste, or combination of solid wastes, which because of its quantity, concentration or physical, chemical or infectious characteristics may:

- A. Cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or
- B. Pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of or otherwise managed (G.S. 130A-290(8)).

Federal regulations define a waste as a hazardous waste if it exhibits a characteristic of a hazardous waste (40 CFR 261.20 through 261.24); has been listed as hazardous (40 CFR 261.31 through 261.33); or is a mixture containing a listed hazardous waste and a non-

hazardous solid waste (unless the mixture is specifically excluded or no longer exhibits any of the characteristics of a hazardous waste) (40 CFR 261.3).

Investigation Derived Waste includes all water, soil, drilling mud, decontamination wastes, discarded personal protective equipment, etc. from site investigations, exploratory borings, piezometer and monitoring well installation, refurbishment, abandonment and other investigative activities.

Limit of Detection or detection limit The lowest concentration level that can be determined to be statistically different from a blank (99 percent confidence). The LOD is typically determined to be in the region where the signal to noise ratio is greater than 5. Limits of detection are matrix, method, and analyte specific.

Limit of Quantitation or lower limit of quantitation The level above which quantitative results may be obtained with a specified degree of confidence. The LOQ is mathematically defined as equal to 10 times the standard deviation of the results of a series of replicates used to determine a justifiable limit of detection. Limits of quantitation are matrix, method, and analyte specific.

Lower Reporting Concentration The concentration below which reported analytical results must be qualified as estimated. For analytical procedures requiring analysis of a series of standards, the concentrations of these standards must bracket the concentration of the samples analyzed. One of the standards must have a concentration equal to the laboratory's lower reporting concentration for the parameter involved (15A NCAC 2H .0805 (a)(7)(I)).

Method Detection Limit The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (40 CFR 136 Appendix B).

Petroleum or Petroleum Product means crude oil or any fraction thereof which is a liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), including any such liquid which consists of a blend of petroleum and alcohol and which is intended for use as a motor fuel. The terms "petroleum" and "petroleum product" do not include any hazardous substance as defined in Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Pub. L. No. 96-510, 94 Stat. 2767, 42 U.S.C. § 9601(14) as amended; any substance regulated as a hazardous waste under Subtitle C of Title II of the Resource Conservation and Recovery Act of 1976, Pub. L. 94-580, 90 Stat. 2806, 42 U.S.C. § 6921 et seq., as amended; or any mixture of petroleum or a petroleum product containing any such hazardous substance or hazardous waste in greater than de minimis quantities (G.S. 143-215.94A(10)).

Petroleum Contaminated Soil or Soil Containing Petroleum Products shall mean any soil that has been exposed to petroleum products because of any emission, spillage, leakage, pumping, pouring, emptying, or dumping of petroleum products onto or beneath the land surface and that exhibits characteristics or concentrations of typical petroleum product constituents in sufficient quantities as to be detectable by compatible laboratory analytical procedures (15A NCAC 2H .0203(24)).

Practical Quantitation Limit The lowest concentration of a given material that can be reliably achieved among laboratories within specified limits of precision and accuracy by a given analytical method during routine laboratory analysis (15A NCAC 2L .0102 (15)).

Release Any spilling, leaking, emitting, discharging, escaping, leaching or disposing from an UST system into groundwater, surface water or subsurface soils.

Reportable Concentration Concentrations of typical petroleum product constituents in sufficient quantities as to be detectable by compatible laboratory analytical procedures.

Reporting Limit An arbitrary number below which data is not reported. The reporting limit may or may not be statistically determined, or may be an estimate that is based upon the experience and judgement of the analyst. Analytical results below the reporting limit are expressed as "less than" the reporting limit. Reporting limits are not acceptable substitutes for detection limits unless specifically approved by the Department for a particular test.

Soil Scientist means an individual who is a Certified Professional in Soils through the NCRCPs (N.C. Registry of Certified Professionals in Soils) or a Certified Professional Soil Scientist or Soil Specialist by ARCPACS (American Registry of Certified Professionals in Agronomy, Crops and Soils) or a Registered Professional Soil Scientist by NSCSS (the National Society of Consulting Soil Scientist) or can provide documentation that he/she meets the minimum education and experience requirements for certification or registration by one or more of the organizations named in this Subparagraph or upon approval by the Director, an individual with a demonstrated knowledge of soil science (15A NCAC 2H .0203(38)).

Surface Water means all waters of the state as defined in G.S. 143-212 except underground waters. ("Waters" shall mean any stream, river, creek, brook, run, canal, swamp, lake, sound, tidal estuary, bay, reservoir, waterway, wetlands or any other body or accumulation of water, surface or underground, public or private, natural or artificial, which is contained within, flows through, or borders upon this State, or any portion thereof, including those portions of the Atlantic Ocean over which this State has jurisdiction. (1973, c. 534, s. 1; c. 1262, s. 23; 1977, c. 771, s. 4; 1979, c. 535, ss. 3-10; c. 981, ss. 3-5; 1979, 2nd Sess., c. 1209, ss. 1, 2; 1987, c. 827, s. 155; 1989, c. 656, s. 1; c. 727, s. 218(111); 1995, c. 377, s. 12; 1997-443, s. 11A.119(a))) (15A NCAC 2H .0203(42)).

Total Petroleum Hydrocarbons (TPH) means the concentration of petroleum fuel contamination present in soil as measured by the California Gas Chromatograph method or additional methods as approved by the Director (15A 2H .0805 (a)(1)).

Waste Oil means any used non-hazardous petroleum product other than crankcase oil. Crankcase oil mixed with other used nonhazardous petroleum products will be considered as waste oil. (15A NCAC 2H .0203 (45)).

3.0 Acronyms

<u>BLS</u>	Below land surface
<u>CFR</u>	Code of Federal Regulations
<u>COC</u>	Chain-of-Custody
<u>COPC</u>	Chemicals of Potential Concern
<u>DENR</u>	Department of Environment and Natural Resources
<u>DOT</u>	Department of Transportation
<u>DWQ</u>	Division of Water Quality
<u>DWM</u>	Division of Waste Management
<u>EPA</u>	Environmental Protection Agency (United States)
<u>EPH</u>	Extractable Petroleum Hydrocarbons
<u>FID</u>	Flame Ionization Detector
<u>GC</u>	Gas Chromatograph
<u>GC/MS</u>	Gas Chromatography/Mass Spectrometry
<u>HDPE</u>	High Density Polyethylene
<u>IATA</u>	International Air Transport Association
<u>IDW</u>	Investigation Derived Waste
<u>IPE</u>	Isopropyl ether (also DIPE diisopropyl ether)
<u>LOD</u>	Limit of Detection
<u>LOQ</u>	Limit of Quantitation
<u>MADEP</u>	Massachusetts Department of Environmental Protection
<u>MDL</u>	Method Detection Limit
<u>MSCC</u>	Maximum Soil Contaminant Concentration
<u>MSDS</u>	Material Safety Data Sheet
<u>MTBE</u>	Methyl tert butyl ether (also methyl tertiary butyl ether)
<u>NC</u>	North Carolina
<u>NCAC</u>	North Carolina Administrative Code
<u>NCDA&CS</u>	North Carolina Department of Agriculture & Consumer Services
<u>NCDENR</u>	North Carolina Department of Environment and Natural Resources
<u>NCGS</u>	North Carolina General Statutes
<u>OAH</u>	Office of Administrative Hearings
<u>PCBs</u>	Polychlorinated Biphenyls

<u>PE</u>	Polyethylene
<u>PID</u>	Photoionization Detector
<u>PP</u>	Polypropylene
<u>PPE</u>	Personal Protective Equipment
<u>PVC</u>	Polyvinyl chloride
<u>QA/QC</u>	Quality Assurance/Quality Control
<u>RCRA</u>	Resource Conservation and Recovery Act
<u>SM</u>	Standard Methods
<u>SS</u>	Stainless steel
<u>SW</u>	Solid Waste
<u>TPH</u>	Total Petroleum Hydrocarbons (sometimes referenced as TPFH - “F” for fuels)
<u>TPH DRO</u>	Total Petroleum Hydrocarbon Diesel Range Organics
<u>TPH GRO</u>	Total Petroleum Hydrocarbon Gasoline Range Organics
<u>UST</u>	Underground Storage Tank
<u>VOA</u>	Volatile Organic Analysis
<u>VOC</u>	Volatile Organic Compound
<u>VPH</u>	Volatile Petroleum Hydrocarbons

4.0 General Sampling Procedures

Sampling activities are associated with UST closures, soil remediation permitting and assessment and corrective actions. A systematic sampling approach must be used to assure that sample collection activities provide usable data. Sampling must begin with an evaluation of background information, historical data and site conditions. General sampling procedures are described in this section. The location, type and number of environmental samples for specific monitoring activities (e.g. closure, ex-situ soil remediation and assessment and corrective action) are described in the specific guideline documents for each type of activity. These documents are available in hard copy from the UST Section Central Office and/or Regional Offices, (see Figure 1 for office locations). Electronic versions are available for download from the Division of Waste Management web site at <http://wastenot.enr.state.nc.us/>. Activity and matrix specific sampling procedures are included in the appendices of this document.

4.1 Planning

Begin sampling activities with planning and coordination. See Appendix A for recommendations and suggestions on laboratory selection. See Appendix B for analytical reporting requirements that must be communicated to the laboratory in the selection process to ensure the laboratory can meet project specific needs. **The party contracting with the laboratory is responsible for effectively communicating reporting requirements and evaluating data usability as it relates to specific monitoring activities.**

1. Equipment - Select appropriate equipment based on the sampling source, the analytes of interest and the sampling procedure. The equipment construction must be consistent with the analytes or analyte groups to be collected (see Tables 12, 13, 14, 15 and 16). Bring precleaned equipment to the field, or use equipment that has been certified clean by the vendor or laboratory.
2. Dedicated Equipment Storage - Store all dedicated equipment (except dedicated pump systems or dedicated drop pipes) in a controlled environment. If possible, store equipment in an area that is located away from the sampling site. If equipment other than dedicated pumps or dedicated drop pipes are stored in monitoring wells, suspend the equipment above the formation water. Securely seal the monitoring well in order to prevent tampering between sampling events. Decontaminate all equipment (except dedicated pumps or drop pipes) before use according to the applicable procedures outlined in Appendix C.
3. Sample Containers - The analyses to be performed on the sample determine the construction of sample containers. See Tables 3, 5, 8 and 11 for acceptable sample container, preservation and hold time options for approved analytical procedures. Inspect all containers and lids for flaws (cracks, chips, etc.) before use. Sampling kits for sample collection and transport may be purchased from some commercial laboratories and include all the items needed (sample containers, shipping cartons, etc.) for collection and shipment of samples.

4.2 Sample Collection

1. Contamination Prevention

- a) Take special effort to prevent cross contamination or environmental contamination when collecting samples.
 1. If possible, collect samples from the least contaminated sampling location (or background sampling location, if applicable) to the most contaminated sampling location.
 2. Collect the ambient or background samples first, and store them in separate ice chests or separate shipping containers within the same ice chest (i.e. untreated plastic bags).
 3. Collect samples in flowing water from downstream to upstream.
- b) Do not store or ship highly contaminated samples (concentrated wastes, free product, etc.) or samples suspected of containing high concentrations of contaminants in the same ice chest or shipping container with other environmental samples.
 1. Isolate these sample containers by sealing them in separate, untreated plastic bags immediately after collecting, preserving, labeling, etc.
 2. Use a clean, untreated plastic bag to line the ice chest or shipping container.
- c) All sampling equipment should be thoroughly decontaminated and transported in a manner that does not allow it to become contaminated. Arrangements should be made ahead of time to decontaminate any sampling or measuring equipment that will be reused when taking samples from more than one well. Field decontamination of sampling equipment will be necessary before sampling each well to minimize the risk of cross contamination. Decontamination procedures should be included in reports as necessary. See Appendix C for decontamination procedures. Please note that sampling equipment and containers may be used that are certified pre-cleaned by the vendor or laboratory. When collecting aqueous samples, rinse the sample collection equipment with a portion of the sample water before taking the actual sample. Sample containers do not need to be rinsed. In the case of petroleum hydrocarbons, oil and grease, or containers with pre-measured preservatives, the sample containers cannot be rinsed.
- d) Place all fuel-powered equipment away from, and downwind of, any site activities (e.g., purging, sampling, decontamination).
 1. If field conditions preclude such placement (i.e., the wind is from the upstream direction in a boat), place the fuel source(s) as far away as possible from the sampling activities and describe the conditions in the field notes.
 2. Handle fuel (i.e., filling vehicles and equipment) prior to the sampling day. If such activities must be performed during sampling, the personnel must wear disposable gloves.
 3. Dispense all fuels, dispose of gloves downwind, and well away from the sampling activities.
 4. If sampling at active gas stations, stop sample collection activities during fuel deliveries.

2. Filling Out Sample Labels - At a minimum, the label or tag shall identify the sample with the sample identification (sample ID), date of collection, analysis requested, collector, and preservative(s). Additional information (i.e., a location identification code) may be included as a part of the tag or label. It is easier to fill out the label before you stick it on the

vial/bottle. It is easier to place the label on the bottle before you collect the sample. Print legibly with indelible ink. Include the following information:

- c) Date and Time of sampling
 - d) Analysis required [i.e., VOCs (EPA 8260B), SVOCs (EPA 8270C), Metals (SM 3030C)]
 - e) Sample collector
 - f) Preservative used, if any [i.e., HCl, Na₂S₂O₃, NO₃, ice, etc.]
 - g) Sampling site (i.e. name of the facility, residence, etc.)
3. Sample Collection Order - Unless field conditions justify other sampling regimens, collect samples in the following order:
- a) Volatile Organics and Volatile Inorganics
 - b) Extractable Organics, Petroleum Hydrocarbons, Aggregate Organics and Oil and Grease
 - c) Total Metals
 - d) Inorganic Nonmetallics, Physical and Aggregate Properties, and Biologicals
 - e) Microbiological

NOTE: *If the pump used to collect groundwater samples cannot be used to collect volatile or extractable organics, then collect all other parameters and withdraw the pump and tubing. Then collect the volatile and extractable organics.*

4. Composite Samples - Do not collect composite samples unless required by permit. Samples will be composited as a means of reducing sample handling and analytical costs. Composite samples are prepared differently depending on the analysis required and the relative tendency of the contaminant analyzed to vaporize.

Composite sampling will be used for soil samples collected for soil remediation permitting. Samples collected for volatile organic analysis cannot be dried, ground or mixed if they are to reflect the concentrations found in the soil. Since methanol extracted samples lend themselves to composite sampling techniques, the methanol preservation technique, or one of the alternative high level preservation techniques outlined in Appendix E, followed by methanol extraction, will be required to preserve primary samples to be composited and analyzed for volatiles analysis (i.e. TPH GRO or SW-846 8260B).

If compositing is required, use the following procedures:

- a) Label container(s) as unmixed composite (i.e. for TPH DRO, SW-846 8270C or metals), or as primary samples to be composited by the laboratory (i.e. for TPH GRO or SW-846 8260B).
- b) Select sampling points from which to collect each aliquot.
- c) Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location and place in an approved sample container (see Table 2).
- d) Use an appropriate preservation option selected in coordination with the analytical laboratory.
- e) Notify the laboratory that the sample(s) is/are a composite sample(s).
- f) When collecting soil samples for semi-volatile or metals analysis, do not mix sample aliquots before containerizing. Notify the laboratory that the sample is an unmixed composite sample, and request that the laboratory thoroughly mix the sample before sample preparation or analysis.

- g) When collecting soil samples for volatiles analysis, the six primary samples collected for each composite sample shall be collected and preserved in **separate** VOA vials. Notify the laboratory that the primary samples are to be methanol extracted individually and representative portions of the methanol extracts composited by the laboratory for analysis.

NOTE: *Collection and preservation options for composite soil samples requiring volatiles analysis are provided in Appendix E. Unless otherwise approved by the UST Section, all volatiles soil samples for ex-situ soil remediation must be grab samples collected as primary samples in **separate** containers and may **not** be composited in the field before being submitted to a DWQ Certified Laboratory.*

4.3 Health and Safety

Implement all local, state and federal requirements relating to health and safety. Follow all local, state and federal requirements pertaining to the storage and disposal of any hazardous or investigation derived wastes.

1. The UST Section recommends wearing protective gloves when conducting all sampling activities. They must be worn unless:
 - a) The sample source is considered to be non-hazardous.
 - b) The samples will not be analyzed for trace constituents.
 - c) The part of the sampling equipment that is handled without gloves does not contact the sample source.
2. Gloves serve to:
 - a) Protect the sample collector from potential exposure to sample constituents.
 - b) Minimize accidental contamination of samples by the collector.
 - c) Preserve accurate tare weights on preweighed sample containers.

Do not let gloves come into contact with the sample or with the interior or lip of the sample container. Use clean, new, unpowdered and disposable gloves. Various types of gloves may be used as long as the construction materials do not contaminate the sample or if internal safety protocols require greater protection. Note that certain materials that may potentially be present in concentrated effluent can pass through certain glove types and be absorbed in the skin. Many vendor catalogs provide information about the permeability of different gloves and the circumstances under which the glove material might be applicable. The powder in powdered gloves can contribute significant contamination. Powdered gloves are not recommended unless it can be demonstrated that the powder does not interfere with the sample analysis.

Change gloves:

- After preliminary activities, such as pump placement;
 - After collecting all the samples at a single sampling point; or
 - If torn, or used to handle extremely dirty or highly contaminated surfaces.
- Properly dispose of all used gloves as investigation derived wastes.

3. Properly manage all investigation derived waste (IDW) so contamination is not spread into previously uncontaminated areas. This includes all water, soil, drilling mud, decontamination wastes, discarded personal protective equipment (PPE), etc. from site investigations, exploratory

borings, piezometer and monitoring well installation, refurbishment, abandonment, and other investigative activities. Manage all IDW that is determined to be RCRA-regulated hazardous waste according to the local, state and federal requirements.

Properly dispose of IDW that is not a RCRA-regulated hazardous waste but is contaminated above the Department's Soil Cleanup Target Levels or the state standards and/or minimum criteria for ground water quality. See the UST Section "Guidelines for Assessment and Corrective Action" for information regarding the disposal of drill cuttings/mud and purged well water as a result of field environmental investigations. Under 15A NCAC 2H .0217(a)(9) [Waste Not Discharged to Surface Waters – Permitting by Regulation], "drilling muds, cuttings and well water from the development of wells are deemed permitted in accordance with NCGS 143-215.1(d), and thus no individual Division permit need be issued. If the drill cuttings/mud or purged well water is contaminated with hazardous waste, contact the DWM Hazardous Waste Section (919 733-2178) for disposal options. Figures 4 and 5 are decision flow diagrams with guidance on the proper disposal for drill cuttings/mud and purged well water that result from field investigations and/or cleanup operations. Maintain all containers holding IDW in good condition. Periodically inspect the containers for damage and ensure that all required labeling (DOT, RCRA, etc.) are clearly visible.

4.4 Preservation, Holding Times and Container Types

1. Samples must be preserved by one of the options indicated in Appendix E for Soils, Appendix F, G or H for water and Appendix I for air. See Tables 3, 5 and 8 for soils and Table 11 for water. **The holding times and preservation options listed in the above-referenced tables or Appendices supersede those in individual analytical methods.**
2. The preservation protocols in the referenced tables require immediate preservation. "Immediate" is defined as "within 15 minutes of sample collection." Perform all preservation onsite unless samples can be transported back to the laboratory within 15 minutes of collecting the sample (i.e. mobile laboratory). Two of the preservation options for volatiles soil samples for the inhibition of biodegradation are an exception. These options are detailed in Tables 3, 5 and 8 and in Appendix E.
3. 24-hour composite water samples are the exception to the "15-minute" criterion.
4. If the sample preservation requires thermal preservation, the automatic sampler must be able to maintain the required temperature by packed ice or refrigeration. When chemical preservation is also required, begin the preservation process within 15 minutes of the last collected sample.
5. Check the pH of samples at these recommended frequencies:
 - a) During the first sampling event at a particular site, check all samples that are pH adjusted except volatile organics. and
 - b) During subsequent visits to a particular site, check at least one sample per parameter group that must be pH-adjusted.

4.5 Sample Storage and Transport

Store samples for transport carefully to prevent samples from breaking and to maintain a temperature of approximately 4 degrees Celsius (°C). Add ice, if necessary, and transport to a N.C. DWQ-certified laboratory as soon as possible. Avoid unnecessary handling of sample containers. Avoid heating (room temperature or above, including exposure to sunlight) or freezing of the sample containers. Reduce the time between sample collection and delivery to a laboratory whenever possible, and be sure that the analytical holding times of your samples can be met by the laboratory (see Tables 3, 5, 8 or 11).

1. A complete chain-of-custody (COC) form must be maintained to document all transfers and receipts of the samples. Be sure that the sample containers are labeled with the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials and any other pertinent information for sample identification. The labels should contain a unique identifier (i.e., unique well numbers) that can be traced to the COC form. The details of sample collection must be documented on the COC. The COC must include the following:

- a) a description of each sample (including QA/QC samples) and the number of containers (sample location and identification);
- b) signature of the sampler;
- c) the date and time of sample collection;
- d) the analytical method to be performed;
- e) the sample type (i.e., water or soil);
- f) the regulatory agency (i.e., NCDENR/DWM – UST Section);
- g) signatures of all persons relinquishing and receiving custody of the samples; and dates and times of custody transfers.

2. It may be a good idea to pack samples so that they are segregated by site, sampling location or by sample analysis type. When COC samples are involved, it is best to try to segregate samples in coolers by site as much as possible. If samples from multiple sites will fit in one cooler, they may be packed in the same cooler with the associated field sheets and a single COC form for all. For safety and billing reasons, coolers should be packed so that a maximum weight of 50 pounds is not exceeded. Use additional coolers as necessary. It is strongly recommended that all sample containers be placed in plastic bags (segregated by analysis and location) and then completely surrounded by ice.

- a) Prepare and place trip blanks in an ice filled cooler before leaving for the field.
- b) Segregate samples by analysis and place in sealable plastic bags.
- c) Pack samples carefully in the cooler placing ice around the samples.
- d) Review the COC. The COC form must accompany the samples to the laboratory. **The trip blank(s) must also be recorded on the COC form.**
- e) Place completed COC form in a waterproof bag, sealed and taped under the lid of the cooler. Secure shipping containers with strapping tape to avoid accidental opening.
- f) For COC samples, a tamper-proof seal may also be placed over the cooler lid or over a bag or container containing the samples inside the shipping cooler. "COC" or "EMERG" shall be written in indelible ink on the cooler seal to alert sample receipt technicians to

priority or special handling samples. The date and sample handler's signature must also be written on the COC seal.

- g) Deliver the samples to the laboratory or ship by commercial courier.

NOTE: *If transport time to the laboratory is not long enough to allow samples to be cooled to $\leq 6^{\circ}\text{C}$, a temperature reading of the sample source must be documented as the field temperature on the COC form. A downward trend in temperature will be adequate even if cooling to $\leq 6^{\circ}\text{C}$ is not achieved. The field temperature should always be documented if there is any question as to whether samples will have time to cool to $\leq 6^{\circ}\text{C}$ during shipment. Thermometers must be calibrated annually against an NIST traceable thermometer and documentation must be retained.*

4.6 Laboratory Reports

Results of analyses must be included in the laboratory analytical report. See Appendix A for details (Selecting a Laboratory). All compounds analyzed using a certified method must be reported. All soil sample analytical results must be reported on a dry weight basis. See Appendix B (Analytical Reporting Requirements) for information to be communicated to the N.C. DWQ Certified Laboratory selected to analyze your samples. Analytical reporting requirements are also included as an attachment to soil remediation permits. Provide this information to the laboratory you select to analyze your samples. The laboratory report must include the seven required report elements outlined in Appendix B.

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Table 1
Approved Methods for Soil Analyses at Petroleum UST Closures

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Suspected Contaminant	Approved Analytical Method (See Note)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	EPA 5030 w/ 8015B GRO or California Method* OR EPA 5035/8260B with IPE & MTBE and MADEP VPH: Aliphatics/Aromatics	Any amount above MDL
2. Medium/High Boiling Point Fuels: jet fuels, kerosene, diesel, varsol, mineral spirits, naphtha, fuel oil #2, etc.	EPA 5030 w/ 8015B GRO and EPA 3550 w/ 8015B DRO or California Method* OR EPA 5035/8260B with IPE & MTBE, MADEP VPH Aliphatics/Aromatics, EPA 8270C and MADEP EPH: Aliphatics/Aromatics	Any amount above MDL
3. Heavy Fuels: #4, #5, #6 fuel oils; motor oil; hydraulic fluid; etc.	EPA 3550 w/ 8015B DRO or California Method* OR EPA 8270C and MADEP EPH: Aliphatics/Aromatics	Any amount above MDL
4. Used / Waste Oil	EPA 8081A (pesticides) , EPA 8082 (PCBs) (8081A & 8082 Not required if UST is located at a service station) , EPA 3050 or 3051 Preparation: Total Metals (Chromium and Lead) AND EITHER EPA 5030 w/ 8015B GRO or California Method and EPA 3550 w/ 8015B DRO or California Method* OR EPA 5035/8260B with IPE & MTBE, MADEP VPH: Aliphatics/Aromatics, EPA 8270C and MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL

* Please note that if the closure sample results analyzed by EPA 5030 w/ 8015B GRO or EPA 3550w / 8015B DRO or California Method are ≥ 10 mg/kg TPH, then risk based analytical methods will ultimately be required.

NOTE: 1) Other EPA approved comparable methods, which have similar costs, the same constituents and equivalent or lower detection limits, may be used. 2) Method Detection Limits and Reporting Limits: For target analytes with Maximum Soil Contaminant Concentrations below laboratory lower reporting concentrations, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory lower reporting concentration, must be reported and qualified as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. See Appendix B for tables of volatile and semi-volatile target analytes, Maximum Soil Contaminant Concentrations, and routine laboratory lower reporting limits. The laboratory lower reporting concentration must be indicated for all analytes and must be supported by documentation retained by the laboratory.

Table 2**Approved Methods for Soil Analyses at
Non-Petroleum UST Closures**

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Suspected Contaminant	Approved Analytical Method (See Notes)	Reportable Concentrations
1. Metals	Total Metals with EPA 3050B Preparation (analyze for site specific metals)	Any amount above the MDL
2. Halogenated Solvents	EPA 5035/8021B or 5035/8260B	Any amount above the MDL
3. Non-Halogenated Solvents	EPA 5035/8021B or 5035/8260B (5035/8015B if appropriate for known solvent)	
4. Non-Petroleum - Unknown	EPA 5035/8260B, EPA 8270C, EPA 8081A, EPA 8082 AND Total Metals with EPA 3050B Preparation (RCRA metals - Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium and Silver)	Any amount above the MDL
5. Pesticides	Contact NC Dept. of Agriculture & Consumer Services/ Pesticide Section (919) 733-3556 AND N.C. DENR / UST Section at (919) 733-8486	Any amount above the MDL
6. For substances not covered in 1 through 5	Contact N.C. DENR / UST Section (919) 733-8486	Any amount above the MDL

NOTE: 1) Other EPA approved comparable methods, which have similar costs, the same constituents and equivalent or lower detection limits, may be used. 2) Method Detection Limits and Reporting Limits: For non-petroleum soil samples, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and qualified as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. See Appendix B for tables of volatile and semi-volatile target analytes, Maximum Soil Contaminant Concentrations, and routine laboratory lower reporting limits. The laboratory lower reporting concentration must be indicated for all analytes and must be supported by documentation retained by the laboratory.

Table 3
Approved Sample Containers and Preservatives for Soil Analyses for Closure
(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Method	Number and Type of Container	Preservation Options	Holding Times
EPA 5030 w/ 8015B GRO or California Method	Duplicate pre-weighed VOA vials with Methanol and Teflon-lined screw caps Extra VOA vial w/o preservative*	Field Preserve AND Cool to 4°C	28 days
MADEP VPH	Duplicate EnCore samplers or equivalent OR Duplicate pre-weighed empty VOA vials with Teflon-lined screw caps Extra VOA vial w/o preservative*	Cool to 4°C AND Complete laboratory preservation** or analyze within 48 hours	
EPA 5035/8260B	Triplicate pre-weighed VOA vials with chemical preservatives and Teflon-lined screw caps Extra VOA vial w/o preservative*	Field Preserve Two w/ Sodium Bisulfate*** and One w/ Methanol AND Cool to 4°C	14 days
EPA 5035/8021B EPA 5035/8015B	Triplicate EnCore samplers or equivalent OR Duplicate pre-weighed VOA vials w/ stir bar, and One empty pre-weighed VOA vial with Teflon-lined screw caps Extra VOA vial w/o preservative*	Cool to 4°C AND Complete laboratory preservation** or analyze within 48 hours	
EPA 3550 w/ 8015B DRO or California Method EPA 8270C EPA 8081A EPA 8082	8-oz glass jar with Teflon-lined screw cap	Cool to 4°C	Extract within 14 days and analyze extracts within 40 days of extraction.
MADEP EPH	4-oz (120-mL) wide-mouth amber glass jar with Teflon-lined screw cap	Cool to 4°C	Extract within 7 days and analyzed extracts within 40 days of extraction.
Total Metals	4-oz polyethylene or glass jar	Cool to 4°C	6 months

- * Use for dry weight determination and for soil characterization (i.e., laboratory effervescence check) of low concentration samples suspected to contain carbonate minerals.
- ** See Appendix E for details on preservation options. Consult with laboratory when selecting the preservation option and ensure option is documented with analytical results
- *** If low level sodium bisulfate or equivalent preservation is required, check with the laboratory that will be doing the analysis for any other requirements. Sample size should be limited to 5 to 10 grams, depending on soil type. See Appendix E for additional sampling details..

Table 4
Approved Methods for Soil Analyses for a Permit

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Methods (See Notes)	Reportable Concentration
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	1. EPA 5030 w/ 8015B GRO or California Method 2. EPA 5030/8260B with IPE & MTBE, EPA 8270C 3. EPA 9045C (pH), and EPA 1311 (TCLP) Metals* Methods required for sampling purposes: routine monitoring 1 , permit completion 1 &2, and initial characterization 1,2 &3.	Any amount above MDL
2. Medium/High Boiling Point Fuels: jet fuels, kerosene, diesel, varsol, mineral spirits, naphtha, fuel oil #2, etc.	1. EPA 5030 and 3550 w/ 8015B GRO & DRO or California Method 2. EPA 5030/8260B with IPE & MTBE, EPA 8270C 3. EPA 9045C (pH), and EPA 1311 (TCLP) Metals* Methods required for sampling purposes: routine monitoring 1, permit completion 1 &2, and initial characterization 1,2 &3.	Any amount above MDL
3. Heavy Fuels: #4, #5 and #6 fuel oils; motor oil; hydraulic fluid; etc.	1. EPA 3550 w/ 8015B DRO or California Method 2. EPA 5030/8260B with IPE & MTBE, EPA 8270C, 3. EPA 9045C (pH), and EPA 1311 (TCLP) Metals* Methods required for sampling purposes: routine monitoring 1 permit completion 1 &2 and initial characterization 1,2 &3.	Any amount above MDL
4. Used / Waste Oil	1.EPA Method 9071A** or B 2. EPA 5030/8260B with IPE & MTBE, EPA 8270C, 3. EPA 9045C (pH), and EPA 1311 (TCLP) Metals Methods required for sampling purposes: routine monitoring 1 permit completion 1 &2 and initial characterization 1,2 &3.	Any amount above MDL
5. For substances not covered in 1 through 4	Contact N.C. DENR / UST Section (919) 733-8486	Contact the UST Section.

* In lieu of TCLP analysis, a total analysis of the TCLP constituents to document that individual analytes are not present at levels which could exceed TCLP regulatory levels.

** Method 9071A is allowed until freon extraction is no longer allowed, then Method 9071B will be required.

NOTES: 1) If TCLP metals exceed TCLP limits, contact the DWM-Hazardous Waste Section at (919) 733-2178 for disposal information. 2) For permit completion sampling, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and qualified as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. See Appendix B for tables of volatile and semi-volatile target analytes, Maximum Soil Contaminant Concentrations, and routine laboratory lower reporting limits.

Table 5
Approved Sample Containers and Preservatives for Soil Analyses for a Permit
(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Method	Container	Preservative	Holding Times
EPA 5030 w/ 8015B GRO or California Method	Six pre-weighed VOA vials with Methanol and Teflon-lined screw caps Extra VOA vial w/o preservative*	Field Preserve AND Cool to 4°C	28 days
	Six pre-weighed empty VOA vials with Teflon-lined screw caps Extra VOA vial w/o preservative*	Cool to 4°C AND Complete laboratory preservation** or analyze within 48 hours	
EPA 5030/8260B	Six pre-weighed VOA vials with Methanol and Teflon-lined screw caps Extra VOA vial w/o preservative*	Field Preserve AND Cool to 4°C	14 days
	Six pre-weighed empty VOA vials with Teflon-lined screw caps Extra VOA vial w/o preservative*	Cool to 4°C AND Complete laboratory preservation** or analyze within 48 hours	
EPA 3550 w/ 8015B DRO or California Method EPA 9071A*** or 9071B EPA 8270C EPA 8082	8-oz glass jar with Teflon-lined screw cap	Cool to 4°C	Extract within 14 days and analyze extracts within 40 days of extraction.
Total Metals	8-oz polyethylene or glass jar	Cool to 4°C	6 months

* Use for dry weight determination and for soil characterization (i.e., pH by EPA SW-846 Method 9045C).

** See Appendix E for details on preservation options. Consult with laboratory when selecting the preservation option. Option must be documented with analytical results.

*** EPA Method 9071A will be allowed until the laboratory use of freon as an extraction solvent is no longer allowed.

Table 6
Approved Analytical Methods for Assessment and Corrective Action for
Petroleum Contaminated Soil

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	EPA 5035/ 8260B with IPE & MTBE AND MADEP VPH: Aliphatics/Aromatics	Any amount above the MDL
2. Medium/High Boiling Point Fuels: jet fuels, kerosene, diesel, varsol, mineral spirits, naphtha, fuel oil #2, etc.	EPA 5035/ 8260B with IPE & MTBE, MADEP VPH: Aliphatics/Aromatics, EPA 8270C, AND MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
3. Heavy Fuels: #4, #5 and #6 fuel oils; motor oil; hydraulic fluid; etc.	EPA 8270C AND MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
4. Used / Waste Oil	EPA 5035/8260B with IPE & MTBE, MADEP VPH: Aliphatics/Aromatics, EPA 8270C, 8081A (pesticides)*, 8082 (PCBs)* MADEP EPH: Aliphatics/Aromatics, AND EPA 3050B or 3051 Preparation: Total Metals (Chromium and Lead)	Any amount above the MDL

* PCBs and pesticides are not required for service station/garage waste oil.

NOTES: 1) Other EPA approved comparable methods, which have similar costs, the same constituents and equivalent or lower detection limits, may be used. Once contaminants have been initially identified by GC/MS methods, more economical compound specific methods may be used. 2) Method Detection Limits and Reporting Limits: For target analytes with Maximum Soil Contaminant Concentrations below laboratory lower reporting concentrations, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory lower reporting concentration, must be reported and qualified as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. See Appendix B for tables of volatile and semi-volatile target analytes, Maximum Soil Contaminant Concentrations, and routine laboratory lower reporting limits. The laboratory lower reporting concentration must be indicated for all analytes and must be supported by documentation retained by the laboratory.

Table 7
Approved Analytical Methods for Assessment and Corrective Action for Non-Petroleum Contaminated Soil

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Metals	EPA 3050B or 3051 Preparation: Total Metals (site specific)	Any amount above the MDL
2. Halogenated Solvents	EPA 5035/8021B or 5035/8260B	Any amount above the MDL
3. Non-Halogenated Solvents	EPA 5035/8021B or 5035/8260B (8015B if appropriate for known solvent),	Any amount above the MDL
4. Non-Petroleum - Unknown	EPA 5035/8260B (volatiles), 8270C (semi-volatiles), 8081A (pesticides) and 8082 (PCBs) AND EPA 3050B or 3051 Preparation: Total Metals (RCRA Metals: Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium and Silver)	Any amount above the MDL
5. Pesticides	Contact N.C. Dept. of Agriculture & Consumer Services/ Pesticide Section (919) 733-3556 AND N.C. DENR / UST Section at (919) 733-8486	Any amount above the MDL
6. For substances not covered in 1 through 5	Contact N.C. DENR / UST Section (919) 733-8486	Any amount above the MDL

NOTES: 1) Other EPA approved comparable methods, which have the same constituents and equivalent or lower detection limits, may be used. 2) Method Detection Limits and Reporting Limits: For non-petroleum soil samples, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory reporting limit, must be reported and flagged as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. See Appendix B for tables of volatile and semi-volatile target analytes, Maximum Soil Contaminant Concentrations, and routine laboratory lower reporting limits. The laboratory lower reporting concentration must be indicated for all analytes, and must be supported by documentation retained by the laboratory.

Table 8
Sample Containers and Preservatives for Soil Analyses for Assessment and Corrective Action
(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Method	Container	Preservative	Holding Times
MADEP VPH	Duplicate pre-weighed VOA vials with Methanol and Teflon-lined screw caps Extra VOA vial w/o preservative*	Field Preserve AND Cool to 4°C	28 days
	Duplicate EnCore samplers or equivalent OR Duplicate pre-weighed empty VOA vials with Teflon-lined screw caps Extra VOA vial w/o preservative*	Cool to 4°C AND Complete laboratory preservation** or analyze within 48 hours	
EPA 5035/8260B	Triplicate pre-weighed VOA vials with chemical preservatives and Teflon-lined screw caps Extra VOA vial w/o preservative*	Field Preserve Two w/ Sodium Bisulfate*** and One w/ Methanol AND Cool to 4°C	14 days
EPA 5035/8021B EPA 5035/8015B	Triplicate EnCore samplers or equivalent OR Duplicate pre-weighed VOA vials w/ stir bar, and One empty pre-weighed VOA vial with Teflon lined screw caps Extra VOA vial w/o preservative*	Cool to 4°C AND Complete laboratory preservation** within 48 hours	
EPA 8270C EPA 8081A EPA 8082	8-oz glass jar with Teflon-lined screw cap	Cool to 4°C	Extract within 14 days and analyze extracts within 40 days of extraction.
MADEP EPH	4-oz (120-mL) wide-mouth amber glass jar with Teflon-lined screw cap	Cool to 4°C	Extract within 7 days and analyzed extracts within 40 days of extraction.
Total Metals	4-oz polyethylene or glass jar	Cool to 4°C	6 months

- * Use for dry weight determination and for soil characterization (i.e., laboratory effervescence check) of low concentration samples suspected to contain carbonate minerals.
- ** See Appendix E for details on preservation options. Consult with laboratory when selecting the preservation option and ensure option is documented with analytical results.
- *** If low level sodium bisulfate or equivalent preservation is required, check with the laboratory that will be doing the analysis for any other requirements. Sample size should be limited to 5 to 10 grams, depending on soil type. See Appendix E for additional sampling details.

Table 9
Approved Methods for Water Analyses for Petroleum Contamination
(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Suspected Contaminant	Approved Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	1. MADEP VPH: Aliphatics/Aromatics, 2. Lead (SM 3030C* Preparation), AND either 3. SM 6210D** with IPE & MTBE OR EPA Methods 601 and 602 with IPE, MTBE, EDB** and Xylenes	Any amount above the MDL
2. Medium/High Boiling Point Fuels: kerosene, diesel, varsol, mineral spirits, naphtha, jet fuels, #2 fuel oil, etc.	1. EPA 602 with Xylenes, 2. MADEP VPH: Aliphatics/Aromatics, 3. EPA 625 plus 10 largest non-target peaks identified, 4. MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
3. Heavy Fuels: #4, #5 and #6 fuel oil; motor oil; hydraulic fluid; etc.	1. EPA 625 plus 10 largest non-target peaks identified 2. MADEP EPH: Aliphatics/Aromatics	Any amount above the MDL
4. Used / Waste Oil	1. SM 6210D, 2. MADEP VPH: Aliphatics/Aromatics, 3. EPA 625 plus 10 largest non-target peaks identified, 4. MADEP EPH: Aliphatics/Aromatics, 5. Metals (SM 3030C* prep.): lead and chromium.	Any amount above the MDL

* Total holding time from collection to laboratory filtering with a 0.45 micron filter is 72 hours.

** For identifying EDB, use EPA Method 504.1, initially and at closure.

NOTE: 1) Other EPA approved comparable methods, which have similar costs, the same constituents and equivalent or lower detection limits, may be used. Once contaminants have been initially identified by GC/MS methods, more economical compound specific methods may be used. 2) Method Detection Limits and Reporting Limits: For target analytes with Groundwater Quality Standards below laboratory lower reporting concentrations, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory lower reporting concentration, must be reported and qualified as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. See Appendix B for tables of volatile and semi-volatile target analytes, Groundwater Quality Standards, and routine laboratory lower reporting limits. The laboratory lower reporting concentration must be indicated for all analytes and must be supported by documentation retained by the laboratory.

Table 10

Approved Methods for Water Analyses for Non-Petroleum Contamination

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Suspected Contaminant	Approved Analytical Method (See Notes)	Reportable Concentrations
1. Metals	SM 3030C*prep: (site specific metals)	Any amount above the MDL
2. Solvents: a. Halogenated/Non-Halogenated b. Ethylene Glycol c. Formaldehyde	a. SM 6210D b. EPA 8015B c. Chromatropic Acid Method	Any amount above the MDL
3. Non-Petroleum - Unknown	1. SM 6210D, 2. EPA 625 plus 10 largest non-target peaks identified, AND 3. Metals (SM 3030C*prep): (RCRA Metals- Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium and Silver)	Any amount above the MDL
4. Pesticides	Contact N.C. Dept. of Agriculture & Consumer Services/ Pesticide Section at (919) 733-3556 AND N.C. DENR / UST Section at (919) 733-8486.	Not Applicable
5. For substances not covered in 1 - 4	Contact N.C. DENR / UST Section at (919) 733-8486.	Not Applicable

* Total holding time from collection to laboratory filtering with a 0.45 micron filter is 72 hours.

NOTE: 1) Other EPA approved comparable methods, which have similar costs, the same constituents and equivalent or lower detection limits, may be used. Once contaminants have been identified by GC/MS methods, more economical compound specific methods may subsequently be used. 2) Method Detection Limits and Reporting Limits: For target analytes with Groundwater Quality Standards below laboratory lower reporting concentrations, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory lower reporting concentration, must be reported and qualified as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. See Appendix B for tables of volatile and semi-volatile target analytes, Groundwater Quality Standards, and routine laboratory lower reporting limits. The laboratory lower reporting concentration must be indicated for all analytes and must be supported by documentation retained by the laboratory.

Table 11
Approved Sample Containers and Preservatives for Water Analyses

(Laboratories must be certified by the North Carolina DWQ to perform the following methods.)

Method	Container	Preservative*	Holding Times
EPA 601/602 SM 6210D MADEP VPH	Duplicate 40-mL VOA vials with Teflon-lined septa screw cap	Add 3 to 4 drops of 1:1 HCl* Cool to 4 °C	14 days
MADEP EPH	1-L amber glass with Teflon-lined screw cap	Add 5-mL of 1:1 HCl (to pH<2) Cool to 4 °C	Samples must be extracted within 14 days and extracts analyzed within 40 days.
EPA 625	1-L amber glass with Teflon-lined screw cap	Cool to 4 °C	Samples must be extracted within 7 days and extracts analyzed within 40 days.
SM 3030C (Metals)	500-mL polyethylene or glass jar	Add 5-mL of 1:1 HNO ₃ (to pH<2) Cool to 4 °C Submit to lab within 48 hours of collection	3030C prep within 72 hours of collection and analyze within 6 months of prep.

* Check with the laboratory that will be doing the analysis for any other requirements. Some laboratories prefer to use sodium bisulfate as an alternative to HCl to preserve volatiles samples.

Table 12
Equipment Construction Materials

Construction Material ¹	Acceptable Analyte Groups	Precautions
Metals		
316 Stainless Steel	All analyte groups. Recommended for inorganic nonmetallics, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted. ²
300-Series Stainless Steel (304, 303, 302)	Suitable for all analyte groups (if used, check for corrosion before use). Recommended for inorganic nonmetallics, metals, volatile and extractable organics.	Do not use if weathered, corroded or pitted. ² If corroded, samples may be contaminated with iron, chromium, copper or nickel. Check for compatibility with water chemistry for dedicated applications. Do not use in low pH, high chloride or high TDS waters.
Low Carbon Steel Galvanized Steel Carbon Steel	Inorganic nonmetallics only.	Appropriate liners must be used. Teflon liners for organics. Plastic or Teflon liners for metals. Galvanized equipment will also contaminate with zinc and cadmium. If used to collect large samples (e.g., dredges), samples may be collected from portions of the interior of the collected material.
Brass	Inorganic nonmetallics only.	Do not use if weathered, corroded or pitted. ²
Plastics³		
Teflon and other fluorocarbon polymers	All analyte groups. Especially recommended for trace metals and organics.	Easily scratched. Do not use if scratched or discolored.
Polypropylene Polyethylene	All analyte groups.	Easily scratched. Do not use if scratched or discolored.
Polyvinyl chloride (PVC)	All analyte groups except extractable and volatile organics	Do not use when collecting extractable or volatile organic samples.
Tygon, Silicone, Neoprene	All analyte groups except extractable and volatile organics.	Do not use when collecting extractable or volatile organic samples. Do not use silicone if sampling for silica.
Viton	All analyte groups except extractable and volatile organics.	Minimize contact with sample. Use only if no alternative material exists.
Glass		
Glass, borosilicate	All analyte groups except silica and boron.	None

¹ Refers to construction material of the portions of the sampling equipment that come in contact with the sample (e.g., housing of variable speed submersible pump must be stainless steel if extractable organics are samples; the housing of a variable speed submersible pump used to sample metals may be plastic.

² Corroded/weathered surfaces are active sorption sites for organic compounds.

³ Plastics used in connections with inorganic trace element samples (including metals) must be uncolored or white.

Table 13
Construction Material Selection for Sample Collection Equipment

Analyte Group	Acceptable Materials
Extractable Organics	Teflon Stainless steel Glass Polypropylene Polyethylene All parts of the system, including connectors and gaskets, must be considered. Viton may be used if no other material is acceptable.
Volatile Organics	Teflon Stainless steel Glass Polypropylene Polyethylene All parts of the system, including connectors and gaskets, must be considered. Viton may be used if no other material is acceptable.
Metals	Teflon Stainless steel Polyethylene, including HDPE Polypropylene Tygon, Viton, Silicone, Neoprene PVC Glass (except silica and boron)
Ultratrace Metals	Teflon Polyethylene, including HDPE Polypropylene Polycarbonate Mercury must be in glass or Teflon
Inorganic Nonmetallics	Teflon Stainless steel Low carbon, galvanized or carbon steel Polyethylene, including HDPE Polypropylene Tygon, Viton, Silicone, Neoprene PVC Glass Brass

Table 14
Equipment for Collecting Groundwater Samples

Activity	Equipment Type
Well Purging	Variable speed centrifugal pump Variable speed submersible pump Variable speed bladder pump Variable speed peristaltic pump Bailer with lanyard
Well Stabilization	pH meter DO meter Conductivity meter Thermometer/Thermistor Turbidimeter Flow-through cell Multi-function meters
Sample Collection	Variable speed peristaltic pump Variable speed submersible pump Variable speed bladder pump Bailer with lanyard (See Appendix F for cautions when using bailers for sample collection.)
Groundwater Level	Electronic sensor Chalked tape

Table 15
Water Sampling Equipment Use and Construction

EQUIPMENT	CONSTRUCTION HOUSING ¹	TUBING ¹	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
WATER SAMPLING					
<u>GROUNDWATER</u>					
1. Positive displacement pumps ²					
a. Submersible (turbine, helical rotor, gear driven)	SS, Teflon	SS, Teflon, PE, PP	Purging	All analyte groups	See notes ^{3,4,5} , must be variable speed
			Sampling	All analyte groups	See notes ^{3,4,5} , must be variable speed
	SS, Teflon	Non-inert ⁶	Purging	All analyte groups	See notes ^{3,4,5} , must be variable speed; polishing required ⁷
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	Must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
	Non-inert ⁶	Non-inert ⁶	Purging	All analyte groups	See notes ^{3,4,5} , must be variable speed; polishing required ⁷
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	Must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
b. Bladder pump (no gas contact)	SS, Teflon, PE, PP or PVC if permanently installed	SS, Teflon, PE, PP	Purging	All analyte groups	See notes ^{3,4,5} , must be variable speed
			Sampling	All analyte groups	See notes ^{3,4} , must be variable speed Bladder must be Teflon if sampling for volatile or extractable organics or PE if used in portable pumps
	SS, Teflon, PE, PP	Non-inert ⁶	Purging	All analyte groups	See notes ^{3,4} , must be variable speed; polishing required ⁷
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	This configuration is not recommended See notes ^{3,4} , must be variable speed If sampling for metals, the tubing must be non-metallic if not SS
	Non-inert ⁶	Non-inert ⁶	Purging	All analyte groups	See notes ^{3,4} , must be variable speed; polishing required ⁷
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	See notes ^{3,4} , must be variable speed; polishing required ⁷ If sampling for metals, the tubing must be

EQUIPMENT	CONSTRUCTION HOUSING ¹	TUBING ¹	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
					non-metallic if not SS
2. Suction lift pumps					
a. Centrifugal	N/A	SS, Teflon, PE, PP	Purging	All analyte groups	See note ⁴ , foot-valve required Must be variable speed
	N/A	Non-inert ⁶	Purging	All analyte groups	See note ⁴ , foot-valve required; polishing required ⁷ Must be variable speed
b. Peristaltic	N/A	SS, Teflon, PE, PP	Purging	All analyte groups	See note ⁴ , foot-valve required; polishing required ⁷ or continuous pumping required Must be variable speed
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	See note ⁴ , medical grade silicone tubing in pump head Must be variable speed
				Extractable organics	See note ⁴ , configured with trap as specified in Appendix F or use Teflon-lined tubing in the pump head
	N/A	Non-inert ⁶	Purging	All analyte groups	See note ⁴ , foot-valve required Must be variable speed
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	See note ⁴ , medical grade silicone tubing in pump head Must be variable speed
3. Bailers					
	SS, Teflon, PE or PP	N/A	Purging	All analyte groups	None, <u>see Appendix F</u>
		N/A	Sampling	All analyte groups	None, <u>see Appendix F</u>
	Non-inert ⁶	N/A	Purging	All analyte groups <u>except</u> volatile and extractable organics	None, <u>see Appendix F</u> If sampling for metals, the tubing must be non-metallic if not SS
			Sampling	All analyte groups <u>except</u> volatile and extractable organics	None, <u>see Appendix F</u> If sampling for metals, the tubing must be non-metallic if not SS
<u>SURFACE WATER</u>					
1. Intermediate containers such as pond sampler, scoops, beakers, buckets, and dippers	SS, Teflon, Teflon-coated, HDPE, PP	N/A	Grab sampling	All analyte groups	None
	Glass	N/A		All analyte groups except boron and fluoride	None
	Non-inert ⁶	N/A		All analyte groups <u>except</u> volatile and	None

EQUIPMENT	CONSTRUCTION HOUSING ¹	TUBING ¹	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
				extractable organics	
2. Nansen, Kemmerer, Van Dorn, Alpha and Beta Samplers, Niskin (or equivalent)	SS, Teflon, Teflon-coated, HDPE, PP	N/A	Specific depth grab sampling	All analyte groups	None
	Non-inert ⁶	N/A		All analyte groups <u>except</u> volatile and extractable organics	None
3. DO Dunker	SS, Teflon, glass, HDPE, PP	N/A	Water column composite sampling	All analyte groups	None
4. Bailers – double valve	SS, Teflon, HDPE, PP	N/A	Grab sampling	All analyte groups	None
	Non-inert ⁶	N/A	Grab sampling	All analyte groups <u>except</u> volatile and extractable organics	None If sampling for metals, the tubing must be non-metallic if not SS
5. Peristaltic pump	N/A	SS, Teflon, PE, PP	Specific depth sampling	All analyte groups <u>except</u> volatile and extractable organics Extractable organics	Medical grade silicone tubing in pump head Must be variable speed See note ⁴ , configured as specified in Figure 4, or use Teflon-lined tubing in the pump head
	N/A	Non-inert ⁶		All analyte groups <u>except</u> volatile and extractable organics	Medical grade silicone tubing in pump head Must be variable speed

Acronyms:

N/A	not applicable	SS	stainless steel	HDPE	high density polyethylene
PE	polyethylene	PP	polypropylene	PVC	polyvinyl chloride

¹ Refers to tubing and pump housings/internal parts that are in contact with purged or sampled water (interior and exterior of delivery tube, inner lining of the discharge tube, etc.).

² If used to collect volatile or extractable organics, all power cords and other tubing must be encased in Teflon , PE or PP.

³ If used as a non-dedicated system, pump must be completely disassembled, if practical, and cleaned between wells.

- ⁴ Delivery tubing must be precleaned and precut at the base of operations or laboratory. If the same tubing is used during the sampling event, it must be cleaned and decontaminated between uses.
- ⁵ In-line check valve required.
- ⁶ “Non-inert” pertains to materials that are reactive (adsorb, absorb, etc.) to the analytes being sampled. For organics, materials include rubber and plastics (except PE and PP) and PVC. For metals, materials include brass, galvanized, and carbon steel.
- ⁷ “Polishing”: When purging for volatile or extractable organics, the entire length of tubing or the portion which comes in contact with the formation water must be constructed of Teflon, SS, PE or PP. If other materials (e.g., PVC, garden hoses, etc.) are used, the following protocols must be followed: 1) slowly withdraw the pump from the water column during the last phase of purging, 2) to remove any water from the well that may have contacted the exterior of the pump and/or tubing, remove a single well volume with the sampling device before sampling begins. **Do not use Tygon** for purging if purgeable or extractable organics are of interest. Polishing **is not recommended**; use of sampling equipment constructed of appropriate materials is preferred.

Table 16
Soil Sampling Equipment Use and Construction

EQUIPMENT	CONSTRUCTION HOUSING ¹	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
SOIL SAMPLING				
<u>SOILS</u>				
1. Core barrel (or liner)	SS, Teflon, glass, Teflon-coated, aluminum, PE, PP	Sampling	All analyte groups. ²	See notes ^{3,4,5}
	Non-inert ⁶ nonmetallics	Sampling	All analyte groups	See note ⁷
	Non-inert ⁶ metals	Sampling	All analyte groups	See note ⁷
2. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, HDPE, PP	Sampling	All analyte groups ²	
		Compositing	All analyte groups except volatile organics	Samples for volatile organics must grab samples
	Plastic	Sampling and compositing	All analyte groups <u>except</u> volatile and extractable organics	None Must be nonmetallic if not SS
3. Mixing tray (pan)	SS, Teflon, glass, Teflon-coated, aluminum, HDPE, PP	Sampling	All analyte groups ²	See note ⁵
		Compositing or homogenizing	All analyte groups except volatile organics	See note ⁵
	Non-inert ⁶	Compositing or homogenizing	All analyte groups	See notes ^{4,5,7} ; must be nonmetallic if not SS
4. Shovel, hand/bucket auger	SS	Sampling	All analyte groups ²	None
	Non-SS	Sampling	All analyte groups ²	See notes ^{4,5,7}
5. Split spoon	SS or carbon steel w/ Teflon insert	Sampling	All analyte groups ²	See notes ^{4,5,7}
6. Shelby tube	SS	Sampling	All analyte groups ²	See note ³
	Carbon steel	Sampling	All analyte groups	See notes ^{3,4,7}
<u>SEDIMENT</u>				
1. Coring devices	SS, Teflon, glass, Teflon-coated, aluminum, HDPE, PP	Sampling	All analyte groups ²	See notes ^{3,4,5}
	Non-inert ⁶ nonmetallics	Sampling	All analyte groups	See note ⁷
	Non-inert ⁶ metals			See notes ^{4,5,7}

EQUIPMENT	CONSTRUCTION HOUSING ¹	USE	PERMISSIBLE ANALYTE GROUPS	RESTRICTIONS AND PRECAUTIONS
2. Grab – Young, Petersen, Shipek	Teflon, Teflon-lined, SS	Sampling	All analyte groups ²	None
	Carbon steel	Sampling	All analyte groups	See notes ^{4,5}
3. Dredges – Eckman, Ponar, Petit Ponar, Van Veen	SS	Sampling	All analyte groups ²	None
	Carbon steel, brass	Sampling	All analyte groups	See notes ^{4,5}
4. Trowel, scoop, spoon or spatula	SS, Teflon, Teflon-coated, HDPE, PP	Sampling	All analyte groups ²	
	Plastic	Compositing	All analyte groups except volatile organics	Samples for volatile organics be grab samples
		Sampling and compositing	All analyte groups <u>except</u> volatile and extractable organics	None must be nonmetallic if not SS
5. Mixing tray (pan)	SS, Teflon, glass, Teflon-coated, aluminum, HDPE, PP	Sampling	All analyte groups ²	See note ⁵
		Compositing or homogenizing	All analyte groups except volatile organics	See note ⁵
	Non-inert ⁶	Compositing or homogenizing	All analyte groups <u>except</u> volatile and extractable organics	none See note ⁵ ; must be nonmetallic if not SS
WASTE⁸				
1. Scoop	SS	Liquids, solids & sludges	All analyte groups ²	Cannot collect deeper phases
2. Spoon	SS	Solids, sludges	All analyte groups ²	Cannot collect deeper phases
3. Push tube	SS	Solids, sludges	All analyte groups ²	Cannot collect deeper phases
4. Auger	SS	Solids	All analyte groups ²	None
5. Sediment sampler	SS	stockpiles	All analyte groups ²	None
6. Backhoe bucket	Steel	Solids, Sludges	All analyte groups ²	Difficult to clean Volatiles and metals must be taken from the interior part of the sample
7. Split spoon	SS	Solids	All analyte groups ²	

- ¹ Refers to tubing and pump housings/internal parts that are in contact with purged or sampled water (interior and exterior of delivery tube, inner lining of the discharge tube, etc.).
- ² Do not use if collecting for hexavalent chromium (Chromium⁺⁶)
- ³ If samples are sealed in the liner for transport to the laboratory, the sample for VOC analysis must be taken from the interior part of the core.
- ⁴ If a non-stainless steel (carbon steel, aluminum) liner, core barrel or implement is used, take the samples for metals, purgeable organics and organics from the interior part of the core sample.
- ⁵ Aluminum foil, trays or liners may be used only if aluminum is not an analyte of interest.
- ⁶ “Non-inert” pertains to materials that are reactive (adsorb, absorb, etc.) to the analytes being sampled. For organics, materials include rubber, plastics (except PE and PP), and PVC. For metals, materials include brass, galvanized, and carbon steel.
- ⁷ If non-inert-liner, core barrel or implement is used, take samples from the interior part of the collected sample.
- ⁸ If disposable equipment of alternative construction materials is used, the construction material must be compatible with the chemical composition of the waste, cannot alter the characteristics of the waste sample in any way, and cannot contribute analytes of interest or any interfering components.
- ⁹ Peristaltic pump may be used without vacuum trap assembly if the flexible, Teflon-lined tubing is used in the pump head.

Figure 1
Regional Office Locations and Map



North Carolina Department of Environment and Natural Resources

Division of Waste Management
UST Section Central Office
1637 Mail Service Center
Raleigh NC 27699-1637
(919) 733-8486 FAX: (919) 733-9413

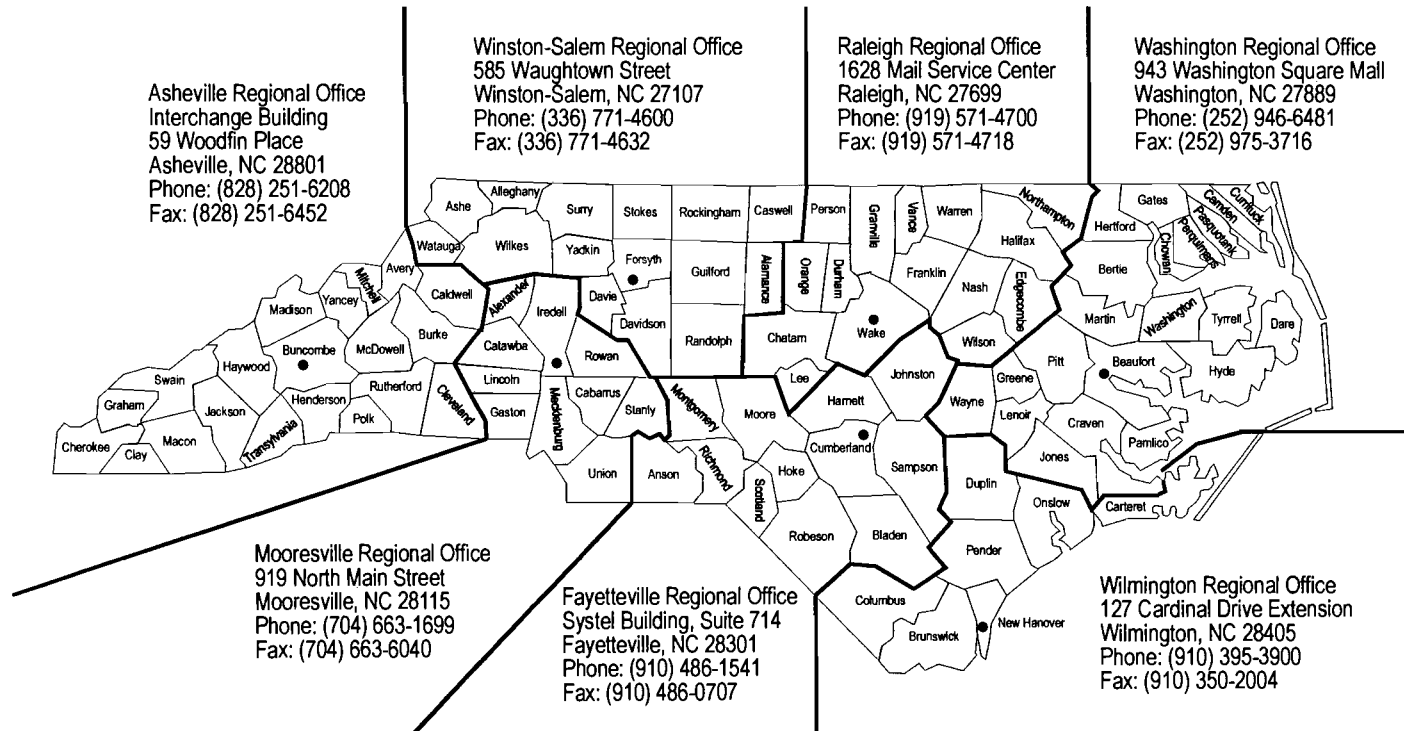
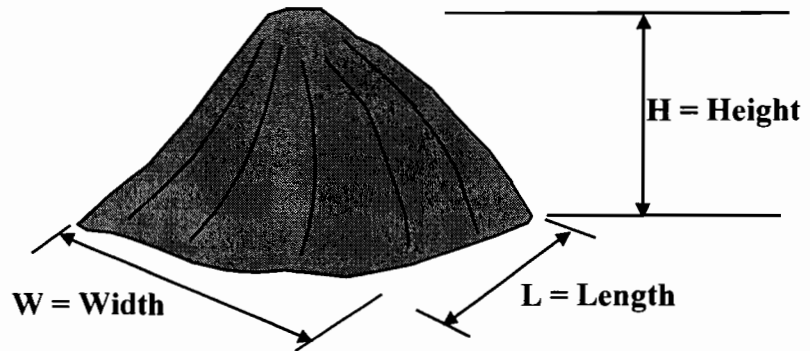
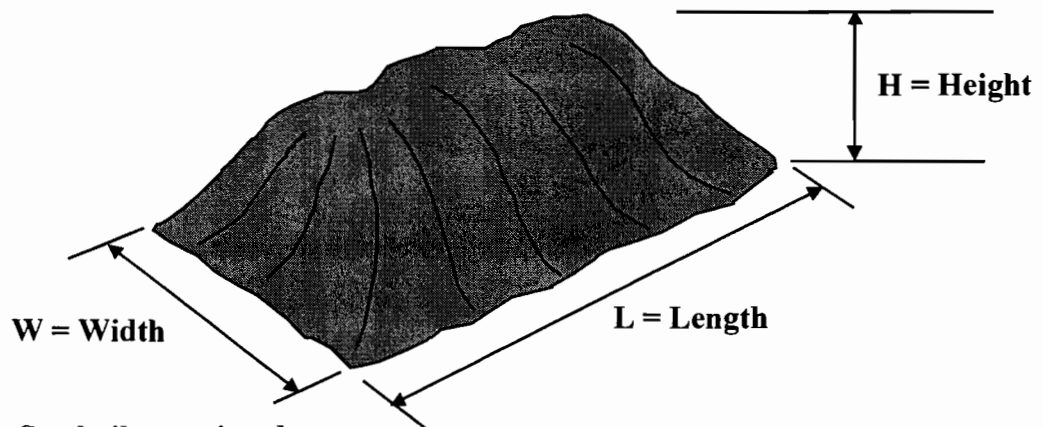


Figure 2 (copy)
Volumes of Stockpiles

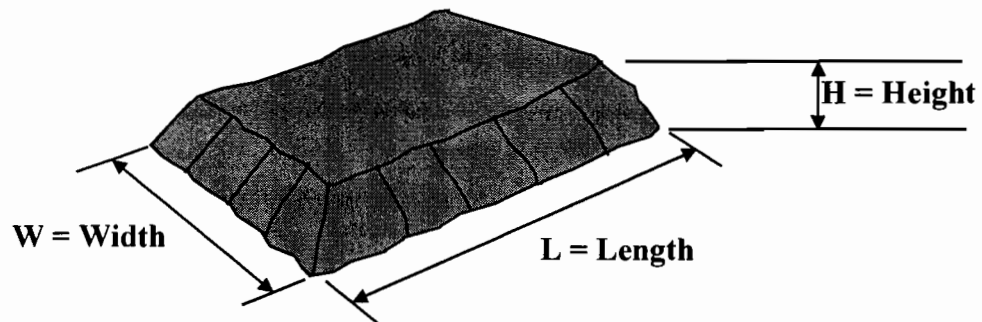
$$L > W > H$$



Conical Stockpiles:
Volume = $(H \times L \times W)/3$



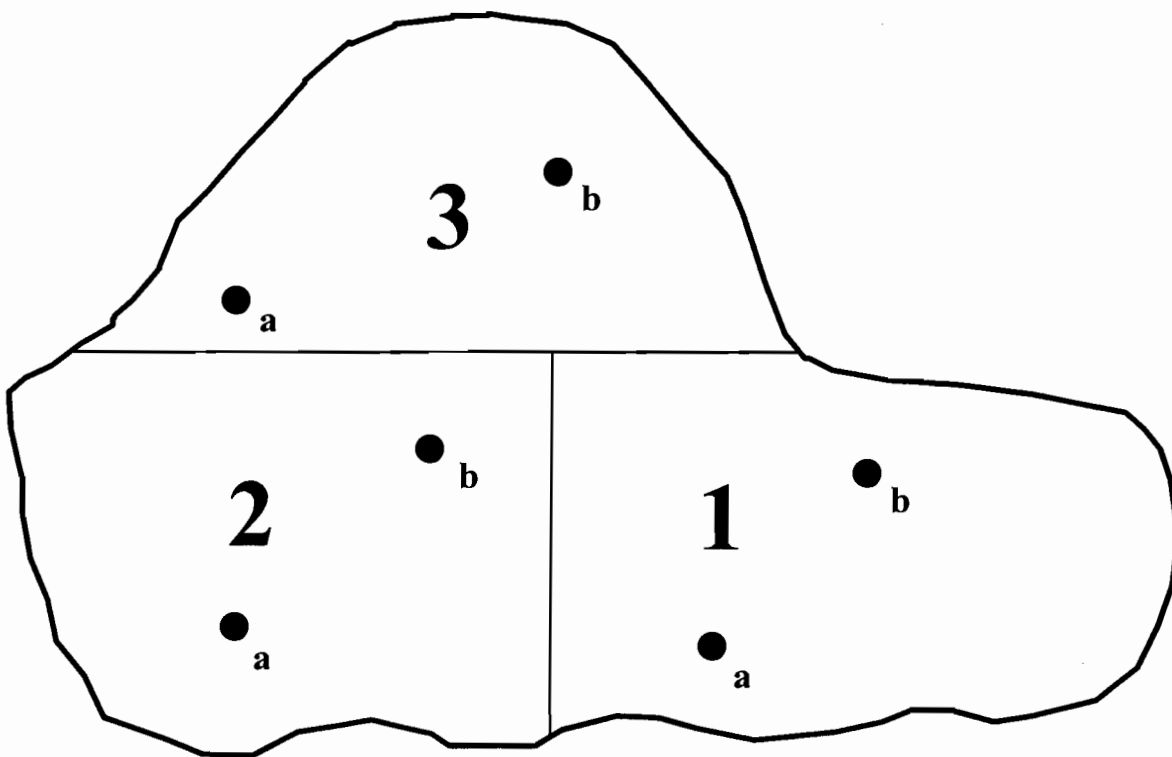
Rectangular Stockpiles - pointed crest:
Volume = $(H \times L \times W)/2$



Rectangular Stockpiles - flat topped:
Volume = $H \times [(L \times W) - (2 \times H \times W)]$

Note: These equations have been simplified for ease of calculation.

Figure 3 (copy)
Soil Stockpile Sampling Map (Example)



Stockpile Type: Rectangle, Flat-topped

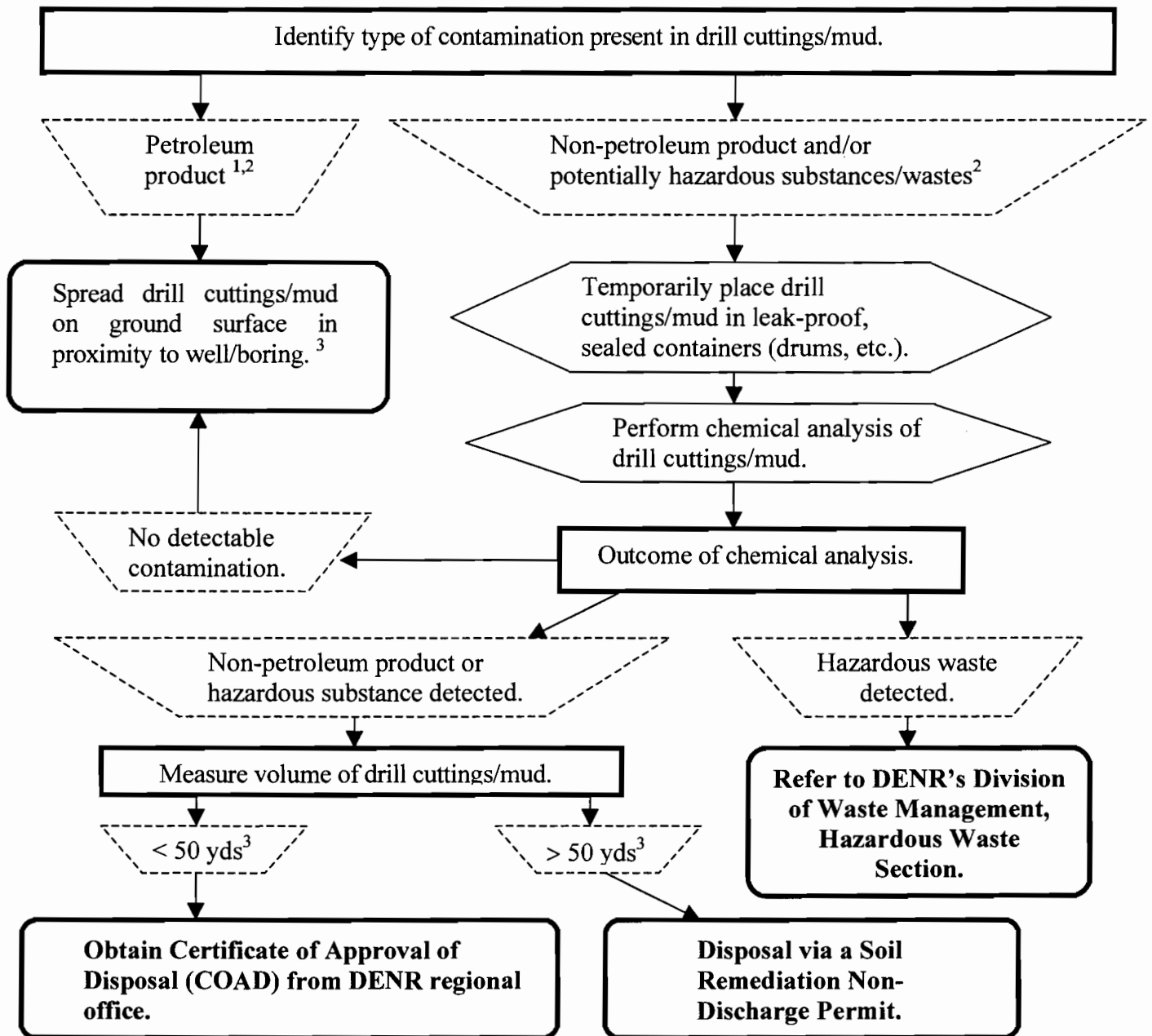
Volume = $4 \times [(21 \times 11) - (2 \times 4 \times 11)]$ = 572 cubic yards

where: Height (maximum) = 12 feet = 4 yards
 Length (maximum) = 63 feet = 21 yards
 Width (maximum) = 33 feet = 11 yards

<u>Composite Samples</u>	<u>3 Primary Samples per core</u>	<u>Sample Depths</u>
1	core 1a	1', 4', 7'
	core 1b	1', 5', 8'
2	core 2a	2', 6', 10'
	core 2b	1', 4', 7'
3	core 3a	1', 3', 5'
	core 3b	2', 5', 8'

Note: *Each composite sample contains six primary samples, three from core "a" and three from core "b."*

Figure 4
DISPOSAL OF DRILL CUTTINGS/MUD
As a Result of Environmental Investigations



¹ "petroleum product" means all petroleum products as defined by G.S. 143-215.94A(7) and includes motor gasoline, aviation gasoline, gasohol, jet fuels, kerosene, diesel fuel, fuel oils (#1-#6), and motor oils (new and used) [15A NCAC 2H.0203(25)].

² If the soil contaminants include both petroleum products and non-petroleum products/hazardous substances, then the disposal guidance for non-petroleum products/hazardous substances should be followed.

³ If the well/boring is located in a paved area (asphalt, concrete, etc.), spread drill cuttings/mud on the nearest open ground surface within site property boundaries.

Figure 5
DISPOSAL OF GROUNDWATER

Resulting from Environmental Investigation, Cleanup Operations, or Permitted Wastewater Disposal Activities

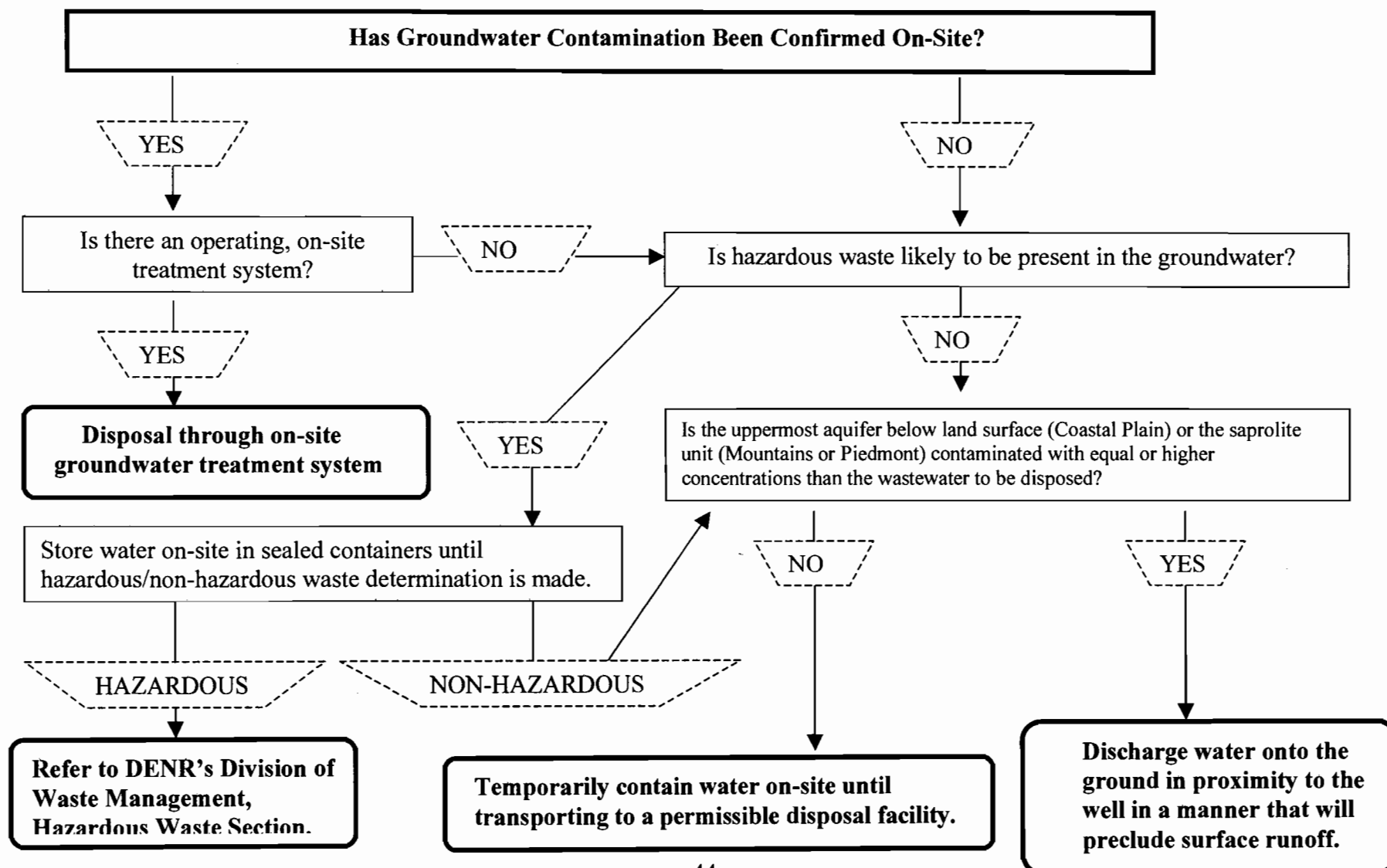
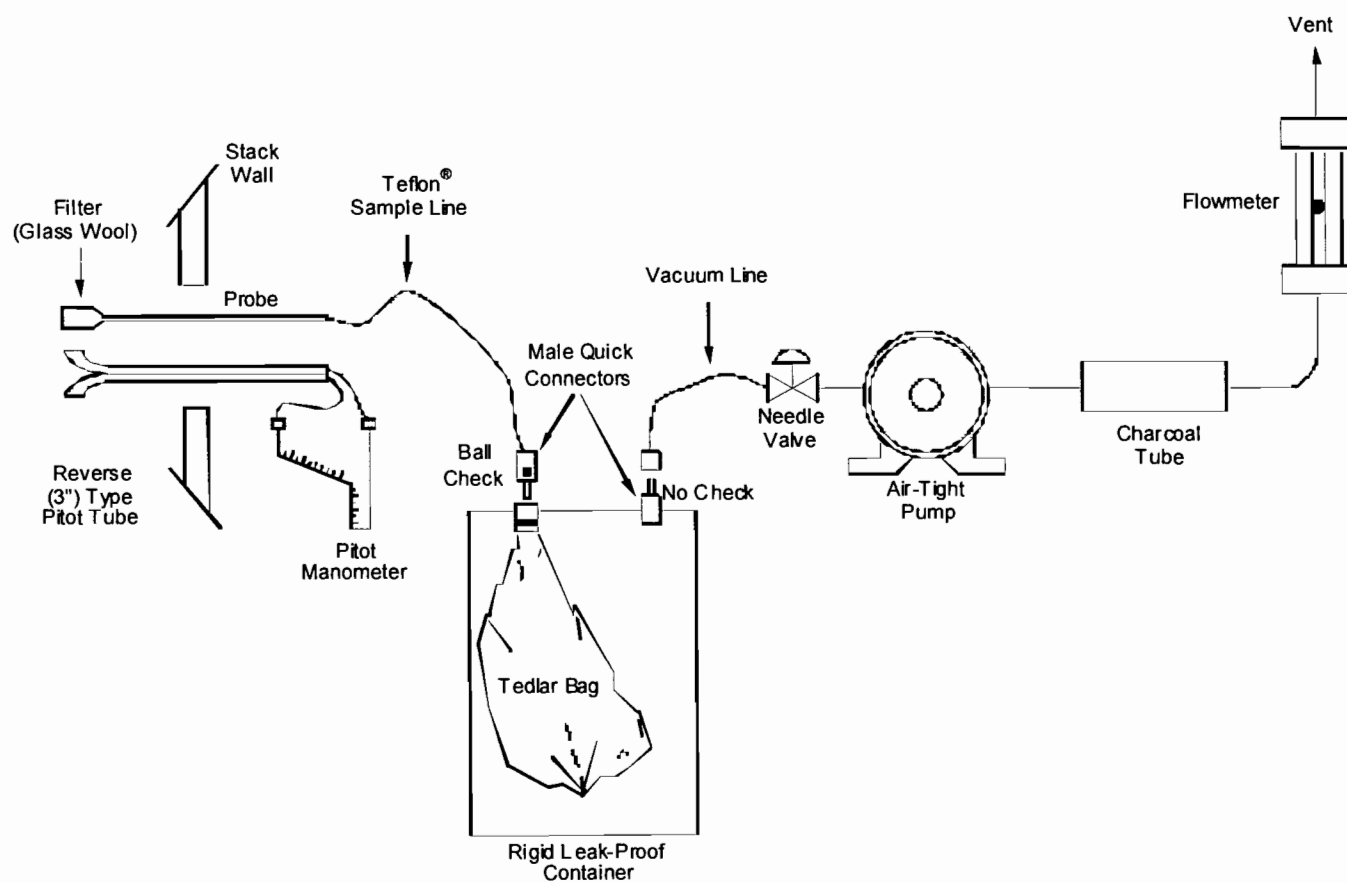


Figure 6
EPA Method 18 Integrated Bag Sampling Train



Appendix A Selecting a Laboratory

The N.C. DENR DWQ Laboratory Certification Program generates a list of certified commercial laboratories. The list includes laboratory contact information and the analytical methods they are certified to perform. A copy of the list may be obtained from the N.C. DENR DWQ Chemistry Laboratory at 4405 Reedy Creek Road, Raleigh, NC 27607, or requested by calling (919) 733-3908. The Laboratory Certification Program has added a list with laboratory contact information to their web page at <http://www.esb.enr.state.nc.us/lab/cert.htm>. Required analytical reporting elements are outlined in Appendix B of this document and Attachment A in permits issued by the N.C. DENR UST Section. Each responsible party, person or organization that uses laboratory services has certain responsibilities to ensure that the laboratory has the appropriate credentials **and** that the data are useable for the intended needs. These responsibilities include:

1. Evaluate the Laboratory: Ensure that the laboratory has the proper credentials. Ensure that the laboratory can produce data of a quality that will be acceptable to N.C. DENR's DWM UST Section.
2. Think in Terms of Quality, not Just Dollars: A laboratory that produces data that is not acceptable to the regulatory agency usually means that the laboratory will need to repeat the work. It is more cost effective to select a laboratory that will meet the quality needs of the project even if that laboratory is not the low bidder.
3. Continue Evaluation: In order to ensure that the laboratory provides data of a consistent quality, do not rely on just the initial evaluation of a laboratory. Other quality control measures will provide the ability to continuously evaluate the laboratory data quality.
4. Evaluate the Reported Data: Review the final laboratory reports against the original expectations and acceptable quality control measures.
5. Ask Questions: The consumer has the right to question laboratory results and receive a logical, clear response. An informed client increases the probability of quality data and data acceptability.

A. Identifying Laboratory Needs

The consumer should be able to identify these critical needs before considering any laboratory:

1. The purpose for which the data are needed.
 - a) The consumer must determine expectations for data quality in terms of the precision, accuracy and detection limit (reporting level or criteria) for each reported value.
 - b) Examples include: permit compliance at some specified concentration levels, compliance monitoring at specified reporting levels; and site cleanup to specified soil and water cleanup levels.
2. The benefits of using contracted or in-house analytical services.
3. The specific laboratory services that are required:
 - a) Are sample collection and sample analysis required, or just sample analysis?
 - b) Types of samples (groundwater, soils, air, etc.).
 - c) The number, frequency and types of samples to be analyzed.
 - d) The test methods that must be used (normally found in permits, guidance documents or relevant rules).

- e) The expected quality based on regulatory requirements.
- f) The expected turnaround time for laboratory analysis.
- g) The deliverables including the report format.
- h) Field related services such as sample collection.
- 4. Any required laboratory credentials, such as certification.
- 5. Identify key personnel in your company that will interface with the laboratory.
- 6. Understand the current market price for the tests to be performed.

B. Evaluating the Laboratory

1. Laboratory Credentials - The laboratory must hold certification from the N.C. DENR DWQ Laboratory Certification Program.
2. On-site Visit - Conduct an on-site visit to verify the laboratory's capabilities and to determine if the laboratory has the equipment and personnel resources necessary for proposed services.
 - a) The laboratory must show a willingness to meet the client's needs.
 - b) The laboratory (both the analytical and administrative areas) should appear organized.
 - c) The analytical staff must be knowledgeable about the services to be provided.
 - d) The administrative staff must appear organized.
 - e) The laboratory must have the capacity to accommodate the proposed scope of work in terms of personnel and equipment.
3. Laboratory Performance Evaluation - Blind Check Samples: Before you sign a contract or agreement, submit a set of blind check samples to the laboratory. A blind check sample is a sample in a real matrix (water, soil, sediment, etc.) that appears to be a real sample, except that the submitter has a list of the components and their known concentration values. Submit the sample(s) to the laboratory as a routine sample(s). Evaluate the results of the reported values against the certified values in the sample(s). The values must be within the laboratory's stated precision for the measurement.
4. Customer Satisfaction
 - a) Obtain a list of current and previous clients.
 - b) Call several of the clients to determine their satisfaction with laboratory.

C. Contracting

1. Purpose
 - a) Provide a detailed list of the scope of services to be contracted.
 - b) Include the purpose for which the data will be used (permit, compliance, etc.).
2. Key Contacts - Identify key contacts for both laboratory and client:
 - a) Administrative: Dealing with billing, contract writing, invoicing, etc.
 - b) Technical: Dealing with data, and quality control issues and problems.
 - c) Sample Control: Dealing with scheduling, shipping supplies and sample receipt.
3. Anticipated Needs - Specify:
 - a) The schedule of activities;
 - b) The expected number of samples, matrices and tests; and
 - c) Field support services, including containers, preservatives, cleaning and calibration services.
4. Expectations

- a) Certification - The laboratory must maintain certification for the analyte, test methods and matrices to be performed. The laboratory must immediately notify clients if its certification status for any analytical method changes. The laboratory must flag and justify any results that were not generated in accordance with certification requirements.
- b) Analytical Expectations - Provide a copy of the permit, sampling plan or guidance document that outlines the regulatory agency's requirements, a list of approved analytical methods to be performed and the matrices for each method (included in Tables for specific sampling activities). Site and activity-specific information must be considered when deciding whether reporting down to MDL is needed. Highly contaminated samples will not be able to meet routine MDLs due to required dilution. Specify the expected turn-around time for the analyses. Specify the shipping schedule if sample containers or supplies are to be provided.
- c) Container/Equipment Services - State the scope of container and equipment services:
Pre-cleaned Containers: types and numbers
Preservatives
Equipment type and numbers.
Equipment calibration
- d) Quality Control - State adherence to both method and internal quality control requirements. Specify acceptable ranges for spikes, duplicates, surrogates and other QC measures if appropriate.
- e) Custody/Sample Tracking - State a time-period for retaining all records if greater than five years. Make arrangements for the transfer of records should the laboratory go out of business or transfer ownership before the records retention time period has lapsed. Specify the level of custody (routine, legal, etc.).
- f) Minimum Reporting Levels - Provide the laboratory with the minimum acceptable values to be reported (See Appendix B for routine lower reporting concentrations). Describe contingencies if these levels cannot be met (i.e. explanation in case narrative).
- g) Reporting Format - All analytical reports issued by the laboratory must comply with N.C. DENR DWM UST Section and DWQ Laboratory Certification Program requirements. Specify whether the information must be provided as hardcopy or electronic or both. If electronic, specify the format for submission.
- h) Deliverables - Specify any deliverables needed over and above the basic report elements outlined in Appendix B.
 - A. Copies of all raw data and associated records, or
 - B. Description of any modifications to methods.
- i) Subcontracting - The laboratory should inform the client **before** any analytical services are subcontracted to another laboratory. The laboratory **must** ensure that the subcontracted laboratory meets the same qualifications and requirements as the primary laboratory. A copy of the analytical report from subcontracted laboratories **must** be submitted to the client.
- j) Method Modifications - The laboratory must identify any modifications that have been made to the requested analytical methods. The client must be notified of any method modifications prior to use in the laboratory, and must provide written consent.
- k) Dilutions - Negotiate how multiple dilutions will be handled. They may be considered a separate analysis and therefore an additional cost. Agree to pay for the analysis of multiple dilutions only if:

1. The sample concentration exceeds the calibration range and the laboratory was not aware of the expected sample concentration, or
2. A dilution is required (and it is possible) to quantitate all contaminants of concern and/or achieve their routine laboratory lower reporting limits (i.e. where closure is possible).

NOTE: *Samples must never be diluted routinely or without cause. Dilutions may not provide the reporting limits necessary for compounds with cleanup standards near routine laboratory lower reporting concentrations or practical quantitation limits. However, the analysis of undiluted or less diluted samples in an attempt to obtain lower reporting limits may damage analytical instrumentation. If lower detection and reporting limits are needed, but are not possible due to interferences in the sample, an explanation in the case narrative with supporting documentation will be required. Multiple dilutions will not be reimbursed as a separate analysis by the State Trust Fund.*

5. Penalties and Consequences

- a) Negotiate penalties or other consequences (no payment) for these problems:
 1. Failure to provide data or associated (expected) information,
 2. Failure to meet deadlines,
 3. Failure to provide acceptable data, and
 4. Failure to meet contract requirements.
- b) Consider these consequences:
 1. Costs of re-sampling,
 2. Fines incurred because of unacceptable data,
 3. Costs associated with having evaluated and/or processed unacceptable data, and
 4. Re-analysis costs (if re-analysis is due to laboratory error or failed QC).
- c) Reserve the right to reject data, however if any data are used, laboratory should be paid according to negotiated terms.

D. On-Going Evaluation

1. Monitor laboratory's performance against the specific contract requirements.
2. Continue to use blind QC samples as a measure of routine performance. Either submit vendor supplied samples, samples prepared to a known concentration, or split samples with another laboratory.

E. Data Review

The end user of the data must realize that the use of approved analytical methods by a certified laboratory cannot assure defensibility and data quality. The primary questions of data assessment should be, "Are the data effective for making the specified decisions, and are both the sampling and analytical documentation accompanying the data sufficient to establish that they are?" The end user of the data who has access to site specific information must follow the key to defensible environmental decision-making by openly acknowledging all underlying assumptions and managing all sources of uncertainty that can significantly impact the correctness of a decision to the degree feasible. Often a "weight of evidence" approach is needed because no single piece of

information can provide definitive evidence given the complexities present in environmental systems. A number of questions must be asked to establish that data is of known quality and demonstrated as useful and reliable for the intended purpose. The concept of effective data embodies the principle that the information value of data (i.e., data quality) depends heavily upon the interaction between sampling design, analytical design, and the intended use of the data. Considering site-specific conditions, sample support, quality control, and data documentation assure the scientific defensibility of effective data.

1. Are the reported concentrations different from the routine (expected) levels?
2. Is the same value reported for the same analyte (except non-detects) in the same set of samples or over a historical period of time?
3. Do the parts add up to the total? Total values must be greater than or equal to dissolved values.
4. Are different but related analyses consistent?
 High turbidity and high total suspended solids.
 High turbidity and increased method detection limits for other tests.
5. Do results indicate a sample collection problem such as high dissolved oxygen in groundwater or high turbidity and elevated metals results?
6. Are the QC check samples within acceptable ranges and are the ranges reasonable?
7. Are non-detects reported correctly (should be a value with a qualifier code defined in a key)?
8. Over the history of laboratory use, were any QC problems reported?
9. Is there any laboratory or field blank contamination?
10. Do the reports contain all required information?

F. Ask questions if:

1. There are problems associated with the data review.
2. The QC check sample data are not acceptable.
3. The laboratory consistently reports the same QC failure.
4. The laboratory uses different methods than requested.
5. The laboratory subcontracts analyses without notifying the client.
6. The laboratory does not meet any of the contract requirements.
7. The laboratory misses holding times.
8. The laboratory fails to provide requested resource(s) (e.g., containers, calibration, etc.) in a timely manner.
9. There any doubts about the acceptability of the data.
10. Detection limits are above the expected values and the laboratory provides no reasonable explanation.

Note: There are two types of analytical lower limits: detection limits (DLs) and quantitation limits (QLs). The DL is the lowest concentration that can reliably be distinguished from zero, but is not quantifiable with acceptable precision. At the DL, the analyte is proven to be present, but its reported concentration is an estimate. The QL is the lowest concentration which can be not only detected, but also quantified with a specified degree of precision. At the QL, the analyte is both proven present and measured reliably. Risk assessments often inappropriately report and handle data near the limits of detection. Common errors include (1) omission of detection limits,

(2) failure to define detection limits which are reported, and (3) unjustified treatment of non-detects as zero. The practice of omitting information on DLs from risk assessments conceals important uncertainties about potential levels of undetected risk.

G. Scheduling Services

1. Notify the laboratory about the analytical and equipment needs at least a week in advance of the actual sampling trip.
2. Even if the trip is routine (monthly, weekly, quarterly compliance sampling), notify the laboratory of the number and type of samples to be collected, as well as any needs for specific reporting requirements. Also communicate expected contamination levels. This is important if a highly contaminated site is sampled.

Appendix B Analytical Reporting Requirements

To help ensure reporting requirements are met, verify that the N.C. DWQ-certified Laboratory selected to perform analyses on your samples has access to a copy of the following analytical reporting requirements. All compounds analyzed using a certified method must be reported. The laboratory report must include the following required report elements.

A. Required Report Elements

1. NC DWQ-certified Laboratory name, address, certification number, contact and phone number
2. Client/Facility name & address
3. Date of report preparation
4. Chain-of-Custody form including:
 - a) a description of each sample (including QA/QC samples) and the number of containers (sample location and identification);
 - b) signature of the sampler;
 - c) the date and time of sample collection;
 - d) the analytical method to be performed;
 - e) the sample type (i.e., water or soil);
 - f) the regulatory agency (i.e., N.C. DENR/DWM – UST Section);
 - g) signatures of all persons relinquishing and receiving custody of the samples, and dates and times of custody transfers.
5. Case Narrative (written on laboratory letterhead or analytical report and signed by the laboratory supervisor or his/her designee): The case narrative should include a detailed description of all problems encountered in the analysis and a discussion of possible reasons for any QA/QC criteria outside acceptance limits.
6. Summary of Analytical Results including:
 - a) Client's sample identification and the corresponding laboratory identification
 - b) Sample matrix,
 - c) Dates of and methods of analysis, preparation and/or extraction,
 - d) Weight or volume of sample used for analysis/extraction/digestion,
 - e) Dilution or concentration factor for the samples,
 - f) Percentage of moisture in the soil samples,
 - g) Definitions of any data qualifiers,
 - h) Method Detection Limit or Limit of Detection,
 - i) Reporting Limit (i.e., Limit of Quantitation or Practical Quantitation Limit),
 - j) Analytical results with units of measure,
 - k) Signature of Laboratory Supervisor.
7. Summary of QA/QC Results including:
 - a) Method Blank results **and** field or trip blank results if applicable,
 - b) Surrogate recoveries and control limits,
 - c) Laboratory QC Check sample results with percent recoveries and control limits,
 - d) Laboratory duplicate results with relative percent difference and control limits,
 - e) Batch Matrix spike/matrix spike duplicate results (where required by method or permit).

B. Document Retention Criteria

The following items must be retained on file by the laboratory for at least five years after the analysis. They are not required in the report, but must be made available to NCDENR upon request:

1. The NCDENR DWQ laboratory certification number assigned.
2. Copies of all sample gas chromatogram traces with the attached integration report; copies of the reconstructed ion chromatograms (RICs) must be provided if performing the analysis by mass spectroscopy. Chromatograms must be provided for all samples, method blanks, and daily calibration standards. Chromatograms must be identified with a sample identification and the time and date of analysis.
3. A document containing the date and time for the initial calibration and the standards used to verify instrument settings for the data reported. Include the composition and concentration range of standards used to establish and verify maintenance of instrument calibration.
4. A document explaining laboratory quality control samples used for the data reported and results obtained. Include information concerning surrogates, standards, column performance, matrix spike and matrix spike duplicate samples, blank data, and reference samples.
5. A document supporting laboratory reporting limits (i.e. Limit of Quantitation) and method detection limits.

NOTE: *Many GC and GC/MS methods have extensive analyte lists, and the use of a common Method Detection Limit (MDL) for all analytes is useful for reporting purposes. However, this is not an accurate representation of detectability, and setting such a reporting limit is discouraged for compounds that have standards near or below the laboratory lower reporting concentration. Compounds with standards far above the detection limit are not as problematic for reporting purposes, and reasonable compromises can be allowed. For target analytes with Groundwater Quality Standards or Maximum Soil Contaminant Concentrations below laboratory lower reporting concentrations, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. For Ex-Situ Soil Remediation permit completion soil sampling, the MDL concentration must be indicated with the analytical result and results reported down to the MDL. Results above the MDL, but below the laboratory lower reporting concentration, must be reported and qualified as estimated. Blank results for these target analytes must also be reported down to MDL in order to evaluate the low level reporting. The laboratory lower reporting concentration and MDL concentrations must be supported by documentation retained by the laboratory. See the tables in Appendix B for a list of required volatile and semi-volatile target analytes, their associated Groundwater Quality Standards, most restrictive Maximum Soil Contaminant Concentrations, and routine laboratory lower reporting concentrations.*

C. Blank Evaluation Criteria

The purpose of laboratory (or field) blank analysis is to determine the existence and magnitude of contamination resulting from laboratory (or field) activities. The criteria for the evaluation of blanks apply to any blank associated with the samples (e.g., method blanks, instrument blanks, storage blanks, trip blanks and equipment blanks). If problems with any blank

exist, all associated data must be carefully evaluated to determine whether or not there is an inherent variability in the data, or if the problem is an isolated occurrence that does not affect other data.

Action regarding unsuitable blank results depends on the circumstances and origin of the blank. For common laboratory contaminants (*i.e., volatiles such as methylene chloride, acetone, and 2-butanone and semi-volatiles such as common phthalates*), positive sample results should be reported unless the concentration of the compound in the sample is less than or equal to 10 times (10x) the amount in any blank for the common volatile laboratory contaminants, or 5 times (5x) the amount for other volatile target compounds. The case narrative should include an explanation of possible sources of laboratory contamination for the affected laboratory blank(s) (e.g. method, instrument or storage). In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The reviewer should note that blanks may not involve the same weights, volumes or dilution factors as the associated samples. These factors must be taken into consideration when applying the "5x" and "10x" criteria, so a comparison of the total amount of contamination is actually made. The results must not be corrected by subtracting any blank value, unless specified as an option in the method. These results must be identified as being generated by an analytical method with a significant performance-based modification.

D. Required Target Analytes for SW-846 Methods 8260 and 8270

EPA SW-846 Methods 8260 and 8270 include extensive lists of compounds, which may be included as target compounds depending on the use of various preparation techniques. Tables with the required target compounds for these methods are included in this Appendix. These lists are subsets of the extensive list of compounds amenable to analysis by these methods. Unless site specific conditions require additional target compounds, or initial soil analytical results require a shortened target compound list for subsequent sampling, these standardized lists of target compounds are required. At a minimum, to comply with Groundwater rules found in 15A NCAC 2L, these compounds should be reported whenever these SW-846 methods are requested for environmental monitoring samples reported to the UST Section. The laboratories have an option to report this shortened list to their clients if it meets your client's needs. The clients might request additional compounds or the complete list, but at a minimum the laboratories should report these shortened lists.

The compounds included in these lists should have been included in precision and accuracy studies for the initial demonstration of capability and MDL studies for certification by the N.C. Division of Water Quality Laboratory Certification program. However, several additional compounds with North Carolina Groundwater Quality Standards and Maximum Soil Contaminant Concentrations (MSCCs) that were not included in the Method Accuracy and Precision tables have been added. Due to the difficulties in analysis, 2-Chloro ethylvinyl ether, Benzidine and N-Nitrosodimethylamine have not been included on the Target Analyte List. Please note that these compounds can be requested in addition to the standard list if it is required by specific projects.

Many analytical methods are very precise at low levels, resulting in calculated MDLs that will be far below what is analytically achievable in a real sample. It is important to verify that the determined MDL for an organic analyte will produce an instrument signal at that level. The method of serial dilution is usually a good way to verify the detection limit. If the calculated value is not discernible from the background, then the MDL is not reasonable. Perform a serial dilution analysis and recalculate the MDL until an appropriate detection limit is found. The MDLs for many common laboratory solvents should be straightforward to calculate, although the calculated value may not be attainable due to ambient contamination. Laboratories should make every attempt to minimize contamination. The MDLs for these compounds should be reported, and detects must be dealt with on a case by case basis. Results must be qualified where laboratory contamination is documented in blanks, quality control samples or other samples in the same analytical batch.

Appendix B
Analytical Reporting Requirements
Version 1.2 September 1, 2003

Method 8260B North Carolina UST Section Required Target Analytes

8260 Target Analyte	CASRN	GWSTD mg/L	Lower Reporting Concentration ¹ mg/L	Soil to GW MSCC mg/kg	Lower Reporting Concentration ¹ mg/kg
Acetone	67-64-1	0.7	0.010	3	0.050
Benzene	71-43-2	0.001	0.001	0.0056	0.005
Bromobenzene	108-86-1		0.001		0.005
Bromochloromethane	74-97-5		0.001		0.005
Bromodichloromethane	75-27-4	0.0006	0.001		0.005
Bromoform	75-25-2	0.00019	0.001		0.005
Bromomethane	74-83-9		0.002		0.010
2-Butanone (MEK)	78-93-3		0.020		0.100
n-Butylbenzene	104-51-8	0.07	0.001	4	0.005
sec-Butylbenzene	135-98-8	0.07	0.001	3	0.005
tert-Butylbenzene	98-06-6	0.07	0.001	3	0.005
Carbon tetrachloride	56-23-5	0.0003	0.001		0.005
Chlorobenzene	108-90-7	0.05	0.001		0.005
Chlorodibromomethane	124-48-1	0.00041	0.001	0.002	0.005
Chloroethane	75-00-3	2.8	0.002		0.010
Chloroform	67-66-3	0.00019	0.001	0.001	0.005
Chloromethane	74-87-3	0.0026	0.001	0.02	0.005
2-Chlorotoluene	95-49-8	0.14	0.001		0.005
4-Chlorotoluene	106-43-4		0.001		0.005
1,2- Dibromoethane (EDB)	106-93-4	0.0000004	0.001	0.00000197	0.005
1,2-Dichlorobenzene	95-50-1	0.62	0.001	7	0.005
1,3-Dichlorobenzene	541-73-1	0.62	0.001	24	0.005
1,4-Dichlorobenzene	106-46-7	0.075	0.001	1	0.005
Dichlorodifluoromethane	75-71-8	1.4	0.001		0.005
1,1-Dichloroethane	75-34-3	0.7	0.001	4	0.005
1,2-Dichloroethane (1,2-DCA)	107-06-2	0.00038	0.001	0.0018	0.005
1,1-Dichloroethene	75-35-4	0.007	0.001	0.045	0.005
cis-1,2-Dichloroethene	156-59-2	0.07	0.001	0.35	0.005
trans-1,2-Dichloroethene	156-60-5	0.07	0.001	0.38	0.005
1,2-Dichloropropane	78-87-5	0.00056	0.001	0.0029	0.005
1,3-Dichloropropane	142-28-9		0.001		0.005
2,2-Dichloropropane	590-20-7		0.001		0.005
1,1-Dichloropropene	563-58-6		0.001		0.005
cis-1,3-Dichloropropene	10061-01-5	0.0002	0.001	0.0009	0.005
trans-1,3-Dichloropropene	10061-02-6	cis & trans	0.001	cis & trans	0.005
Ethylbenzene	100-41-4	0.029	0.001	0.24	0.005
2-Hexanone	591-78-6	0.28	0.010	1.9	0.050
Isopropyl benzene	98-82-8	0.07	0.001	2	0.005
Isopropyl ether	108-20-3	0.07	0.001	0.37	0.005
4-Isopropyl toluene	99-87-6		0.001		0.005
Methylene chloride	75-09-2	0.005	0.001	0.02	0.005
4-Methyl-2-pentanone (MIBK)	108-10-1		0.010		0.050
Methyl-tert-butyl ether (MTBE)	1634-04-4	0.2	0.002	0.92	0.010
Naphthalene	91-20-3	0.021	0.002	0.58	0.010
n-Propylbenzene	103-65-1	0.07	0.001	2	0.005
Styrene	100-42-5	0.0001	0.001	2.24	0.005
1,1,2,2-Tetrachloroethane	79-34-5	0.00017	0.001	0.001	0.005

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8260 Target Analyte	CASRN	GWSTD mg/L	Lower Reporting Concentration ¹ mg/L	Soil to GW MSCC mg/kg	Lower Reporting Concentration ¹ mg/kg
Tetrachloroethene (PCE)	127-18-4	0.0007	0.001	0.0074	0.005
Toluene	108-88-3	1	0.001	7	0.005
1,1,1-Trichloroethane	71-55-6		0.001		0.005
1,1,2-Trichloroethane	79-00-5		0.001		0.005
Trichloroethene (TCE)	79-01-6	0.0028	0.001	0.183	0.005
Trichlorofluoromethane	75-69-4	2.1	0.001		0.005
1,2,3-Trichlorobenzene	87-61-6		0.001		0.005
1,2,4-Trichlorobenzene	120-82-1	0.07	0.001		0.005
1,2,3-Trichloropropane	96-18-4		0.001		0.005
1,2,4-Trimethylbenzene	95-63-6	0.35	0.001	8	0.005
1,3,5-Trimethylbenzene	108-67-8	0.35	0.001	7	0.005
Vinyl acetate	108-05-4		0.005		0.025
Vinyl chloride	75-01-4	0.000015	0.001		0.005
Xylenes, Total	1330-20-7	0.53	0.005	5	0.025

¹ Please note that lower reporting concentrations in this table should be routinely achievable but are not corrected for dilution factors (i.e. due to high levels of contamination and/or soil moisture). Dilution factors must be applied, which will result in the elevation of these routinely achievable lower reporting concentrations. Soil moisture content, which is sample specific, will result in sample-specific adjustments in method detection limit and reporting limit concentrations.

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Analytical Reporting Requirements
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Method 8270C North Carolina UST Section Required Target Analytes

8270 Target Analyte	CASRN	GWSTD mg/L	Lower Reporting Concentration ¹ mg/L	Soil to GW (Residential) MSCC mg/kg	Lower Reporting Concentration ¹ mg/kg
Acenaphthene	83-32-9	0.08	0.010	8	0.330
Acenaphthylene	208-96-8	0.21	0.010	11	0.330
Anthracene	120-12-7	2.1	0.010	995	0.330
Benzoic Acid	65-85-0	28	0.050	112	1.650
Benz(a)anthracene	56-55-3	0.00005	0.010	0.34	0.330
Benzo(b)fluoranthene	205-99-2	0.000047	0.010	1 (0.88)	0.330
Benzo(k)fluoranthene	207-08-9	0.00047	0.010	12 (9)	0.330
Benzo(g,h,i)perylene	191-24-2	0.21	0.010	6720 (469)	0.330
Benzo(a)pyrene	50-32-8	0.0000047	0.010	0.091 (0.088)	0.330
Benzyl alcohol	100-51-6		0.020		0.660
Bis(2-chloroethoxy)methane	111-91-1	0.010	0.010		0.330
Bis(2-chloroethyl)ether	111-44-4	0.000031	0.010	0.0002	0.330
Bis(2-chloroisopropyl)ether	108-60-1		0.010		0.330
Bis(2-ethylhexyl)phthalate	117-81-7	0.003	0.010	6.67	0.330
4-Bromophenyl phenyl ether	101-55-3		0.010		0.330
Butyl benzyl phthalate	85-68-7	0.1	0.010		0.330
4-Chloroaniline	106-47-8		0.010		0.330
4-Chloro-3-methylphenol	59-50-7		0.020		0.660
2-Chloronaphthalene	91-58-7		0.010		0.330
2-Chlorophenol	95-57-8	0.0001	0.010		0.330
4-Chlorophenyl phenyl ether	7005-72-3		0.010		0.330
Chrysene	218-01-9	0.005	0.010	38	0.330
Dibenz(a,h)anthracene	53-70-3	0.0000047	0.010	0.17 (0.088)	0.330
Dibenzofuran	132-64-9	0.028	0.010	4.7	0.330
Di-n-butyl phthalate	84-74-2	0.7	0.010		0.330
1,2-Dichlorobenzene	95-50-1	0.62	0.010	7	0.330
1,3-Dichlorobenzene	541-73-1	0.62	0.010	24	0.330
1,4-Dichlorobenzene	106-46-7	0.075	0.010	1	0.330
3,3-Dichlorobenzidine	91-94-1		0.020		0.660
2,4-Dichlorophenol	120-83-2		0.010		0.330
Diethyl phthalate	84-66-2	5	0.010		0.330
2,4-Dimethylphenol	105-67-9	0.14	0.010	0.9	0.330
Dimethyl phthalate	131-11-3		0.010		0.330
4,6-Dinitro-2-methylphenol	534-52-1		0.050		1.650
2,4-Dinitrophenol	51-28-5		0.050		1.650
2,4-Dinitrotoluene	121-14-2		0.010		0.330
2,6-Dinitrotoluene	606-20-2		0.010		0.330
Di-n-octyl phthalate	117-84-0	0.14	0.010		0.330
1,2-Diphenylhydrazine (as Azobenzene)	122-66-7		0.050		1.650
Fluoranthene	206-44-0	0.28	0.010	276	0.330
Fluorene	86-73-7	0.28	0.010	44	0.330
Hexachlorobenzene	118-74-1	0.00002	0.010		0.330
Hexachlorobutadiene	87-68-3	0.00044	0.010	0.26	0.330
Hexachlorocyclopentadiene	77-47-4		0.010		0.330
Hexachloroethane	67-72-1		0.010		0.330
Indeno(1,2,3-c,d)pyrene	193-39-5	0.000047	0.010	3 (0.88)	0.330

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8270 Target Analyte	CASRN	GWSTD mg/L	Lower Reporting Concentration ¹ mg/L	Soil to GW (Residential) MSCC mg/kg	Lower Reporting Concentration ¹ mg/kg
Isophorone	78-59-1	0.0368	0.010		0.330
2-Methylnaphthalene	91-57-6	0.028	0.010		0.330
2-Methylphenol	95-48-7		0.010		0.330
4-Methylphenol	106-44-5	0.0035	0.010		0.330
Naphthalene	91-20-3	0.021	0.010	0.58	0.330
Nitrobenzene	98-95-3		0.010		0.330
2-Nitrophenol	88-75-5		0.010		0.330
4-Nitrophenol	100-02-7		0.050		1.650
N-Nitrosodiphenylamine	86-30-6		0.010		0.330
N-Nitroso-di-N-propylamine	621-64-7		0.010		0.330
Pentachlorophenol	87-86-5	0.0003	0.050		1.650
Phenanthrene	85-01-8	0.21	0.010		0.330
Phenol	108-95-2	0.3	0.010		0.330
Pyrene	129-00-0	0.21	0.010	286	0.330
1,2,4-Trichlorobenzene	120-82-1	0.07	0.010	2.6	0.330
2,4,6-Trichlorophenol	88-06-2		0.010		0.330

¹ Please note that lower reporting concentrations in this table should be routinely achievable but are not corrected for dilution factors (i.e. due to high levels of contamination and/or soil moisture) Dilution factors must be applied and will result in the elevation of these routinely achievable lower reporting concentrations. Soil moisture content, which is sample specific, will result in sample specific adjustments in method detection limit and reporting limit concentrations.

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SUBMIT FORM ON YELLOW PAPER ONLY

UST SECTION GROUNDWATER QUALITY MONITORING COMPLIANCE REPORT FORM		Mail Original to UST SECTION 1637 Mail Service Center Raleigh, N.C. 27699-1637 		DIVISION OF WASTE MANAGEMENT PHONE: (919) 733-8486																																													
FACILITY INFORMATION <i>Please Print Clearly or Type</i>																																																	
Facility Name:																																																	
Permit Name (if different):																																																	
Facility Address:																																																	
(City)		County																																															
		(State)		(Zip)																																													
Contact Person:		Telephone#:																																															
Well Location/Site Name:		No. of Wells to be Sampled:																																															
		(from Permit)																																															
Well Identification Number (from Permit):		For Groundwater Treatment Systems																																															
Well Depth: _____ ft.		Check One:																																															
Screened Interval: _____ ft. to _____ ft.		☐ Influent (98)																																															
Depth to Water Level: _____ ft. below measuring point.		☐ Effluent (99)																																															
Measuring Point is _____ ft. above land surface.																																																	
Gallons of water purged before sampling:																																																	
Field analysis: Temp. _____ °C pH _____		Specific Conductance _____ uMhos																																															
Odor _____		Appearance _____																																															
PARAMETERS (Samples for metals were collected unfiltered) <table style="width: 100%;"> <tr> <td style="width: 33%;">COD _____ mg/l</td> <td style="width: 33%;">Nitrite (NO_2^-) as N _____ mg/l</td> <td style="width: 33%;">Ni - Nickel _____ mg/l</td> </tr> <tr> <td>Coliform: MF Fecal _____ /100ml</td> <td>Nitrate (NO_3^-) as N _____ mg/l</td> <td>Pb - Lead _____ mg/l</td> </tr> <tr> <td>Coliform: MF Total _____ /100ml</td> <td>Phosphorus: Total as P _____ mg/l</td> <td>Zn - Zinc _____ mg/l</td> </tr> <tr> <td>(Note: Use MPN method for highly turbid samples.)</td> <td>Orthophosphate _____ mg/l</td> <td>Ammonia Nitrogen _____ mg/l</td> </tr> <tr> <td>Dissolved Solids: Total _____ mg/l</td> <td>Al - Aluminum _____ mg/l</td> <td>Other (Specify Compounds and Concentration Units) _____</td> </tr> <tr> <td>pH (when analyzed) _____ units</td> <td>Ba - Barium _____ mg/l</td> <td></td> </tr> <tr> <td>TOC _____ mg/l</td> <td>Ca - Calcium _____ mg/l</td> <td></td> </tr> <tr> <td>Chloride _____ mg/l</td> <td>Cd - Cadmium _____ mg/l</td> <td></td> </tr> <tr> <td>Arsenic _____ mg/l</td> <td>Chromium: Total _____ mg/l</td> <td></td> </tr> <tr> <td>Grease and Oils _____ mg/l</td> <td>Cu - Copper _____ mg/l</td> <td></td> </tr> <tr> <td>Phenol _____ mg/l</td> <td>Fe - Iron _____ mg/l</td> <td></td> </tr> <tr> <td>Sulfate _____ mg/l</td> <td>Hg - Mercury _____ mg/l</td> <td></td> </tr> <tr> <td>Specific Conductance _____ uMhos</td> <td>K - Potassium _____ mg/l</td> <td></td> </tr> <tr> <td>Total Ammonia _____ mg/l</td> <td>Mg - Magnesium _____ mg/l</td> <td></td> </tr> <tr> <td>TKN as N _____ mg/l</td> <td>Mn - Manganese _____ mg/l</td> <td></td> </tr> </table>					COD _____ mg/l	Nitrite (NO_2^-) as N _____ mg/l	Ni - Nickel _____ mg/l	Coliform: MF Fecal _____ /100ml	Nitrate (NO_3^-) as N _____ mg/l	Pb - Lead _____ mg/l	Coliform: MF Total _____ /100ml	Phosphorus: Total as P _____ mg/l	Zn - Zinc _____ mg/l	(Note: Use MPN method for highly turbid samples.)	Orthophosphate _____ mg/l	Ammonia Nitrogen _____ mg/l	Dissolved Solids: Total _____ mg/l	Al - Aluminum _____ mg/l	Other (Specify Compounds and Concentration Units) _____	pH (when analyzed) _____ units	Ba - Barium _____ mg/l		TOC _____ mg/l	Ca - Calcium _____ mg/l		Chloride _____ mg/l	Cd - Cadmium _____ mg/l		Arsenic _____ mg/l	Chromium: Total _____ mg/l		Grease and Oils _____ mg/l	Cu - Copper _____ mg/l		Phenol _____ mg/l	Fe - Iron _____ mg/l		Sulfate _____ mg/l	Hg - Mercury _____ mg/l		Specific Conductance _____ uMhos	K - Potassium _____ mg/l		Total Ammonia _____ mg/l	Mg - Magnesium _____ mg/l		TKN as N _____ mg/l	Mn - Manganese _____ mg/l	
COD _____ mg/l	Nitrite (NO_2^-) as N _____ mg/l	Ni - Nickel _____ mg/l																																															
Coliform: MF Fecal _____ /100ml	Nitrate (NO_3^-) as N _____ mg/l	Pb - Lead _____ mg/l																																															
Coliform: MF Total _____ /100ml	Phosphorus: Total as P _____ mg/l	Zn - Zinc _____ mg/l																																															
(Note: Use MPN method for highly turbid samples.)	Orthophosphate _____ mg/l	Ammonia Nitrogen _____ mg/l																																															
Dissolved Solids: Total _____ mg/l	Al - Aluminum _____ mg/l	Other (Specify Compounds and Concentration Units) _____																																															
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Total Ammonia _____ mg/l	Mg - Magnesium _____ mg/l																																																
TKN as N _____ mg/l	Mn - Manganese _____ mg/l																																																
PERMIT #: _____ EXPIRATION DATE: _____ Non-DischARGE _____ UIC _____ NPDES _____ TYPE OF PERMITTED OPERATION BEING MONITORED Lagoon _____ Remediation - Infiltration Gallery _____ Spray Field _____ Remediation - _____ Rotary Distributor _____ Land Application of Sludge _____ Other: _____																																																	
NOTE: Values should reflect dissolved and colloidal concentrations. Date sample collected: _____ Date sample analyzed: _____ Laboratory Name: _____ Certification No. _____																																																	

I certify that, to the best of my knowledge and belief, the information submitted in this report is true, accurate and complete, and that the laboratory analytical data was produced using approved methods of analysis by a North Carolina DWQ certified laboratory. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Permittee (or Authorized Agent) Name and Title - Please print or type

US 1-59 Rev. 09/03

Signature of Permittee (or Authorized Agent)

(Date)

EPH (Aliphatics/Aromatics) Laboratory Reporting Form

Client Name _____
Project Name _____
Site Location _____

Laboratory Name _____
NC Certification # (Lab) _____
Sample Matrix _____

Sample Information and Analytical Results							
Method for Ranges: MADEP EPH EPH Surrogate Standards Aliphatic: Aromatic: EPH Fractionation Surrogates #1: #2:		Sample Identification					
		Date Collected					
		Date Received					
		Date Extracted					
		Date Analyzed					
		% Dry Solids					
		Dilution Factor					
Hydrocarbon Ranges	Units of Measure	MDL	RL	Blank			
C9 - C18 Aliphatics*							
C19 - C36 Aliphatics*							
C11 - C22 Aromatics*							
Total TPH							
Sample Surrogate Acceptance Range				40-140%	40-140%	40-140%	40-140%
Aliphatic Surrogate % Recovery							
Aromatic Surrogate % Recovery							
Fractionation Surrogate Acceptance Range				40-140%	40-140%	40-140%	40-140%
Fractionation Surrogate #1 % Recovery							
Fractionation Surrogate #2 % Recovery							

* Unadjusted value. Exclude the concentration of surrogate(s) and/or concentrations of other ranges that elute within the range.
MDL = Method Detection Limit RL = Reporting Limit Blank = Higher of Laboratory Method Blank or other associated blank

EPH rev. 09/03

Were all performance standards for required QA/QC procedures achieved?

Yes No Details Attached

Was blank correction applied as a significant modification of the method ?

Yes No

Were any significant modifications to the EPH method made?

Yes No Details Attached

VPH (Aliphatics/Aromatics) Laboratory Reporting Form

Client Name _____
Project Name _____
Site Location _____

Laboratory Name _____
N.C. Certification # (Lab) _____
Sample Matrix _____

Sample Information and Analytical Results							
Method for Ranges: MADEP VPH VPH Surrogate Standards Aliphatic: Aromatic:		Sample Identification					
		Collection Option (for soil)*					
		Date Collected					
		Date Received					
		Date Extracted					
		Date Analyzed					
		% Dry Solids					
		Dilution Factor					
Hydrocarbon Ranges	Units of Measure	MDL	RL	Blank			
C5 - C8 Aliphatics**							
C9 - C12 Aliphatics**							
C9 - C10 Aromatics**							
Sample Surrogate Acceptance Range				70-130%	70-130%	70-130%	70-130%
Aliphatic Surrogate % Recovery - FID							
Aromatic Surrogate % Recovery - PID							

* Option 1 = Methanol field preservation Option 2 = Pre-weighed empty VOA vial Option 3 = Sampling Device (indicate type)
 ** Unadjusted value. Exclude concentration of surrogate(s), internal standards, and/or other ranges that elute in the range.
 MDL = Method Detection Limit RL = Reporting Limit Blank = Higher of Laboratory Method Blank or Trip Blank (indicate which)

VPH rev. 09/03

Were all performance standards for required QA/QC procedures achieved?

Yes No Details Attached

Were any significant modifications to the VPH method made?

No Yes Details Attached

Appendix C - Decontamination of Field Equipment

Decontamination of personnel, sampling equipment, and containers - before and after sampling - must be used to ensure collection of representative samples and to prevent the potential spread of contamination. Decontamination of personnel prevents ingestion and absorption of contaminants. It must be done with a soap and water wash and deionized or distilled water rinse. Please note that sampling equipment and containers may be used that are certified pre-cleaned by the vendor or laboratory.

All previously used sampling equipment must be properly decontaminated before sampling and between sampling locations, to prevent the introduction of contamination into uncontaminated samples and to avoid cross-contamination of samples. Cross-contamination can be a significant problem when attempting to characterize extremely low concentrations of organic compounds or when working with soils that are highly contaminated.

Clean, solvent-resistant gloves and appropriate protective equipment must be worn by persons decontaminating tools and equipment.

A. Cleaning Reagents

Recommendations for the types and grades of various cleaning supplies are outlined below. The recommended reagent types or grades were selected to ensure that the cleaned equipment is free from any detectable contamination.

1. Detergents: Use Liqui-Nox (or a non-phosphate equivalent) or Alconox (or equivalent). Liqui-Nox (or equivalent) is recommended by EPA, although Alconox (or equivalent) may be substituted if the sampling equipment will not be used to collect phosphorus or phosphorus containing compounds.
2. Solvents
 - a) Use pesticide grade isopropanol as the rinse solvent in routine equipment cleaning procedures. This grade of alcohol must be purchased from a laboratory supply vendor. Rubbing alcohol or other commonly available sources of isopropanol **are not acceptable**.
 - b) Other solvents, such as acetone or methanol, may be used as the final rinse solvent if they are pesticide grade. However, methanol is more toxic to the environment and acetone may be an analyte of interest for volatile organics.
 1. **Do not use** acetone if volatile organics are of interest.
 2. Containerize all methanol wastes (including rinses) and dispose as a hazardous waste.
 - c) Preclean equipment that is heavily contaminated with organic analytes. Use reagent grade acetone and hexane or other suitable solvents. Use pesticide grade methylene chloride when cleaning sample containers. Store all solvents away from potential sources of contamination (gas, copier supplies, etc.).
3. Analyte-Free Water Sources
 - a) Analyte-free water is water in which all analytes of interest and all interferences are below method detection limits. Maintain documentation (such as results from equipment blanks) to demonstrate the reliability and purity of analyte-free water source(s). The source of the water must meet the requirements of the analytical method and must be free

from the analytes of interest. In general, the following water types are associated with specific analyte groups:

1. Milli-Q (or equivalent polished water): suitable for all analyses.
 2. Organic-free: suitable for volatile and extractable organics.
 3. Deionized water: may not be suitable for volatile and extractable organics.
 4. Distilled water: not suitable for volatile and extractable organics, metals or ultratrace metals.
- b) Use analyte-free water for blank preparation and the final decontamination water rinse. In order to minimize long-term storage and potential leaching problems, obtain or purchase analyte-free water just prior to the sampling event. If obtained from a source (such as a laboratory), fill the transport containers and use the contents for a single sampling event. Empty the transport container(s) at the end of the sampling event. Discard any analyte-free water that is transferred to a dispensing container (such as a wash bottle or pump sprayer) at the end of each sampling day.
4. Acids
- a) Reagent Grade Nitric Acid: 10 - 15% (one volume concentrated nitric acid and five volumes deionized water). Use for the acid rinse unless nitrogen components (e.g., nitrate, nitrite, etc.) are to be sampled. If sampling for ultra-trace levels of metals, use an ultra-pure grade acid.
 - b) Reagent Grade Hydrochloric Acid: 10% hydrochloric acid (one volume concentrated hydrochloric and three volumes deionized water). Use when nitrogen components are to be sampled.
 - c) If samples for both metals and the nitrogen-containing components are collected with the equipment, use the hydrochloric acid rinse, or thoroughly rinse with hydrochloric acid after a nitric acid rinse. If sampling for ultra trace levels of metals, use an ultra-pure grade acid.
 - d) Freshly prepared acid solutions may be recycled during the sampling event or cleaning process. Dispose of any unused acids according to local ordinances.

B. Reagent Storage Containers

The contents of all containers must be clearly marked.

1. Detergents: Store in the original container or in a HDPE or PP container.
2. Solvents
 - a) Store solvents to be used for cleaning or decontamination in the original container until use in the field. If transferred to another container for field use, use either a glass or Teflon container.
 - b) Use dispensing containers constructed of glass, Teflon or stainless steel. Note: if stainless steel sprayers are used, any gaskets that contact the solvents must be constructed of inert materials.
3. Analyte-Free Water:
 - a) Transport in containers appropriate for the type of water stored. If the water is commercially purchased (e.g., grocery store), use the original containers when transporting the water to the field. Containers made of glass, Teflon, polypropylene or HDPE are acceptable.

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- b) Use glass or Teflon to transport organic-free sources of water on-site. Polypropylene or HDPE may be used, but are not recommended.
- c) Dispense water from containers made of glass, Teflon, HDPE or polypropylene.
- d) Do not store water in transport containers for more than three days before beginning a sampling event.
- e) If working on a project that has oversight from EPA Region 4, use glass containers for the transport and storage of all water.
- f) Store and dispense acids using containers made of glass, Teflon or plastic.

C. General Requirements

1. Before using any equipment, clean/decontaminate all sampling equipment (pumps, tubing, lanyards, split spoons, etc.) that are exposed to the sample.
2. Before installing, clean (or obtain as certified precleaned) all equipment that is dedicated to a single sampling point and remains in contact with the sample medium (e.g., permanently installed groundwater pump). If you use certified precleaned equipment no cleaning is necessary.
 - a) Clean this equipment any time it is removed for maintenance or repair.
 - b) Replace dedicated tubing if discolored or damaged.
3. Clean all equipment in a designated area having a controlled environment (house, laboratory, or base of field operations) and transport it to the field, precleaned and ready to use, unless otherwise justified.
4. Rinse all equipment with water after use, even if it is to be field-cleaned for other sites. Rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples immediately with water.
5. Whenever possible, transport sufficient clean equipment to the field so that an entire sampling event can be conducted without the need for cleaning equipment in the field.
6. Segregate equipment that is only used once (i.e., not cleaned in the field) from clean equipment and return to the in-house cleaning facility to be cleaned in a controlled environment.
7. Protect decontaminated field equipment from environmental contamination by securely wrapping and sealing with one of the following:
 - a) Aluminum foil (commercial grade is acceptable),
 - b) Untreated butcher paper, or
 - c) Clean, untreated, disposable plastic bags. Plastic bags may be used for all analyte groups except volatile and extractable organics. Plastic bags may be used for volatile and extractable organics, if the equipment is first wrapped in foil or butcher paper, or if the equipment is completely dry.

D. Cleaning Sample Collection Equipment

1. On-Site/In-Field Cleaning
 - a) Cleaning equipment on-site is not recommended because:
 1. Environmental conditions cannot be controlled.
 2. Wastes (solvents and acids) must be containerized for proper disposal.

- b) If you must clean equipment on-site or in field, follow the appropriate cleaning procedure as outlined below in item 5 of this section. Ambient temperature water may be substituted in the hot, sudsy water bath and hot water rinses.

NOTE: *Properly dispose of all solvents and acids.*

- c) Rinse all equipment with water after use, even if it is to be field-cleaned for other sites. Immediately rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples with water.

2. Heavily Contaminated Equipment

In order to avoid contaminating other samples, isolate heavily contaminated equipment from other equipment and thoroughly decontaminate the equipment before further use. Equipment is considered heavily contaminated if it:

- a) Has been used to collect samples from a source known to contain significantly higher levels than background,
- b) Has been used to collect free product, or
- c) Has been used to collect industrial products (e.g., pesticides or solvents) or their byproducts.

NOTE: *Cleaning heavily contaminated equipment in the field is not recommended.*

3. On-Site Procedures

- a) Protect all other equipment, personnel and samples from exposure by isolating the equipment immediately after use.
- b) At a minimum, place the equipment in a tightly sealed, untreated, plastic bag.
- c) Do not store or ship the contaminated equipment next to clean, decontaminated equipment, unused sample containers, or filled sample containers.
- d) Transport the equipment back to the base of operations for thorough decontamination.
- e) If cleaning must occur in the field, document the effectiveness of the procedure, collect and analyze blanks on the cleaned equipment.

4. Cleaning Procedures

- a) If organic contamination cannot be readily removed with scrubbing and a detergent solution, pre-rinse equipment by thoroughly rinsing or soaking the equipment in acetone.
- b) Use hexane only if preceded and followed by acetone.
- c) In extreme cases, it may be necessary to steam clean the field equipment before proceeding with routine cleaning procedures.
- d) After the solvent rinses (and/or steam cleaning), use the appropriate cleaning procedure.
 - 1. Scrub, rather than soak, all equipment with sudsy water.
 - 2. If high levels of metals are suspected and the equipment cannot be cleaned without acid rinsing, soak the equipment in the appropriate acid. Since stainless steel equipment should not be exposed to acid rinses, do not use stainless steel equipment when heavy metal contamination is suspected or present.
- e) If the field equipment cannot be cleaned utilizing these procedures, discard unless further cleaning with stronger solvents and/or oxidizing solutions is effective as evidenced by visual observation and blanks.
- f) Clearly mark or disable all discarded equipment to discourage use.

5. General Cleaning

Follow these procedures when cleaning equipment under controlled conditions. Check manufacturer's instructions for cleaning restrictions and/or recommendations.

- a) Procedure for Teflon, stainless steel and glass sampling equipment - This procedure must be used when sampling for ALL analyte groups: extractable organics, metals, nutrients, etc. or if a single decontamination protocol is desired to clean all Teflon, stainless steel and glass equipment.
 1. Rinse equipment with hot tap water.
 2. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent).
 3. If necessary, use a brush to remove particulate matter or surface film.
 4. Rinse thoroughly with hot tap water.
 5. If samples for trace metals or inorganic analytes will be collected with the equipment that is not stainless steel, thoroughly rinse (wet all surfaces) with the appropriate acid solution.
 6. Rinse thoroughly with analyte-free water. Use enough water to ensure that all equipment surfaces are thoroughly flushed with water.
 7. If samples for volatile or extractable organics will be collected, rinse with isopropanol. Wet equipment surfaces thoroughly with free-flowing solvent. Rinse thoroughly with analyte-free water.
 8. Allow to air dry. Wrap and seal as soon as the equipment is air-dried.
 9. If isopropanol is used, the equipment may be air-dried without the final analyte-free water rinse; however, the equipment must be completely dry before wrapping or use.
 10. Wrap clean sampling equipment according to the procedure described above.
- b) General Cleaning Procedure for Plastic Sampling Equipment
 1. Rinse equipment with hot tap water.
 2. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent).
 3. If necessary, use a brush to remove particulate matter or surface film.
 4. Rinse thoroughly with hot tap water.
 5. Thoroughly rinse (wet all surfaces) with the appropriate acid solution.
 6. Check manufacturer's instructions for cleaning restrictions and/or recommendations.
 7. Rinse thoroughly with analyte-free water. Use enough water to ensure that all equipment surfaces are thoroughly flushed with water. Allow to air dry as long as possible.
 8. Wrap clean sampling equipment according to the procedure described above.

Appendix D – Calibration and Maintenance of Field Equipment

Preventive maintenance activities are necessary to ensure that the equipment can be used to obtain the expected results and to avoid unusable or broken equipment while in the field.

Equipment is properly maintained when:

- It functions as expected during mobilization, and
 - It is not a source of sample contamination (e.g., dust).
1. Follow the manufacturer's suggested maintenance activities and document all maintenance.
 2. Assign equipment a unique ID code (may be the name of the item, if there is only one).
 3. Document the following information on each piece of equipment or instrumentation:
 - Identity (unique identifier code) and description (including software if used),
 - Manufacturer's name, model number and serial number (if applicable),
 - Calibration checks or other tasks that demonstrate that the equipment performs as expected,
 - Manufacturer's operating and maintenance instructions,
 - Written preventive maintenance schedule that includes the activity, and the frequency of each activity,
 - Date(s) of any preventive maintenance, repairs, malfunctions, etc., and
 - name of person(s) performing the task(s).

A. Calibration

The calibration of field instruments is critical to obtain acceptable data. Improper calibration or failure of an instrument in the field might result in improper choice of sample locations, failure to detect contamination, and inefficient and inadequate segregation of clean soils from contaminated soils. Potentially much higher disposal or treatment costs may result.

To ensure that field instruments will be properly calibrated and remain operable in the field, the procedures set out in this section must be used.

1. If PID and FID field instruments are used, instruments must be calibrated before each testing session to yield "total organic vapors" in parts per million to a benzene equivalent. The PID instrument must be operated with a lamp source that is able to detect the contaminants of concern, operates at a minimum of 10.6 eV, and is capable of ionizing those contaminants of concern.
2. Field instruments must be calibrated onsite.
3. All standards used to calibrate field instruments must meet the minimum requirements for source and purity recommended in the equipment's operation manual.
4. If the instrument's operation manual recommends specific calibration requirements for other criteria in calibrating the instrument (such as pH, conductivity, temperature, etc.), those criteria must be adhered to.
5. Acceptance criteria for calibration must be determined depending on the potential contaminant(s). Criteria must be within the limits set in the manufacturer's operations manual.
6. The dates, times and results of all calibrations and repairs to field instruments must be recorded in the field record and the instrument's log.
7. All users of the instrument must be trained to properly calibrate and operate the instrument.

Equipment users must read the operation manual before initial use.

B. Maintenance

1. At a minimum, operation, maintenance, and calibration must be performed in accordance with the instrument manufacturer's specifications.
2. All users of the instrument must be trained in routine maintenance, including battery and lamp replacement, lamp and sensor cleaning, and battery charging.
3. Each instrument's operation and maintenance manual must be present at the site.
4. All field instruments must be inspected before departure for the site and on site.
5. Instrument battery charges must be inspected far enough ahead of time to bring the instrument up to full charge before departure for the site.
6. At a minimum, a source of extra batteries and lamps (if applicable) must be readily available.

Appendix E - Collecting Soil Samples

Soil samples are collected for a variety of purposes. A systematic sampling approach must be used to assure that sample collection activities provide usable data. Sampling must begin with an evaluation of background information, historical data and site conditions. There are three major activities requiring the collection of soil samples: closure, soil remediation permitting and assessment and corrective action. Each of these major activities is described in detail in its own guideline document. This document should be used in conjunction with these activity-specific guidelines, which provide requirements for analytical methods, as well as TPH screening action limits or risk based clean-up levels, to use in decision-making processes.

A. Soil Field Screening Procedures

Field screening is the use of portable devices capable of detecting petroleum contaminants on a real-time basis or by rapid field analytical technique. Field screening should be used to help assess locations where contamination is most likely to be present.

When possible, field-screening samples should be collected directly from the excavation or from the excavation equipment's bucket. If field screening is conducted only from the equipment's bucket, then a minimum of one field screening sample should be collected from each 10 cubic yards of excavated soil. If instruments or other observations indicate contamination, soil should be separated into stockpiles based on apparent degrees of contamination. At a minimum, soil suspected of contamination must be segregated from soil observed to be free of contamination.

1. Field screening devices - Many field-screening instruments are available for detecting petroleum contaminants in the field on a rapid or real-time basis. Acceptable field screening instruments must be suitable for the contaminant being screened. The procedure for field screening using photoionization detectors (PIDs) and flame ionization detectors (FIDs) is described below. If other instruments are used, a description of the instrument or method and its intended use must be provided to the UST Section. **Whichever field screening method is chosen, its accuracy must be verified throughout the sampling process. Use of appropriate standards that match the use intended for the data. Unless the UST Section indicates otherwise, wherever field screening is recommended in this document, instrumental or analytical methods of detection must be used, not olfactory or visual screening methods.**

2. Headspace analytical screening procedure for field screening (semi-quantitative field screening) - The most commonly used field instruments for UST site assessments are FIDs and PIDs. When using FIDs and PIDs, use the following headspace screening procedure to obtain and analyze field-screening samples;

- a) Partially fill (one-third to one-half) a clean jar or clean ziplock bag with the sample to be analyzed. The total capacity of the jar or bag may not be less than eight ounces (app. 250 ml), but the container should not be so large as to allow vapor diffusion and stratification effects to significantly affect the sample;

- b) If the sample is collected from a split spoon, it must be transferred to the jar or bag for headspace analysis immediately after opening the split-spoon. If the sample is collected from an excavation or soil pile, it must be collected from freshly uncovered soil.
- c) If a jar is used, its top must be quickly covered with clean aluminum foil or a jar lid; screw tops or thick rubber bands must be used to tightly seal the jar. If a ziplock bag is used, it must be quickly sealed shut.
- d) Headspace vapors must be allowed to develop in the container for at least 10 minutes but no longer than one hour. Containers must be shaken or agitated for 15 seconds at the beginning and end of the headspace development period to assist volatilization. Temperatures of the headspace must be warmed to at least 40° F (approximately 5° C) with instruments calibrated for the temperature used.
- e) After headspace development, the instrument sampling probe must be inserted to a point about one-half the headspace depth. The container opening must be minimized and care must be taken to avoid the uptake of water droplets and soil particulates.
- f) After probe insertion, the highest meter reading must be taken and recorded. This will normally occur between two and five seconds after probe insertion. If erratic meter response occurs at high organic vapor concentrations or conditions of elevated headspace moisture, a note to that effect must accompany the headspace data.
- g) Calibration of PID and FID field instruments must follow the procedures outlined in Appendix D (Calibration and Maintenance of Field Equipment).
- h) All field screening results must be documented in the field record or log book.

B. Soil Background Sampling

This guidance is primarily designed to assist technical staff in the UST Section to evaluate naturally occurring inorganics (Lead and Chromium) in soils at sites with concentrations above currently established MSCCs. One of the most essential issues for remediating soil contaminated with naturally occurring compounds is the determination of remediation standards for those compounds. A remediation standard for each naturally occurring contaminant in soil may be adjusted based on background conditions. There are some national databases, (e.g., USGS studies), which can provide a sense of the likely background ranges of element concentrations in soils unaffected by most man-made activities. However, local variations and analytical method differences make site-specific sample data collection preferable, and required, in some situations. Whether remediation is required for the site in question is determined by comparison to either naturally occurring background conditions or through risk assessment. In most cases, a sufficient number of samples will not be available to conduct a statistical analysis with appropriate power.

In some situations, non-statistical approaches may be considered more appropriate to compare site contaminant levels to background constituent levels when selecting Chemicals of Potential Concern (COPCs). This policy-based guidance includes the non-statistical twice background criterion currently used by EPA Region 4. There are two basic applications for non-statistical twice background criterion. One requires the collection of a minimum of four site-specific background samples. The other allows the use of historical data to establish the background concentration for the specific soil type in question. The application allowed depends on whether there is evidence of a release of contamination in addition to the naturally occurring inorganics. For sites with no evidence of a release other than the naturally occurring inorganics,

may use historical data. Other sites require site-specific background samples before the currently established MSCC may be adjusted.

The UST Section acknowledges that the twice background criterion is policy-based. Both non-statistical approaches are easily used and easily reviewed methods for background screening. The UST Section believes its use of the twice background criterion is health-protective and yields a reasonable decision without recourse to statistics. Generally, statistical analysis requires more extensive sampling and accompanying expense. The final decision of whether to accept statistical comparison of site sampling data with background concentrations for the purpose of selecting COPCs is at the discretion of the UST Section regional office supervisor.

1. Data Evaluation and Collection for Background-Based Adjustment of Maximum Soil Contaminant Concentrations of Naturally Occurring Inorganics in Soils
 - a) Evaluate the available data to determine which of the two non-statistical approaches may be used. If soil characterization or previous knowledge of the site indicates that the area of potential contamination is located in an area containing fill material, comparison to historical data is not recommended. A soil scientist can usually identify fill areas because of the disturbed nature of the soil profile. In this case a minimum of four site specific background samples are recommended for initial evaluation. If background sample results are highly variable, additional samples will be required to evaluate background levels and non-statistical approaches may not be used. The UST Section Central Office should be consulted before using any type of statistical approach for comparison to background.
 - b) If there is no evidence of a release other than naturally occurring inorganics above MSCCs, comparison to background ranges from historical databases using the non-statistical twice background approach may be used. To obtain comparable historical data to establish the "background" concentration, characterize soil type and use the depth of the samples of concern.
 - c) If there is evidence of a release other than the naturally occurring inorganics, a minimum of four samples must be used to establish "background" in soils. Background samples must be collected in an area that has not been impacted by environmental contamination from the site and from the same depth as site samples to which the background samples will be compared.
 - d) Background soil should be the same type of soil horizon material as the comparison sample. Multiple soil horizons should have "background" established separately (e.g., a minimum of four samples per each soil unit). This will not be necessary unless more than one soil horizon has shown potential impact by contamination at or above relevant MSCCs. Evaluate the soil texture (percent silt, sand, clay), soil pH and cation exchange capacity to confirm that the background samples are from comparable soil types. Many of these soil parameters can be obtained by contacting the local Natural Resources Conservation Service Office (NRCS) and requesting a soil survey report for the County where the site is located. By using the soil survey report, field personnel can evaluate how the soils were originally classified and gain access to average values for the soil series located at the site. Background samples must be analyzed using total constituent analysis.

Soil Texture Classification Chart			
Texture Class	% Sand	% Silt	% Clay
Sands	> 85	<15	0
Loamy Sands	70 - 85	< 30 (silt + clay)	< 30 (silt + clay)
Sandy Loams	50 - 70	< 50	< 20
Loam	<52	28-50	7 - 27
Silt Loam	Trace	50 - 80	12 - 27
Silt	Trace	> 80	<12
Sandy Clay Loams	45 - 72	< 28	20 - 35
Clay Loams	20 - 45	15 - 40	27 - 40
Silty Clay Loams	< 20	60 - 73	27 - 40
Sandy Clays	45-65	0	35 - 55
Silt Clays	0	40 - 60	40 - 60
Clays	<15	< 40	> 40

NOTE: *In order to obtain appropriate background samples, the sampler may be required to collect samples from a near-by, off-site location. The soil in the area under investigation and the soil in the background area may have both been similarly affected by a source unrelated to the UST unit (e.g. air emissions, wastewater sludge operations, etc.). Concentrations found in the background soil may still be acceptable in this situation. Situations will exist where the surrounding area has historically been affected by sources outside of the site (unit) under investigation. **Specific guidelines cannot be outlined for every site; therefore, evaluations must be made on a site-by-site basis.***

- e) In general, background samples should be eliminated and replaced with a like number of samples from uncontaminated areas if:
 - 1. the background samples are taken in areas known or suspected to be contaminated by a source which did not similarly affect the area under investigation, or
 - 2. the background samples have possibly been affected by activities conducted in the area undergoing investigation.
- f) Areas to avoid for background sampling include but are not limited to:
 - 1. past waste management areas where solid and/or hazardous wastes or wastewater may have been placed on the ground, areas of concentrated air pollutant deposition (from a definable localized source), or areas affected by the runoff;
 - 2. roads, roadsides, parking lots, areas surrounding parking lots or other paved areas, railroad tracks, railway areas or other areas affected by their runoff;
 - 3. storm drains or ditches presently or historically receiving industrial or urban runoff;
 - 4. spill areas, material handling areas, such as truck or rail car loading areas, or near pipelines, fill areas and other areas as determined by NCHWS.
- g) Detection Limits - Detection limits should be reviewed before the sampling and analysis is completed to ensure that they do not exceed preliminary remediation goals. This should not be a problem for chromium and lead.

2. Evaluation of Chemicals of Potential Concern

COPCs are chemicals that are carried through the risk assessment process. EPA Region 4 Office of Technical Services (OTS) has designed a screening process to identify COPCs, which are most likely to contribute to an unacceptable risk.

NOTE: This selection process is not designed to eliminate any naturally occurring substance in the subsurface soils as a chemical of potential concern to protect groundwater. The potential for chemicals in subsurface soils to leach to the ground water must be considered for high or intermediate risk sites as required by NCAC 2L .0115 (i)(4). Based on review of site specific information, limited site assessment or interim corrective actions, the Department may determine that the discharge or release poses no significant risk to human health or the environment and reclassify the site as low risk. However, the Department may reclassify the risk posed by a release, if warranted by further information. Such information would concern the potential exposure receptors to the discharge or release or upon receipt of new information concerning changed conditions at the site.

3. COPC Selection Process - The process of selecting COPCs includes a screen that utilizes risk-based concentrations. For naturally occurring substances that exceed the established standard:
 - a) The data for each chemical should be sorted by medium. For this purpose, surface soil and subsurface soil should be considered as separate media. Surface soil is considered the top 12 inches. Identify the background data for each medium.
 - b) For any data which have qualifiers, decide if the qualified data should be retained. Do not eliminate data based on estimated qualifiers.
4. Summarize the following parameters for the naturally occurring substance under review for both the closure and background samples.
 - a) Frequency of detection
 - b) Range of detection limits
 - c) Arithmetic average background concentration
 - d) Arithmetic average of detected concentrations
 - e) Range of detected concentrations
 - f) Risk-based screening value
 - g) Basis for elimination or selection as a COPC
5. Eliminate chemicals as COPCs based on comparison to blanks. See Appendix B for an explanation of blank evaluation criteria.
6. Compare maximum detected concentrations in surface soils to the residential or industrial/commercial maximum soil contaminant concentration, whichever is applicable.
 - a) Eliminate the chemical as a COPC for human exposures if the concentration is less than the screening level.
 - b) Industrial screening values should be used for comparison to the subsurface soils data only for construction work scenarios.
7. For naturally occurring inorganics, compare the on-site maximum detected concentration to two times the average site-specific background concentration. Eliminate the chemical as a COPC if it is less than two times the background level. It should be noted that one background sample, if elevated, is usually not acceptable for comparison or elimination purposes.

- a) Specific guidelines as to the number of background samples cannot be outlined for every site; therefore, evaluations must be made on a site-by-site basis.
- b) A minimum of four background samples is recommended. Additional samples may be needed if background concentrations are highly variable or if sampling locations are determined to be inappropriate.
- c) To use the twice background criterion, the maximum detected concentration on site is compared to twice the average background concentration. If the maximum detected concentration is greater than twice the average background concentration, the chemical is included as a COPC.

NOTE: If a background sample result is not detected at or above the limit of quantitation, half the limit of quantitation is substituted when averaging background concentrations.

C. Soil Sample Preparation for Laboratory Samples

The type of sample container used depends on the type of analysis performed. First, determine the type of sampling activity, type(s) of contaminants expected and the proper analytical method(s) established in Tables 1, 2, 4, 6 or 7. Approved sample containers and preservation requirements for the specified methods sampling activities are included in Tables 3, 5 or 8. Be sure to consult with your selected laboratory for specific needs and requirements prior to sampling.

1. Sampling kits for sample collection and transport may be purchased from some commercial laboratories. The kits include all the items needed (sample containers, shipping cartons, etc.) for the collection and shipment of samples. If you use these services, carefully follow the instructions provided and do not discard any preservative that may have been added to the containers. If you do not choose to use a customized kit provided by your laboratory, use only new containers of the appropriate type for the contaminants you are sampling. Check with the laboratory that will be running the analysis about appropriate sample containers and preservation requirements for each method. **If proper sampling and QA/QC protocols are not followed, the Department may consider your results invalid.**
2. Select sampling equipment based on the type of sample to be collected and the analytes of interest. Choose soil sampling locations so that a representative portion of the soil is collected with minimal disturbance. Locations where natural vegetation is stressed or dead and/or areas that have surficial soil staining may be indicative of improper waste disposal practices.
3. If background sampling is warranted and feasible as determined in the site's work plan or by the project manager, select an upgradient, undisturbed location to obtain the background samples. See Section B above for additional guidance.
4. Do not collect samples for chemical analysis from auger flights or cuttings from hollow stem auger flights, unless you are characterizing waste for disposal.
5. Do not use samples that are collected for geological/lithological or vapor meter determinations for chemical analyses.
6. Equipment and Supplies
 - a) All equipment must be constructed of materials consistent with the analytes of interest. Refer to Table 16 for selection of appropriate equipment.

- b) For information on sampling equipment cleaning requirements, see Appendix C.
- c) For information on preservation and holding time requirements, see Tables 3, 5 or 8.

D. Soil Sample Collection Procedures for Laboratory Samples

The number and type of laboratory samples collected depends on the purpose of the sampling activity. The three major activities are closure, soil remediation permitting and assessment and corrective action. There are different requirements associated with initial characterization, routine monitoring and permit completion for soil remediation permitting and assessment and corrective action. The soil remediation technology employed and the contamination source material also affect the number and type of laboratory samples needed. Samples analyzed with field screening devices may not be substituted for required laboratory samples.

1. General Sample Collection - When collecting samples from potentially contaminated soil, care should be taken to reduce contact with skin or other parts of the body. Disposable gloves should be worn by the sample collector and should be changed between samples to avoid cross-contamination. Soil samples should be collected in a manner that causes the least disturbance to the internal structure of the sample and reduces its exposure to heat, sunlight and open air. Likewise, care should be taken to keep the samples from being contaminated by other material at the site or by other samples collected at the site. When sampling is to occur over an extended period of time, it is necessary to insure that the samples are collected in a comparable manner.
 - a) All samples must be collected with disposable or clean tools that have been decontaminated as outlined in Appendix C.
 - b) Disposable gloves must be worn and changed between sample collections.
 - c) Sample containers must be filled quickly.
 - d) Soil samples must be placed in containers in the order of volatility, for example, volatile organic aromatic samples must be taken first, gasoline range organics next, then heavier range organics, and finally soil classification samples.
 - e) Containers must be quickly and adequately sealed, and rims must be cleaned before tightening lids. Tape may be used only if known not to affect sample analysis.
 - f) Sample containers must be clearly labeled.
 - g) Containers must immediately be preserved according to procedures in this Section. Unless specified otherwise, at a minimum, the samples must be immediately cooled to $4 \pm 2^{\circ}\text{C}$ and this temperature must be maintained throughout delivery to the laboratory.
2. Surface Soil Sampling - Surface soil is generally classified as soil between the ground surface and 6-12 inches below ground surface.
 - a) Remove leaves, grass and surface debris from the area to be sampled.
 - b) Collect samples for volatile organic analyses as described below in Section E.
 - c) Select an appropriate, precleaned sampling device and collect the sample.
 - d) Transfer the sample to the appropriate sample container.
 - e) Clean the outside of the sample container to remove excess soil.
 - f) Label the sample container, place on wet ice to preserve to 4°C , and complete the field notes.
3. Subsurface Soil Sampling - The interval begins at approximately 12 inches below ground surface.

- a) Collect samples for volatile organic analyses as described below in Section E.
 - b) For other analyses, select an appropriate, precleaned sampling device and collect the sample.
 - c) Transfer the sample to the appropriate sample container.
 - d) Clean the outside of the sample container to remove excess soil.
 - e) Label the sample container, place on wet ice to preserve to 4°C, and complete the field notes.
4. Equipment for Reaching the Appropriate Soil Sampling Depth - Samples may be collected using a hollow stem soil auger, Shelby tube or split-spoon sampler. These sampling devices may be used as long as an effort is made to reduce the loss of contaminants through volatilization. In these situations, obtain a sufficient volume of so the samples can be collected without volatilization and disturbance to the internal structure of the samples. Samples should be collected from cores of the soil. Non-disposable sampling equipment must be decontaminated between each sample location.
- a) Shovels and Diggers - Used for soils from approximately 12 inches to a depth when using the implement becomes impractical.
 1. Dig a hole or trench to the required depth.
 2. Follow the general sample collection procedures outlined above in Section D
 - b) Backhoe - Used for soils from approximately 12 inches to a depth when using the implement becomes impractical.
 1. Dig a trench to the appropriate depth.
 2. Expose the sample, in the trench, by using a precleaned spoon, spatula or equivalent to clean away the soil that came in contact with the backhoe bucket.
 3. Use a second precleaned utensil to actually collect the sample from the trench.
 4. Follow the general sample collection procedures outlined above in Section D.
 - c) Hand/Bucket Augers and Hollow Corers - Suitable to reach soils from approximately 12 inches to a depth when using the implement becomes impractical.
 1. Push and rotate the auger into the soil until the bucket is filled.
 2. Addition of a non-contaminating sleeve may allow an undisturbed soil sample to be obtained. The device consists of a standard auger head with a removable sleeve, which is inserted into the auger barrel. In this case, it is the sleeve which fills with soil.
 3. Remove the sleeve from the auger and cap.
 4. If the auger hole is prone to collapse due to low soil cohesion, insert a temporary, rigid PVC casing into the hole. The casing prevents hole collapse and minimizes cross-contamination between soil zones as the auger is advanced. After collecting the samples, remove the temporary casing (if used) and fill the hole.
 5. Remove the sample from the sampler by pushing or scraping the soil with an appropriate, precleaned utensil into an appropriately precleaned tray or aluminum foil.
 6. Remove any portion of the sample that has been disturbed and discard.
 7. Follow the general sample collection procedures outlined above in Section D.
- NOTE:** *If a confining layer has been breached during sampling, grout the hole to land surface with Type-1 Portland cement.*
- d) Split Spoon Sampler - Suitable for reaching soils from approximately 12 inches to depths greater than 10 feet. A split spoon sampler, useful for sampling unconsolidated soil,

consists of two half cylinders (spoons) that fit together to form a tube approximately two feet in length and two inches in diameter. The cylindrical arrangement is maintained by a retaining head and bit rings that screw on at each end of the split spoon. The bit ring has beveled edges to facilitate sampling as the split spoon is forced into the ground.

1. Advance the sampler using the weight of the drilling stem and rods or a mechanical hammer.
 2. Insert a catcher device in the head ring to prevent the loss of unconsolidated sample material during recovery.
 3. After retrieving the split spoon sampler, expose the soil by unscrewing the bit and head rings and splitting the barrel.
 4. If the recovery is enough to accommodate discarding a portion of the sample, discard the top and bottom two to three inches of the sample.
 5. For volatile organic compounds, collect the sample immediately from the center portion of the split spoon using the procedures described below in Section E.
 6. For other analyses, slice the sample from the center portion of the split spoon. Use a clean, decontaminated utensil.
 7. Select an appropriate, precleaned sampling device and collect the sample.
 8. Transfer the sample to the appropriate sample container.
 9. Clean the outside of the sample container to remove excess soil.
 10. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.
- e) Direct Push Rigs – These may be used for depths greater than 10 feet below ground surface. The clear liners are used with direct push rigs. This method is appropriate only for unconsolidated materials. The sampling depth that can be achieved varies depending on the rig and the lithologies that are encountered.
1. Place the liner inside the metal probe rod.
 2. Select a point holder with an opening appropriate for the site lithology and screw it on the probe rod.
 3. Advance the rod a full rod length.
 4. Retrieve the rod.
 5. Remove the point holder.
 6. Remove the liner.
 7. Slice the liner to expose the soil.
 8. After the liner has been sliced, follow the procedures outlined above for the split spoon sampler. If needed collect volatile organic samples immediately after the liner is sliced. If samples for organic vapor analysis screening are required, collect them by slicing the sample(s). Use a clean, decontaminated utensil and place the samples in 8-ounce (preferred) or 16-ounce jars. Immediately cover the opening with aluminum foil and screw on the lid ring. If the contamination is derived from petroleum products, it is acceptable to use a clean gloved hand to transfer the sample(s) to the sample container(s).
 9. For other analyses, slice the sample from the center portion of the split spoon using a clean, decontaminated utensil.
 10. Select an appropriate, precleaned sampling device and collect the sample.
 11. Transfer the sample to the appropriate sample container.
 12. Clean the outside of the sample container to remove excess soil.

13. Label the sample container, place on wet ice to preserve to 4°C, and complete the field notes.
- f) **Shelby Tube Sampler** - The Shelby tube sampler is used to sample unconsolidated soil. It consists of a tube approximately 30 inches long and two inches (or larger) in diameter. One end of the tube has edges beveled into a cutting edge. The other end can be mounted to an adapter, which allows attachment to the drilling rig assembly. After drilling to the required depth with an auger or rotary drill bit, a soil sample is obtained through the auger or directly from the borehole.
 1. Push the Shelby tube into the soil using the drilling rig's hydraulic ram or push manually with a sledge hammer.
 2. Remove the tube from the sampler head.
 3. Extrude the sample from the Shelby tube.
 4. Use a decontaminated utensil to remove any portion of the sample that has been disturbed.
 5. Collect samples for volatile organics immediately from the center portion of the Shelby tube using the procedures described below in Section E.
 6. For other analyses, slice the sample from the center portion of the Shelby tube using a clean, decontaminated utensil.
 7. Transfer the sample to the appropriate sample container.
 8. Clean the outside of the sample container to remove excess soil.
 9. Label the sample container, place on wet ice to preserve to 4°C, and complete the field notes.
- g) **Core Barrel** - A standard core barrel is utilized when consolidated samples (such as limestone or dolomite) are to be collected. The core barrel is a cylinder approximately three feet long and two inches in diameter. The barrel has a removable head ring with small embedded diamonds which allow the device to cut through rock or consolidated soil as the drilling rods are rotated.
 1. Retrieve the sample core by unscrewing the head ring. Slide the sample into a precleaned container.
 2. Use a decontaminated utensil to remove any portion of the sample that has been disturbed.
 3. Remove the sample from the sampler (corer) with a precleaned tool.
 4. Transfer the sample to the appropriate sample container.
 5. Clean the outside of the sample container to remove excess soil.
 6. Label the sample container, place on wet ice to preserve to 4°C and complete the field notes.
5. Equipment to Collect Soil Samples - Equipment and materials that may be used to collect soil samples include disposable plastic syringes and other "industry-standard" equipment and materials that are contaminant-free. Non-disposable sampling equipment must be decontaminated between each sample location.
6. Composite Soil Samples - Composite sampling will be used for soil samples collected for soil remediation permitting. Samples will be composited as a means to reduce sample handling and analytical costs. Each composite sample for soil remediation will be composed of six primary samples. The six primary samples that comprise each composite sample shall be mixed together by the laboratory, with a representative portion of this mixture to be analyzed.

Composite samples are prepared differently depending on the analysis required and the relative tendency of the contaminant analyzed to vaporize.

- a) Samples collected for volatile organic analysis cannot be dried, ground or mixed if they are to reflect the concentrations found in the soil. Since methanol preserved samples lend themselves to composite sampling techniques, the methanol preservation technique will be required to preserve primary samples that are to be composited and analyzed for volatiles analysis (i.e. TPH GRO or SW-846 8260B). The six primary samples collected for volatiles analysis shall be collected and preserved in **separate** VOA vials. The primary samples are methanol extracted. Representative portions of the methanol extracts must be composited by the analytical laboratory using methods that minimize volatile organic loss. See below for details on Volatiles Soil Sample Preservation
- b) The six primary samples collected for metals analysis may be added to a single sample container, clearly marked as composite, for the laboratory to dry, sieve, mix and sub-sample for analysis of a representative portion.
- c) The six primary samples collected for semi-volatiles analysis (i.e. TPH DRO or SW-846 8270C) may be added to a single sample container, clearly marked as composite, for the laboratory to mix and sub-sample for analysis of a representative portion.

7. General Composite Sample Collection Procedures

- a) Soil samples taken to monitor land application or containment and treatment sites, must be obtained from freshly uncovered soil at different depths from each of two randomly selected soil borings made to the maximum depth of waste incorporation.
- b) Soil samples collected from excavation equipment buckets for field screening must be obtained away from the bucket edges. At least six inches of soil must be removed immediately before collection.
- c) If soil samples are collected from a soil boring, the drill hole must be advanced to the desired depth. Then the center rods of the auger must be withdrawn from the drill hole and the plug and pilot bit must be removed from the center rods. The sampler must also be attached to the correct length of drill rod and driven ahead of the auger flights in order to collect a relatively undisturbed sample. After the split spoon or Shelby tube has been retrieved back out of the boring, the desired sample section must be immediately removed from the sampling device. Only soil from the middle portion of the spoon may be used for samples. Soil from the very ends of the spoon must be discarded as it often contains disturbed soils. A clean sampling tool must be used to quickly collect the sample from the undisturbed portion with a minimum of disturbance.
- d) Immediately upon removal from the ground, each primary soil sample must be placed in the appropriate container (See Table 5). Once placed in the container, each sample should be immediately capped and sealed. Be sure that the sample containers are labeled in accordance with Section 4.2, and in such a manner that prevents the labels from peeling away from the containers during transport
- e) Collect six representative portions of soil at the same time the six primary samples are collected. These are to be added to a single, unpreserved container for determination of soil moisture content and dry weight correction factors.

8. Initial Characterization Sampling - Characterizing stockpiled soil is necessary for several reasons. It is used to determine whether treatment or disposal of the soil is needed, to assist with selection of treatment or disposal methods and to establish baseline data for use in

evaluating the effectiveness of treatment. Soil samples for laboratory analysis must be collected from each stockpile.

- a) One composite sample shall be collected per 200 cubic yards for initial characterization of petroleum contaminated soil. For sites containing less than 200 cubic yards, a minimum of one composite sample shall be taken. Results should be secured prior to acceptance at treatment-sites. These composite samples must be analyzed in accordance with the rule as outlined in Section 5.1 B of the "Guidelines for Ex Situ Petroleum Contaminated Soil Remediation," to provide a complete chemical analysis of the typical petroleum contaminated soil to be remediated. Where required, samples must also be analyzed for a determination of hazardous waste constituents using the TCLP described in 40 CFR 261.24 (EPA SW-846/Method 1311 (TCLP) metals). TCLP analysis will be required for all permit applications to dispose of petroleum contaminated soil unless the criteria that relate to the determination of hazardous waste characterization can be met (See Section 5.1 B).
 - b) Each composite sample must be collected from two soil cores composed of a vertical column of soil collected using a soil auger, Shelby tube or split-spoon sampler. Sample collection and preservation must meet the guidelines in Table 5.
 - c) A composite sample is comprised of six primary soil samples; three from core A and three from core B. Primary samples are taken at different depths from each of the two randomly selected soil borings. Each primary sample shall be collected in the field and be analyzed as a composite by a DWQ-certified laboratory.
9. Routine Monitoring and Permit Completion Sampling - The number of soil samples collected from the treated soil are determined below and as required by 15A NCAC 2L .0106 (f).
- a) Soil Sampling for Land Application
 1. Two composite soil samples must be collected from each acre. If the site is less than one acre, collect from each application area following application. For routine monitoring samples the purpose is to monitor the progress of treatment. For permit completion samples the purpose is to determine if soil has been adequately treated and to document that the treatment goals have been reached. See Section 5.1 B of the "Guidelines for Ex Situ Petroleum Contaminated Soil Remediation" for soil analytical methods.
 2. Each composite sample must be collected from two soil cores composed of a vertical column of soil. The cores must extend from land surface to the maximum depth of waste incorporation. Collect samples using a soil auger, Shelby tube or split-spoon sampler. Sample collection and preservation must meet the guidelines in Table 5.
 3. A composite sample is comprised of six primary soil samples, three from core A and three from core B. Primary samples are taken at different depths from each of the two randomly selected soil borings. Each primary sample shall be collected in the field and be analyzed as a composite by a DWQ-certified laboratory.
 - b. Soil Sampling for Containment and Treatment Technologies
 1. One composite sample shall be collected per 200 cubic yards or per source (whichever is smaller), at the application site, at a minimum of six month intervals. For sites containing less than 200 cubic yards, a minimum of one sample shall be taken every six months. For routine monitoring samples, the purpose is to monitor the progress of treatment. For permit completion samples, the purpose is to determine if soil has been adequately treated and to document that the treatment goals have been reached. See

Section 5.1 B of the "Guidelines for Ex Situ Petroleum Contaminated Soil Remediation" for soil analytical methods.

2. Each composite sample must be collected from two soil cores composed of a vertical column of soil. Collected the cores using a soil auger, Shelby tube or split-spoon sampler. Sample collection and preservation must meet guidelines in Table 5.
3. A composite sample is comprised of six primary soil samples. Three from core A and three from core B. Primary samples are taken at different depths from each of the two, randomly selected soil borings. Each primary sample shall be collected in the field and be analyzed as a composite by a DWQ-certified laboratory.

E. Collection and Preservation of Volatiles Soil Samples

SW-846 Method 5035 outlines a variety of options to collect and preserve volatiles soil samples. The method describes a closed-system purge and trap process for the analysis of low level volatile organic compounds (VOC) in soils. The method also describes preparation techniques for high level VOC soil samples to be purged using method 5030 and analyzed by appropriate determinative methods. Additional collection and preservation techniques have also been shown to effectively reduce VOC losses attributable to volatilization and biodegradation. These additional collection and preservation options are acceptable, in addition to the preservation options outlined in Method 5035 and MADEP VPH, for samples analyzed and reported to the N.C. DENR Division of Waste Management UST Section.

1. Low and High Level Methods - Here is a brief description of the low and high level methods, with hold times for various preservation options.

- a) Low Level (≤ 200 $\mu\text{g/kg}$ volatile organics) - SW-846 method 5035 includes a low-level closed-system purge and trap method with a preservation option using sodium bisulfate. However, soils high in carbonate minerals may effervesce on contact with the acidic sodium bisulfate preservation solution. Samples suspected to contain high levels of carbonates require a test sample to check for effervescence. If a rapid or vigorous reaction occurs, discard the sample. Then collect the samples in vials that do not contain the sodium bisulfate preservative solution. Preservation options and acceptable hold times include:
 1. A sample field preserved with sodium bisulfate has a 14-day holding time.
 2. An unpreserved sample (no acid) must be analyzed within 48 hours.
 3. An unpreserved sample in a vial with premeasured analyte-free water must be analyzed within 48 hours.
 4. Holding times for unpreserved samples in vials with premeasured analyte-free water may be extended to 14 days if the laboratory freezes the samples to $-12 \pm 2^{\circ}\text{C}$ within 48 hours of sample collection.
 5. If transported to the laboratory in a sealed coring device or pre-weighed VOA vial without chemical preservative, the samples must be analyzed within 48 hours.
 6. Holding times for sealed coring device samples may be extended to 14 days if the laboratory extrudes the sample into sodium bisulfate, or freezes it to $-12 \pm 2^{\circ}\text{C}$ within 48 hours,.
- b) High Level (> 200 $\mu\text{g/kg}$ volatile organics) - SW-846 method 5035 includes a high level soil method for samples where the closed-system purge and trap sample introduction

technique is not appropriate. For reporting to the N.C. DENR Division of Waste Management UST Section, the high level method will apply to soil samples that require volatiles analysis for TPH or VPH and composite samples required by soil remediation permits. The exact weight of the soil samples and the volume of the methanol used for extraction must be known by the laboratory. Preservation options and acceptable hold times include:

1. A sample field preserved with methanol has a 14-day holding time.
2. An unpreserved sample (no methanol) must be analyzed within 48 hours.
3. Holding times for unpreserved samples in a vial may be extended to 14 days if the laboratory adds methanol within 48 hours and refrigerates at 4°C.
4. Holding times for unpreserved samples in vials may be extended to 14 days if the laboratory freezes the samples to -12 ± 2°C within 48 hours of sample collection.
5. If transported to the laboratory in a sealed coring device, the samples must be analyzed within 48 hours.
6. Holding times for sealed coring device samples may be extended to 14 days if the laboratory either freezes the device at -12 ± 2°C within 48 hours of sample collection or extrudes the sample into methanol, and refrigerates it at 4°C.

NOTE: *While all collection and preservation options for the high level method will be allowed, STF reimbursement will not be made for Sealed-Tube Sampling/Storage Devices used to collect soil remediation permitting composite samples. There are two other less expensive options for collection and preservation listed below. Reimbursement under task code 4.010 and 408 will only be allowed for closure and assessment and corrective action sampling activities conducted through 2003.*

2. Basic Options for Collection and Preservation - Acceptable options to collect and preserve volatiles soil samples to be analyzed and reported to the N.C. DENR Division of Waste Management UST Section are detailed below. Coordination between sampling personnel and the laboratory is essential prior to selection of the sampling containers and preservation options. *Each option involves collection of a small soil plug with a coring device, followed by a single transfer to a pre-weighed VOA vial.* See Tables 3, 5 and 8 for a summary of approved sample containers preservation options and hold times specific to the type of sampling activity.

For closure or assessment and corrective action sampling activities, collect duplicate samples for TPH Gasoline or MADEP VPH aromatics/aliphatics analysis (both for high level purge and trap). Collect three replicate samples for constituent specific EPA 5035/8260B analysis (two for low level closed-system purge and trap and one for high level purge and trap). For soil remediation sampling activities, collect six primary samples for each composite sample required for a soil remediation permit. Composite volatiles soil samples must be methanol extracted and therefore require one of the preservation options for the high level method above. The primary samples are to be composited by the laboratory after the extraction procedure. Portions of methanol extract from the six primary soil samples are to be composited by a DWQ certified laboratory using methods that minimize volatile organic loss. Label containers as primary samples for composite and notify the laboratory that the six primary samples are to be composited.

Be sure to collect an additional aliquot of sample for dry weight determination. This sample may also be used for soil characterization (i.e., effervescence check) for low concentration samples suspected to contain carbonate minerals. Here are the sample collection and preservation options.

a) Field Preservation with Sodium Bisulfate or Methanol

PERFORMANCE STANDARD: Obtain and store an undisturbed soil sample by collecting a small soil plug with a coring device. Follow collection with a single transfer to a pre-weighed VOA vial that contains chemical preservative to inhibit biodegradation.

1. Choose appropriate sampling containers that are labeled, pre-weighed and preserved with sodium bisulfate or purge and trap (or equivalent) grade methanol. All sampling containers should have an open-top screw cap with Teflon-coated silicone rubber septa or equivalent. Sodium bisulfate preserved VOA vials must also contain a stirring device.
2. A 10-30 ml disposable syringe with the end cut off is recommended to obtain an undisturbed soil sample from freshly exposed soils. Sample coring devices designed to estimate the appropriate weight of soil by volume may be used. Extrude the soil into sample container and avoid splashing liquid out of the container.
3. Use a clean brush or paper towel to remove soil particles from the threads of the sample container and screw cap. Tightly apply and secure the screw cap. Gently swirl the sample to break up soil aggregate, if necessary, until soil is covered with sodium bisulfate or methanol. DO NOT SHAKE.
4. Immediately place containers in a cooler with ice for storage in an upright position. Sample containers can be placed in separate zip-lock bags in case of leakage during transport. Transport samples to the analytical laboratory using the appropriate chain-of-custody procedures and forms.

b) Use of Pre-weighed VOA Vials

PERFORMANCE STANDARD: Obtain and store an undisturbed soil sample by collecting a small soil plug with a coring device. Follow collection with a single transfer to a pre-weighed VOA vial. Immediately seal the airtight VOA vial and analyze it within 48 hours or preserve it within 48 hours to inhibit biodegradation.

1. Obtain labeled, pre-weighed VOA vials for the collection and air-tight storage of at least five grams of soil. Pre-weighed vials for analysis by low level, closed system, purge and trap must include a stirring device (i.e., magnetic stir bar).
2. In the field, obtain an undisturbed sample from a freshly exposed soil. Collect soil core samples with disposable cut off syringes or other coring devices and extrude them immediately into pre-weighed VOA vials. Immediately seal the VOA vial, and place it in a cooler. Transport samples to the analytical laboratory using the appropriate chain-of-custody procedures and forms.
3. Samples must either be analyzed or be preserved in the laboratory within 48 hours of collection to inhibit biodegradation. To do this, samples must be either frozen to $-12 \pm 2^{\circ}\text{C}$ or preserved with an appropriate chemical preservative (sodium bisulfate or

purge and trap (or equivalent) grade methanol) at the laboratory within 48 hours of sampling. The laboratory may add sodium bisulfate or purge and trap (or equivalent) grade methanol to the sample after it has been enclosed in a pre-weighed VOA vial. It may be added by using a syringe and puncturing the septum with a 23 or smaller gauge needle. Samples immersed in methanol should not be stored for more than two days in VOA vials that have punctured septa. When methanol is introduced through the septum via a needle, the septum should be replaced if the sample is archived. A ratio of 1 ml methanol to 1 gram soil will minimize the dilution factor. In no case, however, shall the level of soil in the laboratory container exceed the level of methanol (i.e., the soil must be completely immersed in methanol).

c) Use of a Sealed-Tube Sampling/Storage Device

Although the use of these devices will continue to be allowed, State Trust Fund reimbursement under task code 4.010 and 408 will only be allowed for closure and assessment and corrective action sampling activities conducted through 2003.

PERFORMANCE STANDARD: Obtain an undisturbed soil sample and immediately seal it in an airtight container for shipment to a laboratory. Follow collection with a single transfer to a pre-weighed VOA vial. Either analyze or preserve to inhibit biodegradation within 48 hours.

1. Obtain pre-cleaned and/or disposable samplers/containers that allow the collection and air-tight storage of at least five grams of soil.
2. In the field obtain the appropriate number (two or three) of undisturbed, co-located samples from a freshly exposed soil. Immediately seal containers and place them in a cooler. Obtain an extra sample in an empty VOA vial to determine soil moisture content. Transport samples to the analytical laboratory using the appropriate chain-of-custody procedures and forms.
3. Samples must either be analyzed or be preserved in the laboratory to inhibit biodegradation within 48 hours of collection. To do this, samples must be either frozen to $-12 \pm 2^{\circ}\text{C}$ or preserved chemically at the laboratory within 48 hours of sampling. Samples are extruded and immersed in an appropriate chemical preservative (sodium bisulfate or purge and trap (or equivalent) grade methanol) at the laboratory within 48 hours of sampling, at a ratio of 1 mL preservative to 1 gram soil. In no case, however, shall the level of soil in the laboratory container exceed the level of liquid (i.e., the soil must be completely immersed).

NOTE: *Documentation must be provided/available on the ability of the sampler/container to provide an air-tight seal in a manner that results in no statistically significant loss of volatile hydrocarbons for at least 48 hours. Check with the laboratory before collecting samples to make sure that the necessary equipment is available to open the devices and to ensure that the 48-hour holding time can be met.*

Regardless of which sampling option is used, the desired ratio of methanol-to-soil should be 1-ml methanol to 1-gram soil, +/-25%. A soil sample with a minimum weight of four grams is

required. The exact weight of the soil sample and the volume of methanol must be determined by the laboratory when calculating and reporting soil concentration data.

NOTE: *The 1:1 soil to solvent ratio appears to work well for solid samples (e.g., sandy soil) that do not expand to soak up the methanol when it is added. On the other hand, many samples, such as those with a high organic content, may expand and soak up the methanol, making it impossible to remove the methanol extract from the sample container for purging purposes. If the solvent does not cover all of the soil, volatile analytes will escape into the headspace and not be captured in the aliquot of solvent removed from the vial for analysis. In all cases, the soil sample in the vial must be completely covered by methanol.*

3. Container Preparation

- a) All containers must be cleaned using the appropriate sample container cleaning procedures for volatile organics **or be certified as precleaned** (See Appendix C).
- b) Sample Vials - If samples are to be field preserved, vials must be provided with all reagents, stirring devices, labels and vial caps to be used during sample analysis. These vials must be pre-weighed and records must be maintained so that there is an unambiguous link between the tare weight and the filled sample vial.
- c) Pre-weighed vials should be handled with gloves. Protect the sample containers and labels from moisture by using sealable plastic bags.

4. Collection Tips

- a) The pre-weighed sample vials (when used), may contain a pre-measured amount of liquid. The laboratory must weigh the vials before sending them into the field, and then again after receipt. To collect useable samples:
 1. Do not lose any of the liquid either through evaporation or spillage.
 2. Do not use a vial if some of the liquid has spilled, or if it appears that some has leaked during transport.
 3. Use the laboratory-supplied container label for identification information.
 4. Do not apply any additional labels or chain of custody seals to the pre-weighed container.
 5. Do not interchange vial caps or septa.
 6. Protect the sample containers and labels from moisture by using sealable plastic bags.
- b) Transport the pre-labeled and weighed vials, either empty or containing the appropriate volume of chemical preservative, to the field in a cooler with ice. Take precautions to avoid exposing the vials to exhaust fumes or other known airborne contaminants at all times. Use disposable gloves while handling pre-weighed vials and collecting samples.
- c) The sampler must be proficient in estimating the 5-gram weight necessary for each sample. Use sample coring devices designed to estimate the appropriate weight of soil by volume. If an accurate estimate of the 5-gram sample size is desired before sampling begins. Use a balance with a sensitivity of 0.1 gram. Calibrate an electronic balance to weigh 5.0 grams of soil, to the nearest 0.1 gram, for a 40-mL vial. The calibration check weight should approximate the expected combined weight of the closed sample vial that contains methanol and the soil sample. Check the balance calibration before each day's use. Use a set of weights that have been calibrated against NIST-traceable weights at least annually. Use a 10-30 mL disposable plastic syringe with the end cut off or a special soil sampler to obtain an undisturbed soil sample from freshly exposed soil. Collect trial

samples with the syringe. Weigh and note the length of the soil column in the syringe to determine the length of soil corresponding to 5.0 ± 0.5 grams. Discard all trial samples.

- d) Minimize exposure to air by obtaining the sample directly from the sample source., Use a coring device or a commercially designed sampling tool. Collect soil samples within a few minutes, at most, from the time when the surface of the soil has been exposed to the atmosphere.
 - 1. The sample collection device must be designed to fit tightly against the mouth of the vial or be small enough to be inserted into the vial.
 - 2. EnCore or equivalent sampling devices may be used. If the sampling device is transported to the laboratory with a sample, make sure the seals are intact, especially if collecting samples from sandy soils.
 - 3. Disposable "industry standard" coring devices or plastic syringes with the syringe end cut off prior to sampling may only be used once per sampling location.
- e) Collect a soil sample, open a sample vial, and immediately extrude the soil sample into the vial. Avoid splashing methanol if using the methanol preserved VOAs. Use a clean brush or paper towel to quickly brush any soil off the vial threads and immediately seal the vial with the septum and screw cap. Wipe off any soil adhering to the outside of the vial. For methanol preserved vials, gently swirl the sample to break up any soil clumps, if necessary, but do so only until the soil is covered with methanol. **The soil sample must be completely covered by methanol.**
- f) Optionally, weigh the sealed vial containing the soil sample to ensure that 5.0 ± 0.5 grams of sample were added. Obtain a duplicate sample in the same manner. If too little soil is collected, detection limits may be increased. If too much soil is collected in methanol preserved vials, the soil may not be adequately covered with methanol.
- g) Collect a bulk soil sample in a vial without preservatives so that the laboratory can calculate moisture content and dry weight. A portion of this may also be used for soil characterization if field preservation was not performed.

NOTE: *Because water is completely miscible with methanol, naturally occurring moisture contained in the soil sample may result in under-reporting of the true, dry weight VOC concentrations. In general, every percent of moisture (by weight) present in a soil sample will result in a negative bias of about 1 percent. It is the responsibility of the data user to determine the significance of this effect on a site-specific basis. However, moisture contents less than 25% by weight are generally not considered a significant concern. No data adjustments are to be done by the laboratory relative to this issue, although laboratories may reference this phenomenon as a reason for low surrogate recoveries in the case narrative, when appropriate.*

- h) Place each vial in a separate sealable plastic bag immediately after collection. Then, quickly place each sample container in a cooler with plenty of ice. Transport the samples to the analytical laboratory as soon as possible. Use chain-of-custody procedures and forms.

F. Shipping Sample Containers/Collection Devices on Ice

All samples must be stored and transported carefully to prevent samples from breaking and to maintain a temperature of approximately 4°C. If samples are field preserved with methanol, no

additional preservation measures are necessary other than $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ storage. If samples are not field preserved, additional preservation to inhibit biodegradation besides refrigerated (4°C) storage must be applied the same day samples are received and within 48 hours of sample collection. The maximum hold time may be extended to a total of 14 days from sample collection if the laboratory applies measures to inhibit biodegradation within 48 hours of sample collection. Freezing samples to $-12 \pm 2^{\circ}\text{C}$ in empty VOA vials or specially-designed, approved airtight sampling devices is an acceptable alternative to chemical preservation as a means to inhibit biodegradation.

All sample containers containing methanol should be on ice when shipped from the laboratory, before sample collection. The sample containers may be kept in a refrigerator when they are received from the laboratory until they are taken to the field for sample collection. In other words, all sample containers containing methanol should be kept cold from the time they leave the laboratory until the time they return to the laboratory. The reason for keeping the methanol cold at all times is to reduce methanol vaporization, which may magnify the concentration of contaminants in the samples and subsequently increase cleanup costs.

NOTE: *An alternative to shipping on ice and/or field weighing is to mark the meniscus of the methanol after addition to the VOA vial for field personnel to visually inspect and note any apparent loss during shipment. If sample containers containing methanol are not shipped from the laboratory on ice, or if the meniscus of the methanol is not marked for field personnel to visually inspect for apparent loss, then they must be re-weighed to ensure vials have not lost methanol. If field personnel are concerned with methanol loss, individual vials can be re-weighed. Vials with reduction in weight of >0.01 g, if weighed in the laboratory, or > 0.2 g, if weighed in the field, should not be used to collect samples.*

The collection devices which are not shipped with methanol (i.e., specially-designed, approved, airtight sampling devices and pre-weighed empty VOAs) do not need to be shipped on ice from the laboratory. They should be put on ice prior to sample collection and after collection for shipping to the laboratory. Collecting the sample in a chilled collection device will reduce volatilization and will provide a more accurate result of the amount of contamination in the soil.

G. Laboratory Preparation and Shelf-life of Methanol Preserved Vials

1. Preparation

- a) Add 5 ml of **purge and trap grade methanol** to 40-mL VOA vials with open top screw caps and Teflon-coated septa. Add 25 ml if using 60-mL VOA vials. Include a methanol trip blank and a glass jar, or other appropriate container per sample set, for dry weight determination.
- b) Seal the vials with the screw caps and septum seals.
- c) Affix a label to each vial. This eliminates the need to label the vials in the field and assures that the tare weight of the vial includes the label, (The weight of any markings added to the label in the field is negligible.)
- d) Calibrate an electronic balance and weigh each prepared sample vial to within 0.01 gram. Record the tare weight and the date on the label. Store the prepared vials at 4°C and protect them with sealable plastic bags for transport to the field.

2. Shelf-life of methanol preserved bottles - It is recommended that sample containers be ordered and received immediately prior to each job. It is not recommended that a supply of sample containers with methanol be stored unused for long periods of time. The concern with stockpiling sample containers containing methanol is the volatilization of the methanol. This may magnify the contamination levels in the sample and subsequently result in higher cleanup costs. It is recommended that samples collected in sample containers that contain methanol within 14 days of the date the vial was prepared and weighed in the laboratory. When the laboratories weigh the sample and record the weight on the vials, they should also record the date on the vials.

NOTE: *Vials containing methanol should be weighed a second time on the day that they are to be used. Vials found to have lost methanol (reduction in weight of ≥ 0.01 g, if weighed in the laboratory or ≥ 0.2 g, if weighed in the field) should not be used to collect samples. An alternative to field weighing is to mark the meniscus of the methanol after addition to the VOA vial for field personnel to visually inspect and note any apparent loss during shipment. If field personnel are concerned with methanol loss, during shipment to the field and return, individual vials can be re-weighed.*

H. Shipping Methanol Preserved Samples

NOTE: *Prepared vials and samples must be shipped according to U.S. Department of Transportation Regulations. Because methanol is a toxic and flammable liquid it must be handled with appropriate care. Use in a well-vented area and avoid inhaling methanol vapors. The use of protective gloves is recommended when handling or transferring methanol. Vials of methanol should always be stored in a cooler with ice away from sources of ignition, such as extreme heat or open flames.*

1. Shipping Hazardous Materials - Methanol is considered a hazardous material by the US Department of Transportation (DOT) and the International Air Transport Association (IATA). Shipments of methanol between the field and the laboratory must conform to the rules established in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and the most current edition of the IATA Dangerous Goods Regulations. Review these documents or consult with your shipping company for complete details.
2. Small Quantity Exemption - The volumes of methanol recommended in the VPH method fall under the small quantity exemption of 49 CFR Section 173.4. To qualify for this exemption, all of the following conditions must be met.
 - a) The maximum volume of methanol in each sample container must not exceed 30 ml.
 - b) The sample container must not be full of methanol.
 - c) The sample container must be securely packed and cushioned in an upright position. It must be surrounded by a sorbent material capable of absorbing spills from leaks or broken sample containers.
 - d) The package weight must not exceed 64 pounds.
 - e) The volume of methanol per shipping container must not exceed 500 ml.
 - f) The packaging and shipping container must be strong enough to hold up to the intended use.
 - g) The package must not be opened or altered while in transit.

- h) The shipper must mark the shipping container in accordance with the requirements for shipping dangerous goods in acceptable quantities. They must provide the statement, "This package conforms to conditions and limitations specified in 49 CFR 173.4."
- 3. Shipping Papers - All shipments must be accompanied by shipping papers which include the following:
 - a) Proper Shipping Name: Methyl Alcohol
 - b) Hazardous Class: Flammable Liquid
 - c) Identification Number: UN1230
 - d) Total Quantity: (mL methanol/container x the number of containers)
 - e) Emergency Response Info: Methanol MSDS attached
 - f) Emergency Response Phone: provide appropriate number
 - g) Shipping Exemption: DOT-E 173.118, Limited Quantity
- 4. Labeling & Placarding - Labeling and placarding is not required for valid small quantity exemptions (per 49 CFR Section 173.118).

Appendix F Collecting Groundwater Samples

Groundwater samples are collected to identify, investigate, assess and monitor the concentration of dissolved contaminant constituents. To properly assess groundwater contamination, first install sampling points (monitoring wells, etc.) to collect groundwater samples and then perform specific laboratory analyses. All monitoring wells should be constructed in accordance with 15A NCAC 2C .0100 and sampled as outlined in this section.

Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques.

Wells without Plumbing: These wells require equipment to be brought to the well to purge and sample unless dedicated equipment is placed in the well.

Wells with In-Place Plumbing: Wells with in-place plumbing do not require equipment to be brought to the well to purge and sample. In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply. They are generally found at wellfields, industrial facilities and private residences. See Appendix G for procedures to sample wells with plumbing in place .

Air Strippers or Remedial Systems: These types of systems are installed as remediation devices. Sample wells associated with these systems as outlined in Appendix G.

A. Groundwater Sample Preparation

The type of sample containers used depends on the type of analysis performed. First, determine the type(s) of contaminants expected and the proper analytical method(s) established in Tables 9 or 10. Table 11 lists approved sample containers, preservation and hold times for the specified methods. Be sure to consult your selected laboratory for its specific needs and requirements prior to sampling.

Prepare the storage and transport containers (ice chest, etc.) before taking any samples so that each sample can be placed in a chilled environment immediately after collection.

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. In selecting groundwater purging and sampling equipment, give consideration to the depth of the well, the depth to groundwater, the volume of water to be evacuated, the sampling and purging technique, and the analytes of interest. Refer to Tables 12, 13, 14 and 15 for selection of appropriate equipment. Additional supplies, such as reagents and preservatives, may be necessary.

All sampling equipment (bailers, tubing, containers, etc.) must be selected based on its chemical compatibility with the source being sampled (e.g., water supply well, monitoring well) and the contaminants potentially present.

1. Pumps - All pumps or pump tubing must be lowered and retrieved from the well slowly and carefully to minimize disturbance to the formation water. This is especially critical at the air/water interface.
 - a) Above-Ground Pumps
 1. Variable Speed Peristaltic Pump: Use a variable speed peristaltic pump to purge groundwater from wells when the static water level in the well is no greater than 20-25 feet below land surface. If the water levels are deeper than 18-20 feet BLS, the pumping velocity will decrease.
 - A. A variable speed peristaltic pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations.
 - B. Most analyte groups can be sampled with a peristaltic pump if the tubing and pump configurations are appropriate. See Table 15 for proper tubing selection and pump configurations.
 2. Variable Speed Centrifugal Pump: A variable speed centrifugal pump can be used to purge groundwater from 2-inch and larger internal diameter wells. **Do not use** this type of pump to collect groundwater samples.
 - A. When purging is complete, do not allow the water that remains in the tubing to fall back into the well. Install a check valve at the end of the purge tubing.
 - B. See Table 15 for proper tubing selection and allowable analyte groups.
 - b) Submersible Pumps
 1. Variable Speed Electric Submersible Pump: A variable speed submersible pump can be used to purge and sample groundwater from 2-inch and larger internal diameter wells.
 - A. A variable speed submersible pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations.
 - B. Make sure that the pump housing, fittings, check valves and associated hardware are constructed of stainless steel. Make sure that any other materials are compatible with the analytes of interest. See Table 15 for restrictions.
 - C. Install a check valve at the output side of the pump to prevent backflow.
 - D. If purging **and** sampling for organics:
 - The entire length of the delivery tube must be Teflon, polyethylene or polypropylene (PP) tubing.
 - The electrical cord must be sealed in Teflon, polyethylene or PP and any cabling must be sealed in Teflon, polyethylene or PP, or be constructed of stainless steel.
 - All interior components that contact the sample water (impeller, seals, gaskets, etc.) must be constructed of stainless steel or Teflon.
 2. Variable Speed Bladder Pump: A variable speed, positive displacement, bladder pump (no-gas contact) can be used to purge and sample groundwater from 3/4-inch and larger internal diameter wells.
 - A. A variable speed bladder pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations.

- B. The bladder pump system is composed of the pump, the compressed air tubing, the water discharge tubing, the controller and a compressor or compressed gas supply.
- C. The pump consists of a bladder and an exterior casing or pump body that surrounds the bladder and two (2) check valves. These parts can be composed of various materials, usually combinations of polyvinyl chloride (PVC), Teflon, polyethylene, PP and stainless steel. Other materials must be compatible with the analytes of interest. See Table 15 for restrictions.
- D. If purging and sampling for organics:
 - The pump body must be constructed of stainless steel and the valves and bladder must be Teflon, polyethylene or PP.
 - The entire length of the delivery tube must be Teflon, polyethylene or PP.
 - Any cabling must be sealed in Teflon, polyethylene or PP, or be constructed of stainless steel.
- E. Permanently installed pumps may have a PVC pump body as long as the pump remains in contact with the water in the well.

2. Bailers

- a) Purging: Bailers must be used with caution because improper bailing can cause changes in the chemistry of the water due to aeration and loosening particulate matter in the space around the well screen. Use a bailer if there is non-aqueous phase liquid (free product) in the well or if non-aqueous phase liquid is suspected to be in the well. If a bailer is used, follow the procedures outlined below in Section D 4.
- b) Sampling: Bailers must be used with caution following the procedures outlined below in Section D 4.
- c) Construction and Type:
 - 1. Bailers must be constructed of materials compatible with the analytes of interest. See Table 15 for restrictions. Stainless steel, Teflon, rigid medical grade PVC, polyethylene and PP bailers may be used to sample all analytes.
 - 2. Use disposable bailers when sampling grossly contaminated sample sources.
 - 3. NCDENR recommends using dual check valve bailers when collecting samples.
 - 4. Use bailers with a controlled flow bottom to collect volatile organic samples.
- d) Contamination Prevention:
 - 1. Keep the bailer wrapped (foil, butcher paper, etc.) until just before use.
 - 2. Use protective gloves to handle the bailer once it is removed from its wrapping.
 - 3. Handle the bailer by the lanyard to minimize contact with the bailer surface.

3. Lanyards

- a) Lanyards must be made of non-reactive, non-leachable material. They may be cotton twine, nylon, stainless steel, or may be coated with Teflon, polyethylene or PP.
- b) Discard cotton twine, nylon, and non-stainless steel braided lanyards after sampling each monitoring well.
- c) Decontaminate stainless steel, coated Teflon, polyethylene and PP lanyards between monitoring wells (see Appendix C). They do not need to be decontaminated between purging and sampling operations.

B. Water Level and Purge Volume Determination

Collect groundwater samples from fresh water from the aquifer. The amount of water that must be purged from a well is determined by the volume of water and/or field parameter stabilization.

1. General Equipment Considerations - Selection of appropriate purging equipment depends on the analytes of interest, the well diameter, transmissivity of the aquifer, the depth to groundwater and other site conditions.

- a) Use of a pump to purge the well is recommended unless no other equipment can be used or there is non-aqueous phase liquid in the well, or non-aqueous phase liquid is suspected to be in the well.
- b) Bailers must be used with caution because improper bailing:
 1. Introduces atmospheric oxygen, which may precipitate metals (i.e., iron) or cause other changes in the chemistry of the water in the sample (i.e., pH).
 2. Agitates groundwater, which may bias volatile and semi-volatile organic analyses due to volatilization.
 3. Agitates the water in the aquifer and resuspends fine particulate matter
 4. Surges the well, loosening particulate matter in the annular space around the well screen.
 5. May introduce dirt into the water column if the sides of the casing wall are scraped.

NOTE: *It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during the final stages of purging, to minimize turbidity and disturbance of volatile organic constituents.*

2. Initial Inspection

- a) Remove the well cover and remove all standing water around the top of the well casing (manhole) before opening the well.
- b) Inspect the exterior protective casing of the monitoring well for damage. Document the results of the inspection if there is a problem.
- c) It is recommended that you place a protective covering around the well head. Replace the covering if it becomes soiled or ripped.
- d) Inspect the well lock and determine whether the cap fits tightly. Replace the cap if necessary.

3. Water Level Measurements - Use an electronic probe or chalked tape to determine the water level. Decontaminate all equipment before use. Measure the depth to groundwater from the top of the well casing to the nearest 0.01 foot. Always measure from the same reference point or survey mark on the well casing. Record the measurement.

- a) Electronic Probe
 1. Decontaminate all equipment before use.
 2. Follow the manufacturer's instructions for use.
 3. Record the measurement.
- b) Chalked Line Method
 1. Decontaminate all equipment before use.

2. Lower chalked tape into the well until the lower end is in the water. This is usually determined by the sound of the weight hitting the water.
 3. Record the length of the tape relative to the reference point (see Section 3.2 above).
 4. Remove the tape and note the length of the wetted portion.
 5. Record the length.
 6. Determine the depth to water by subtracting the length of the wetted portion from the total length. Record the result.
4. Water Column Determination - To determine the length of the water column, subtract the depth to the top of the water column from the total well depth (or gauged well depth if silting has occurred). The total well depth depends on the well construction. If gauged well depth is used due to silting, report total well depth also. Some wells may be drilled in areas of sinkhole, karst formations or rock leaving an open borehole. Attempt to find the total borehole depth in cases where there is an open borehole below the cased portion.
5. Well Water Volume - Calculate the total volume of water, in gallons, in the well using the following equation:

$$V = (0.041)d \times d \times h$$

Where: V = volume in gallons

d = well diameter in inches

h = height of the water column in feet

The total volume of water in the well may also be determined with the following equation by using a casing volume per foot factor (Gallons per Foot of Water) for the appropriate diameter well:

$$V = [\text{Gallons per Foot of Water}] \times h$$

Where: V = volume in gallons

h = height of the water column in feet

Casing Internal Diameter	Approximate Gallons per Foot of Water
0.75"	0.02
1"	0.04
1.25"	0.06
2"	0.16
3"	0.37
4"	0.65
5"	1.02
6"	1.47
12"	5.88

Record all measurements and calculations in the field records.

6. Purging Equipment Volume - Calculate the total volume of the pump, associated tubing and flow cell (if used), using the following equation:

$$V = p + ((0.041)d \times d \times l) + fc$$

Where: V = volume in gallons

p = volume of pump in gallons

d = tubing diameter in inches

l = length of tubing in feet

fc = volume of flow cell in gallons

7. If the groundwater elevation data are to be used to construct groundwater elevation contour maps, all water level measurements must be taken within the same 24 hour time interval when collecting samples from multiple wells on a site, unless a shorter time period is required. If the site is tidally influenced, complete the water level measurements within the time frame of an incoming or outgoing tide.

C. Well Purging Techniques

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity. Equipment selection must comply with the construction and configuration requirements specified in Table 15.

1. Measuring the Purge Volume - The volume of water that is removed during purging must be recorded. Therefore, you must measure the volume during the purging operation.

- a) Collect the water in a graduated container and multiply the number of times the container was emptied by the volume of the container, or
- b) Estimate the volume based on pumping rate. This technique may be used only if the pumping rate is constant. Determine the pumping rate by measuring the amount of water that is pumped for a fixed period of time, or use a flow meter.

1. Calculate the amount of water that is discharged per minute:

$$D = \frac{\text{Measured amount}}{\text{Total time in minutes}}$$

2. Calculate the time needed to purge one (1) well volume or one (1) purging equipment volume:

$$\text{Time} = \frac{V}{D}$$

Where:

V = well volume or purging equipment volume

D = discharge rate

3. Make new measurements each time the pumping rate is changed.

- c) Use a totalizing flow meter.

1. Record the reading on the totalizer prior to purging.
2. Record the reading on the totalizer at the end of purging.
3. To obtain the volume purged, subtract the reading on the totalizer prior to purging from the reading on the totalizer at the end of purging..
4. Record the times that purging begins and ends in the field records.

2. Purging Measurement Frequency

- a) When purging a well that has the well screen fully submerged and the pump or intake tubing is placed within the well casing above the well screen or open hole, purge a minimum of one (1) well volume prior to collecting measurements of the field parameters. Allow at least one quarter (1/4) well volume to purge between subsequent measurements.

- b) When purging a well that has the pump or intake tubing placed within a fully submerged well screen or open hole, purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) volume of the pump, associated tubing and flow cell (if used) prior to collecting measurements of the field parameters. Take measurements of the field parameters no sooner than two (2) to three (3) minutes apart. Purge at least three (3) volumes of the pump, associated tubing and flow cell, if used, prior to collecting a sample.
 - c) When purging a well that has a partially submerged well screen, purge a minimum of one (1) well volume prior to collecting measurements of the field parameters. Take measurements of the field parameters no sooner than two (2) to three (3) minutes apart.
3. Purging Completion - Wells must be adequately purged prior to sample collection to ensure representation of the aquifer formation water, rather than stagnant well water. This may be achieved by purging three volumes from the well or by satisfying any one of the following three purge completion criteria:
- a) Three (3) consecutive measurements in which the three (3) parameters listed below are within the stated limits, dissolved oxygen is no greater than 20 percent of saturation at the field measured temperature, and turbidity is no greater than 20 Nephelometric Turbidity Units (NTUs).
 - 1. Temperature: $\pm 0.2^{\circ} \text{C}$
 - 2. pH: ± 0.2 Standard Units
 - 3. Specific Conductance: $\pm 5.0\%$ of reading

Document and report the following, as applicable. The last four items only need to be submitted once:

- 1. Purging rate.
 - 2. Drawdown in the well, if any.
 - 3. A description of the process and the data used to design the well.
 - 4. The equipment and procedure used to install the well.
 - 5. The well development procedure.
 - 6. Pertinent lithologic or hydrogeologic information.
- b) If it is impossible to get dissolved oxygen at or below 20 percent of saturation at the field measured temperature or turbidity at or below 20 NTUs, then three (3) consecutive measurements of temperature, pH, specific conductance and the parameter(s) dissolved oxygen and/or turbidity that do not meet the requirements above must be within the limits below. The measurements are:
- 1. Temperature: $\pm 0.2^{\circ} \text{C}$
 - 2. pH: ± 0.2 Standard Units
 - 3. Specific Conductance: $\pm 5.0\%$ of reading
 - 4. Dissolved Oxygen: $\pm 0.2 \text{ mg/L}$ or 10%, whichever is greater
 - 5. Turbidity: $\pm 5 \text{ NTUs}$ or 10%, whichever is greater

Additionally, document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- 1. Purging rate.
- 2. Drawdown in the well, if any.
- 3. A description of conditions at the site that may cause the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open hole portion of the well with a downhole dissolved oxygen probe.

4. A description of conditions at the site that may cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
5. A description of the process and the data used to design the well.
6. The equipment and procedure used to install the well.
7. The well development procedure.
8. Pertinent lithologic or hydrogeologic information.

If the Department's review of the submitted data determines that both the elevated dissolved oxygen and turbidity measurements are due to naturally occurring conditions, then only the first two (2) items are required to be submitted in future reports. However, if the Department cannot determine if the dissolved oxygen or turbidity are elevated due to naturally occurring conditions, more data are required. In addition to the first two (2) items, a description of the conditions at the site that may have caused the affected parameter(s) to be high will be required in future reports.

- c) If after five (5) well volumes, three (3) consecutive measurements of the field parameters temperature, pH, specific conductance, dissolved oxygen, and turbidity are not within the limits stated above, check the instrument condition and calibration, purging flow rate and all tubing connections to determine if they might be affecting the ability to achieve stable measurements. It is at the discretion of the consultant/contractor whether or not to collect a sample or to continue purging. Further, the report in which the data are submitted must include the following, as applicable. The last four (4) items only need to be submitted once.

1. Purging rate.
2. Drawdown in the well, if any.
3. A description of conditions at the site that may cause the Dissolved Oxygen to be high and/or Dissolved Oxygen measurements made within the screened or open hole portion of the well with a downhole dissolved oxygen probe.
4. A description of conditions at the site that may cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
5. A description of the process and the data used to design the well.
6. The equipment and procedure used to install the well.
7. The well development procedure.
8. Pertinent lithologic or hydrogeologic information.

If a review of the data shows that both the elevated dissolved oxygen and turbidity measurements are due to naturally occurring conditions, then only the first two (2) items are required to be submitted in future reports. However, if it cannot be determined that the dissolved oxygen or turbidity are elevated due to naturally occurring conditions, more data is required. In addition to the first two (2) items, a description of the conditions at the site that may have caused the affected parameter(s) to be high will be required in future reports.

- d) One fully dry purge (not recommended). This criterion applies only if purging was attempted, and if it was impossible to balance the pumping rate with the rate of recharge at very low pumping rates (< 100 mL/minute). If wells have previously and consistently purged dry, and the current depth to groundwater indicates that the well will purge dry during the current sampling event, minimize the amount of water removed from the well by using the same pump to purge and collect the sample:

1. Place the pump or tubing intake within the well screened interval.

2. Use very small diameter Teflon, polyethylene or PP tubing and the smallest possible pump chamber volume. This will minimize the total volume of water pumped from the well and reduce drawdown.
 3. Select tubing that is thick enough to minimize oxygen transfer through the tubing walls while pumping.
 4. Pump at the lowest possible rate (100 mL/minute or less) to reduce drawdown to a minimum.
 5. Purge at least two (2) volumes of the pumping system (pump, tubing and flow cell, if used).
 6. Measure pH, specific conductance, temperature, dissolved oxygen and turbidity, then begin to collect the samples.
4. Collect samples immediately after purging is complete. The time period between completing the purge and sampling cannot exceed six hours. If sample collection does not occur within one hour of purging completion, re-measure the five field parameters: temperature, pH, specific conductance, dissolved oxygen and turbidity, just prior to collecting the sample. If the measured values are not within 10 percent of the previous measurements, re-purge the well. The exception is "dry" wells (see section C above).
5. Lanyards
- a) Securely fasten lanyards, if used, to any downhole equipment (bailers, pumps, etc.).
 - b) See Section A above for acceptable lanyard types and use.
 - c) Use bailer lanyards in such a way that they do not touch the ground surface.

D. Wells Without Plumbing

1. Tubing/Pump Placement

- a) If you are attempting to minimize the volume of purge water, the pump will be used for both purging and sampling, the well screen interval is less than or equal to 10 feet, and the well screen is fully submerged, position the intake hose or pump at the midpoint of the screened or open hole interval.
- b) If monitoring well conditions do not allow minimizing of the purge water volume, or you intend to collect samples with equipment different than that used to purge, position the pump or intake hose near the top of the water column. This will ensure that all stagnant water in the casing is removed.
- c) If the well screen or borehole is partially submerged, and the pump will be used for both purging and sampling, position the pump midway between the measured water level and the bottom of the screen. Otherwise, position the pump or intake hose near the top of the water column.

2. Non-dedicated (portable) pumps

- a) Variable Speed Peristaltic Pump
 1. Wear sampling gloves to position the decontaminated pump and tubing.
 2. Attach a short section of tubing to the discharge side of the pump and into a graduated container.
 3. Attach one end of a length of new or precleaned tubing to the pump head flexible hose.
 4. Place the tubing as described in one of the options listed above.
 5. Change gloves before beginning to purge.

6. Measure the depth to groundwater at frequent intervals.
 7. Record these measurements.
 8. Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
 9. If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
 10. If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that water is removed from the top of the water column.
 11. Record the purging rate each time the rate changes.
 12. Measure the purge volume.
 13. Record this measurement.
 14. Decontaminate the pump and tubing between wells (see Appendix C) or if precleaned tubing is used for each well, only the pump.
- b) Variable Speed Centrifugal Pump
1. Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
 2. Wear sampling gloves to position the decontaminated pump and tubing.
 3. Place the decontaminated suction hose so that water is always pumped from the top of the water column.
 4. Change gloves before beginning to purge.
 5. Equip the suction hose with a foot valve to prevent purge water from re-entering the well.
 6. Measure the depth to groundwater at frequent intervals.
 7. Record these measurements.
 8. To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
 9. If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
 10. If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.
 11. Record the purging rate each time the rate changes.
 12. Measure the purge volume.
 13. Record this measurement.
 14. Decontaminate the pump and tubing between wells (see Appendix C) or if precleaned tubing is used for each well, only the pump.
- c) Variable Speed Electric Submersible Pump
1. Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
 2. Wear sampling gloves to position the decontaminated pump and tubing.
 3. Carefully position the decontaminated pump as described in one of the options in Section D 1 above.
 4. Change gloves before beginning to purge.
 5. Measure the depth to groundwater at frequent intervals.
 6. Record these measurements.

7. To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
 8. If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
 9. If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that water is removed from the top of the water column.
 10. Record the purging rate each time the rate changes.
 11. Measure the purge volume.
 12. Record this measurement.
 13. Decontaminate the pump and tubing between wells (see Appendix C) or only the pump if precleaned tubing is used for each well.
- d) Variable Speed Bladder Pump
1. Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
 2. Wear sampling gloves to position the decontaminated pump and tubing.
 3. Attach the tubing and carefully position the pump.
 4. Change gloves before beginning purging.
 5. Measure the depth to groundwater at frequent intervals.
 6. Record these measurements.
 7. To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
 8. If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
 9. If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that water is removed from the top of the water column.
 10. Record the purging rate each time the rate changes.
 11. Measure the purge volume.
 12. Record this measurement.
 13. Decontaminate the pump and tubing between wells (see Appendix C) or if precleaned tubing is used for each well, only the pump.
3. Dedicated Portable Pumps - Place dedicated pumps as described in one of the options in Section D 1 above.
- a) Variable Speed Electric Submersible Pump
1. Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
 2. Wear sampling gloves.
 3. Measure the depth to groundwater at frequent intervals.
 4. Record these measurements.
 5. Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
 6. If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdraw with the recharge rate.
 7. Record the purging rate each time the rate changes.
 8. Measure the purge volume.

9. Record this measurement.
- b) Variable Speed Bladder Pump
 1. Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
 2. Wear sampling gloves.
 3. Measure the depth to groundwater at frequent intervals.
 4. Record these measurements.
 5. Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
 6. If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdraw with the recharge rate.
 7. Record the purging rate each time the rate changes.
 8. Measure the purge volume.
 9. Record this measurement.
4. Bailers - Using bailers for purging is not recommended unless care is taken to use proper bailing technique, or if free product is present in the well or suspected to be in the well.
 1. Minimize handling the bailer as much as possible.
 2. Wear sampling gloves.
 3. Remove the bailer from its protective wrapping just before use.
 4. Attach a lanyard of appropriate material (see Section A).
 5. Use the lanyard to move and position the bailer.
 6. Lower and retrieve the bailer slowly and smoothly.
 7. Lower the bailer carefully into the well to a depth approximately a foot above the water column.
 8. When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached.
 9. Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column.
 10. Allow time for the bailer to fill with aquifer water as it descends into the water column.
 11. Carefully raise the bailer. Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.
 12. Measure the purge volume.
 13. Record the volume of the bailer.
 14. Continue to carefully lower and retrieve the bailer as described above until the purging is considered complete, based on either the removal of 3 well volumes or after meeting any of the other purge completion criteria listed above in Section B.
 15. Remove at least one (1) well volume before collecting measurements of the field parameters. Take each subsequent set of measurements after removing at least one quarter (1/4) well volume between measurements.

E. Groundwater Sampling Techniques

1. Purge wells using the techniques outlined in Section B.
2. Replace the protective covering around the well if it is soiled or torn after completing the purging operations.

3. Equipment Considerations

- a) Some pumps may be used to sample groundwater. Follow all notes and restrictions as defined in Tables 14 and 15 and discussed in Section A when using pumps to collect samples.

NOTE: *The only pumps that are currently approved for use to collect volatile organic samples through the pump are: stainless steel and Teflon variable speed submersible pumps, stainless steel and Teflon or polyethylene variable speed bladder pumps, and permanently installed PVC bodied pumps, as long as the pump remains in contact with the water in the well at all times.*

- b) Collect the sample into the sample container from the sampling device. Do not use intermediate containers.
- c) In order to avoid contaminating the sample or loss of analytes from the sample:
 1. Handle the sampling equipment as little as possible.
 2. Minimize the equipment that is exposed to the sample.
- d) Dedicated Sampling Equipment
 1. Whenever possible, use dedicated equipment. It significantly reduces the chance of cross-contamination.
 2. Dedicated is defined as equipment that is to be used solely for one location for the life of that equipment (e.g., permanently mounted pump).
 3. All material construction and restrictions from Tables 14 and 15 also apply to dedicated equipment. Purchase equipment with the most sensitive analyte of interest in mind.
4. Cleaning/Decontamination
 - A. Clean or make sure dedicated pumps are clean before installation. They do not need to be cleaned prior to each use, but must be cleaned if they are withdrawn for repair or servicing.
 - B. Clean or make sure any permanently mounted tubing is clean before installation.
 - C. Change or clean tubing when the pump is withdrawn for servicing.
 - D. Clean any replaceable or temporary parts as specified in Appendix C.
 - E. Collect equipment blanks on dedicated pumping systems when the tubing is cleaned or replaced.
 - F. Clean or make sure dedicated bailers are clean before placing them into the well.
 - G. Collect an equipment blank on dedicated bailers before introducing them into the water column.
 - H. Suspend dedicated bailers above the water column if they are stored in the well.

F. Sampling Wells Without Plumbing

1. Sampling with Pumps – The following may be used to sample for organics: Variable speed stainless steel and Teflon submersible pumps; and stainless steel, Teflon or polyethylene bladder pumps; and permanently installed PVC bodied pumps, as long as the pump remains in contact with the water in the well at all times. The delivery tubing must be Teflon, polyethylene or PP. Extractable organics may be collected through a peristaltic pump if flexible interior-wall Teflon, polyethylene or PP tubing is used in the pump head. Or if the flexible tubing used in the pump head is other than the types listed, through a peristaltic pump with a vacuum trap. Tubing coming

in contact with samples must be one of the types listed. Follow all notes and restrictions as defined in Tables 14 and 15 and discussed in Section A when using pumps to collect samples.

a) Peristaltic Pump

1. Volatile Organics:

- A. Remove the drop tubing from the inlet side of the pump.
- B. Submerge the drop tubing into the water column.
- C. Prevent the water in the tubing from flowing back into the well.
- D. Remove the drop tubing from the well.
- E. Carefully allow the groundwater to gravity drain into the sample vials. Avoid turbulence. Do not aerate the sample.
- F. Repeat steps B through E until enough vials are filled.

Alternatively

- G. Use the pump to fill the drop tubing.
- H. Quickly remove the tubing from the pump.
- I. Prevent the water in the tubing from flowing back into the well.
- J. Remove the drop tubing from the well.
- K. Carefully allow the groundwater to drain into the sample vials. Avoid turbulence. Do not aerate the sample.
- L. Repeat steps G through K. until enough vials are filled.

Or:

- M. Use the pump to fill the drop tubing
- N. Withdraw the tubing from the well.
- O. Reverse the flow on the peristaltic pumps to deliver the sample into the vials at a slow, steady rate.
- P. Repeat steps M through O until enough vials are filled.

2. Extractable Organics

- A. If the tubing in the pump head is polyethylene or PP, or is Teflon lined, the samples may be collected through the pump.
- B. If the tubing in the pump head is not polyethylene or PP, or is not Teflon lined, use the pump and vacuum trap method.
 1. Assemble the components of the pump and trap according to Figure 4.
 2. The sample container should be the trap.
 3. All equipment that contacts the groundwater before the sample container must be constructed of Teflon, polyethylene, PP, stainless steel or glass, including the transport tubing to and from the sample container, the interior liner of the container cap and all fittings. Do not use a rubber stopper as a cap.
 4. Connect the outflow tubing from the container to the influent side of the peristaltic pump.
 5. Turn the pump on and reduce the flow rate to a smooth and even flow.
 6. Discard a small portion of the sample to allow an air space.
 7. Preserve (if required), label and complete the field notes.

3. Inorganics

- A. Inorganic samples may be collected from the effluent tubing. There are a few restrictions on tubing type (see Table 15).
- B. If samples are collected from the pump, decontaminate all tubing (including the tubing in the head) or change it between wells.

C. Preserve (if required), label and complete field notes.

b) Variable Speed Bladder Pump

1. If sampling for organics, the pump body must be constructed of stainless steel and the valves and bladder must be Teflon. All tubing must be Teflon, polyethylene, or PP and any cabling must be sealed in Teflon, polyethylene or PP, or made of stainless steel.
2. After purging to a smooth even flow, reduce the flow rate.
3. When sampling for volatile organic compounds, reduce the flow rate to 100-200 mL/minute, if possible.

c) Variable Speed Submersible Pump

1. The housing must be stainless steel.
2. If sampling for organics, the internal impellers, seals and gaskets must be constructed of stainless steel, Teflon, polyethylene or PP. The delivery tubing must be Teflon, polyethylene or PP; the electrical cord must be sealed in Teflon; and any cabling must be sealed in Teflon or constructed of stainless steel.
3. After purging to a smooth even flow, reduce the flow rate.
4. When sampling for volatile organic compounds, reduce the flow rate to 100-200 mL/minute, if possible.

2. Sampling with Bailers - A high degree of skill and coordination are necessary to collect representative samples with a bailer.

a) General Considerations

1. Minimize handling the bailer as much as possible.
 - A. Wear sampling gloves.
 - B. Remove the bailer from its protective wrapping just before use.
 - C. Attach a lanyard of appropriate material (see Section A above).
 - E. Use the lanyard to move and position the bailers.
2. Do not allow the bailer or lanyard to touch the ground.
3. Rinsing
 - A. If the bailer is certified precleaned, no rinsing is necessary.
 - B. If both a pump and a bailer are to be used to collect samples, rinse the exterior and interior of the bailer with sample water from the pump before removing the pump.
 - C. If the purge pump is not appropriate for collecting samples (e.g., non-inert components), rinse the bailer by collecting a single bailer of the groundwater to be sampled. Use the technique described in 2 b, Bailing Technique, below.
 - D. Discard the water appropriately.
 - E. Do not rinse the bailer if Oil and Grease samples are to be collected.

b) Bailing Technique

1. Collect all samples that are required to be collected with a pump before collecting samples with the bailer.
2. Raise and lower the bailer gently to minimize stirring up particulate matter in the well and the water column, which can increase sample turbidity.
3. Lower the bailer carefully into the well to a depth approximately a foot above the water column. When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached.
4. Do not lower the top of the bailer more than one foot below the top of the water table, so that water is removed from the top of the water column.

5. Allow time for the bailer to fill with aquifer water as it descends into the water column.
 6. Do not allow the bailer to touch the bottom of the well or particulate matter will be incorporated into the sample. Carefully raise the bailer. Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.
 7. Lower the bailer to approximately the same depth each time.
 8. Collect the sample.
 - A. Install a device to control the flow from the bottom of the bailer and discard the first few inches of water.
 - B. Fill the appropriate sample containers by allowing the sample to slowly flow down the side of the container.
 - C. Discard the last few inches of water in the bailer.
 9. Repeat steps 1 through 9 for additional samples.
 10. As a final step measure the DO, pH, temperature, turbidity and specific conductance after the final sample has been collected. Record all measurements and note the time that sampling was completed.
3. Sampling Wells with Floating Non-Aqueous Phase Liquid: NCDENR does not recommend the sampling of wells with floating non-aqueous phase liquid for trace contaminants. This concerns primarily petroleum related sites, but includes any chemical product (e.g., solvent) that floats on the water table. Sample data from such wells cannot provide useful information regarding the level of contamination. Furthermore, these wells may never provide legitimate data as they may have become permanently chemically damaged by the product being in contact with the well casing for an extended period of time. NCDENR does reserve the right to require sampling of these wells - not for levels of trace contaminants - but for confirmation of an appropriate remediation technique. This type of sampling is performed below the non-aqueous phase layer.
- a) Non-Aqueous Phase Liquid Sampling: Non-aqueous phase liquid may be evident in a cased monitoring well or in an open excavation.
 1. Non-aqueous phase liquid is normally sampled for two reasons:
 - A. Documentation for its existence and thickness; and
 - B. Determination of the type of product so that the proper analyses can be performed to determine extent. This is only feasible for relatively recent releases, as it may not be possible to identify weathered product.
 2. Disposable plastic (acrylic, clear PVC) bailers are recommended for sampling. Disposable polyethylene and PP bailers are also acceptable. Other wide mouth vessels may be used for sampling non-aqueous phase liquid in an excavation.
 3. Monitoring Well
 - A. If a non-aqueous phase liquid is identified in a monitoring well during the water level measurement, measure its thickness in the well. If the thickness of the non-aqueous phase liquid is greater than 0.01 foot, or if product globules are present, collect a sample using a precleaned, disposable bailer.
 - B. Measure the product thickness to the nearest 0.01 foot after withdrawing the bailer.
 - C. Pour a portion of the product into a glass sample container.

- D. This sample is considered a concentrated waste. Therefore, package the container in protective wrapping to prevent breakage, isolate it from other samples, and ice to 4° C.
- 4. Equipment that is dedicated to sampling non-aqueous phase liquid does not need to be cleaned according to the standard, full decontamination protocols. Acrylic or PVC bailers that are never used for trace contaminant sampling may be cleaned as listed below. It is recommended that all cleaning be done in the lab, office or base of operations and not in the field.
 - A. Disassemble bailers and intermediate vessels and soak in hot, sudsy tap water using a brush to clean away all particulates and greasy films.
 - B. Rinse with hot tap water.
 - C. Thoroughly rinse with analyte free water.
 - D. An optional acid rinse may be used to strip the equipment of any hard to clean residues.
 - E. The solvent rinse is not mandatory since this equipment is not used for contaminant sampling, other than the product itself. It is not recommended on clear acrylic.
- b) Sampling Below Product
 - 1. This type of depth-specific sampling is an attempt to sample the dissolved constituents in the water column below the product layer. This sampling is performed only at the request of the UST Section.
 - 2. These data provide information that helps define adequate groundwater treatment. Without these data, incorrect and sometimes unnecessarily expensive remediation techniques may be designed for a situation where they are not required.
 - 3. There are some substantial logistical problems involved with sending a sampler through non-aqueous phase liquid to sample the groundwater below. Although there are some products designed specifically for this type of sampling, they are expensive and the results may not be commensurate with their cost. The use of “self-engineered” equipment or coverings may be the best option.
 - 4. These data are only to be used for qualitative use and will aid in deciding on an appropriate remediation technique.
 - 5. Wrapping bailers and tubing in plastic seems to be the most popular technique in getting past the product layer.
 - 6. Although not recommended, some have wrapped submersible pumps in several layers of plastic and retrieved each layer by a separate lanyard. One suggestion would be to use a rigid piece of stainless steel tubing wrapped in plastic.
 - A. Once the covered tubing is past the layer, pull up on the plastic, piercing the plastic and exposing the (somewhat) clean tubing inlet.
 - B. Introduce the wrapped hose slowly so as not to introduce any more product into the dissolved layer located below.
 - C. Perform this procedure with a peristaltic pump or a vacuum pump linked to a trap bottle. To use this setup, the water table must be no deeper than 15-20 feet. Be aware that actual sampling may occur several feet below the product layer.

G. Sampling Low Permeability Aquifers or Wells that have Purged Dry

1. Collect the sample(s) after the well has been purged. Minimize the amount of water removed from the well by using the same pump to purge and collect the sample. If the well has purged dry, collect samples as soon as sufficient sample water is available.
2. Measure the five field parameters temperature, pH, specific conductance, dissolved oxygen and turbidity at the time of sample collection.
3. Advise the analytical laboratory and the client that the usual amount of sample for analysis may not be available.

Appendix G Collecting Samples from Wells with Plumbing in Place

In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply. They are generally found at wellfields, industrial facilities and private residences.

1. Air Strippers or Remedial Systems - These types of systems are installed as remediation devices. Collect influent and effluent samples from air stripping units as described below.
 - a) Remove any tubing from the sampling port and flush for one to two minutes.
 - b) Remove all hoses, aerators and filters (if possible).
 - c) Open the spigot and purge sufficient volume to flush the spigot and lines and until the purging completion criteria have been met.
 - d) Reduce the flow rate to approximately 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples.
 - e) Follow procedures for collecting samples from water supply wells as outlined below.
2. Water Supply Wells - Water supply wells with in-place plumbing do not require equipment to be brought to the well to purge and sample. Water supply wells at UST facilities must be sampled for volatile organic compounds (VOCs) and semivolatile compounds (SVOCs). If a waste oil tank is present, the well should also be sampled for lead and chromium. See 15A NCAC 2N .0304 for monitoring requirements associated with enhanced leak detection. Water supply wells may also be sampled if there is suspicion of a release from a UST facility.
 - a) Procedures for Sampling Water Supply Wells
 1. Label sample containers prior to sample collection.
 2. Prepare the storage and transport containers (ice chest, etc.) before taking any samples so that each collected sample can be placed in a chilled environment immediately after collection.
 3. Selecting the Sampling Location
 - A. You must choose the tap closest to the well, preferably at the wellhead. The tap must be before any holding or pressurization tank, water softener, ion exchange, disinfection process or before the water line enters the residence, office or building. If no tap fits the above conditions, a new tap that does must be installed.
 - B. The well pump must not be lubricated with oil, as that may contaminate the samples.
 - C. The sampling tap must be protected from exterior contamination associated with being too close to a sink bottom or to the ground. If the tap is too close to the ground for direct collection into the appropriate container, it is acceptable to use a smaller (clean) container to transfer the sample to a larger container.
 - D. Leaking taps that allow water to discharge from around the valve stem handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.
 4. Disconnect any hoses, filters, or aerators attached to the tap before sampling.
 5. Do not sample from a tap close to a gas pump. The gas fumes could contaminate the sample.

b) Collecting Volatile Organic Samples

1. Equipment Needed

- A. VOC sample vials [40 milliliters, glass, may contain 3 to 4 drops of hydrochloric acid (HCl) as preservative]
- B. Disposable gloves and protective goggles
- C. Ice chest/cooler
- D. Ice
- E. Packing materials (sealable plastic bags, bubble wrap, etc.)
- F. Lab forms

2. Sampling Procedure

- A. Run the water from your well for at least 15 minutes. If you have a deep well you will need to run the water for longer (purging three well volumes is best). If your tap or spigot is located directly before a holding tank, it is a good idea to open a tap after the holding tank to prevent any backflow into the tap where you will take your sample. This will ensure that the water you collect is water “fresh” from the well and not from the holding tank.
- B. After running the water for at least 15 minutes, reduce the flow of water. The flow should be reduced to a trickle but not so slow that it begins to drip. A smooth flow of water will make collecting the samples easier and more accurate.
- C. Remove the cap of a VOC vial and hold the vial under the stream of water to fill it. Be careful not to spill any acid that is in the vial.
- D. For best results use a low flow of water and angle the vial slightly so that the water runs down the inside of the vial (see Figure 1 below). This will help keep the sample from being agitated, aerated or splashed out of the vial. It will also increase the accuracy of the sample. As the vial fills and is almost full, turn the vial until it is straight up and down so the water won't spill out.
- E. Fill the vial until the water is just about to spill over the lip of the vial. The surface of the water sample should become mounded. (see Figure 2 below) It is a good idea not to overfill the vial, especially if an acid preservative is present in the vial.

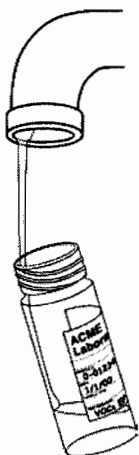


Figure 1



Figure 2



Figure 3

Appendix G
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- F. Carefully replace and screw the cap onto the vial. Some water may overflow as the cap is put on.
 - G. After the cap is secure, turn the vial upside down and gently tap the vial to see if any bubbles are present. If bubbles are present in the vial, remove the cap, add more water and check again to see if bubbles are present (see E above). Repeat as necessary.
 - H. After two samples without bubbles have been collected, the samples should be labeled and prepared for shipment. The sample will need to be kept at a temperature of 4° C.
- c) Collecting Extractable Organic and/or Metals Samples
- 1. Equipment Needed
 - A. SVOC sample bottle [1 liter, amber glass] and/or Metals sample bottle [0.5 liter, polyethylene or glass, 5 milliliters of nitric acid (HNO₃) preservative]
 - B. Disposable gloves and protective goggles
 - C. Ice Chest/Cooler
 - D. Ice
 - E. Packing materials (sealable plastic bags, bubble wrap, etc.)
 - F. Lab forms
 - 2. Sampling Procedure
 - A. Run the water from your well for at least 15 minutes. If you have a deep well you will need to run the water for longer (purging three well volumes is best). If your tap or spigot is located directly before a holding tank it is a good idea to leave a tap after the holding tank running to prevent any backflow into the tap where you will take your sample. This will ensure that the water you collect is water “fresh” from the well and not from the holding tank.
 - B. After running the water for at least 15 minutes, reduce the flow of water. A low flow of water will make collecting the samples easier and more accurate.
 - C. Remove the cap of a SVOC or metals bottle and hold it under the stream of water to fill it.
 - D. The bottle does not have to be completely filled (i.e., you can leave an inch or so of headspace in the bottle).
 - E. After filling, screw on the cap, label the bottle and prepare for shipment. The sample will need to be kept at a temperature of 4° C.

Appendix H Collecting Surface Water Samples

The following topics include acceptable equipment selection and equipment construction materials; and standard grab, depth-specific and depth-composited surface water sampling techniques.

1. General Cautions - When using watercraft, take samples near the bow, away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction. When wading, collect samples upstream from the body. Avoid disturbing sediments in the immediate area of sample collection. Collect water samples prior to taking sediment samples when obtaining both from the same area (site). Unless dictated by permit, program or order, sampling at or near man-made structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns. Collect surface water samples from downstream towards upstream.

2. Equipment and Supplies - Use sampling equipment constructed of materials consistent with the analytes of interest. Refer to Tables 12 and 13 for material selection. Select equipment based on the analytes of interest, the specific equipment use and the available equipment. Refer to Table 15 for selection of appropriate equipment. For information on sample containers, preservation and holding time requirements, see Table 11. For information on sampling equipment cleaning requirements, see Appendix C. Sampling events will most frequently employ the suction lift sample gathering system.

A. Surface Water Sampling Techniques - Use the following protocols when collecting surface water samples. Adhere to all general protocols applicable to aqueous sampling when following the surface water sampling procedures addressed below.

1. Manual Sampling: Use manual sampling for collecting grab samples for immediate in-situ field analyses. Use manual sampling in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to observe and/or note unusual conditions.

a) Surface Grab Samples - Do not use sample containers containing premeasured amounts of preservatives to collect grab samples. If the sample matrix is homogeneous, then the grab method is a simple and effective technique for collection purposes. If homogeneity is not apparent, based on flow or vertical variations (and should never be assumed), then use other collection protocols. Where practical, use the actual sample container submitted to the laboratory for collecting samples to be analyzed for oil & grease, volatile organic compounds (VOCs) and microbiological samples. This procedure eliminates the possibility of contaminating the sample with an intermediate collection container. The use of unpreserved sample containers as direct grab samplers is encouraged since the same container can be submitted for laboratory analysis after appropriate preservation. This procedure reduces sample handling and eliminates potential contamination from other sources (e.g., additional sampling equipment, environment, etc.).

1. Grab directly into sample container
2. Slowly submerge the container, opening neck first, into the water.
3. Invert the bottle so the neck is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.
4. Return the filled container quickly to the surface.

5. Pour out a few mL of sample away from and downstream of the sampling location. This procedure allows for the addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
 6. Add preservatives, securely cap container, label and complete field notes.
If sample containers are attached to a pole via a clamp, submerge the container and follow steps 3 – 5 but omit steps 1 and 2.
- b) Sampling with an Intermediate Vessel or Container: If the sample cannot be collected directly into the sample container to be submitted to the laboratory, or if the laboratory provides prepreserved sample containers, use an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be constructed appropriately, including any poles or extension arms used to access the sample location.
1. Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample.
 2. Collect the sample as outlined above using the intermediate vessel.
 3. Use pole mounted containers of appropriate construction to sample at distances away from shore, boat, etc. Follow the protocols above to collect samples.
- c) Peristaltic Pump and Tubing: The most portable pump for this technique is a 12 volt peristaltic pump. Use appropriately precleaned, silastic tubing in the pump head and attach polyethylene, Tygon, etc. tubing to the pump (see restrictions listed in Tables 12 and 13). This technique is not acceptable for Oil and Grease, EPH, VPH or VOCs. Extractable organics can be collected through the pump if flexible interior-wall Teflon, polyethylene or PP tubing is used in the pump head or if used with the organic trap setup as shown in Figure 4.
1. Lower appropriately precleaned tubing to a depth of 6 – 12 inches below water surface, where possible.
 2. Pump 3 – 5 tube volumes through the system to acclimate the tubing before collecting the first sample.
 3. Fill individual sample bottles via the discharge tubing. Be careful not to remove the inlet tubing from the water.
 4. Add preservatives, securely cap container, label and complete field notes.
- d) Mid-Depth Grab Samples: Mid-depth samples or samples taken at a specific depth can approximate the conditions throughout the entire water column. The equipment that may be used for this type of sampling consists of the following depth-specific sampling devices: Kemmerer, Niskin, Van Dorn type, etc. You may also use pumps with tubing or double check-valve bailers. Certain construction material details may preclude its use for certain analytes (see Tables 12 and 13). Many Kemmerer samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Some newer devices are constructed of stainless steel or are all Teflon or Teflon-coated. These are acceptable for all analyte groups without restriction.
1. Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.
 2. Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.

3. Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.
 4. At the desired depth, send the messenger weight down to trip the closure mechanism.
 5. Retrieve the sampler slowly.
 6. Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.
 7. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described in section A above.
- e) Double Check-Valve Bailers: Collect samples using double check-valve bailers if the data requirements do not necessitate a sample from a strictly discrete interval of the water column. Bailers with an upper and lower check-valve can be lowered through the water column. Water will continually be displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. Sampling with this type of bailer must follow the same protocols outlined above, except that a messenger weight is not applicable. Although not designed specifically for this kind of sampling, a bailer is acceptable when a mid-depth sample is required. This sampler does not perform as well as the devices described above or the pump and tubing described in the next section.
1. As the bailer is dropped through the water column, water is displaced through the body of the bailer. The degree of displacement depends upon the check-valve ball movement to allow water to flow freely through the bailer body.
 2. Slowly lower the bailer to the appropriate depth. Upon retrieval, the two check-valves seat, preventing water from escaping or entering the bailer.
 3. Rinse the sampling device with ample amounts of site water prior to collecting the first sample.
 4. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described above.
- f) Peristaltic Pump and Tubing: The most portable pump for this technique is a 12 volt peristaltic pump. Use appropriately precleaned, silastic tubing in the pump head and attach HDPE, Tygon, etc. tubing to the pump (see restrictions listed in Tables 12 and 13). This technique is not acceptable for Oil and Grease, EPH, VPH or VOCs. Extractable organics can be collected through the pump if flexible interior-wall Teflon, polyethylene or PP tubing is used in the pump head, or if used with an organic trap setup.
1. Measure the water column to determine the maximum depth and the sampling depth.
 2. Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do not use a lead weight. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament nylon, etc.) so that it is located below the inlet of the tubing.
 3. Turn the pump on and allow several tubing volumes of water to be discharged before collecting the first sample.
 4. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described above.

Appendix I Collecting Air Samples

The following topics include acceptable equipment selection and equipment construction materials, and standard grab sampling techniques for the collection of air samples from vapor extraction units by the EPA Method 18 Bag Procedure. Analysis includes benzene, toluene, ethylbenzene, xylene and total petroleum hydrocarbons as isooctane. Other EPA approved comparable methods, which have similar costs, the same constituents, and equivalent or lower detection limits, may be used.

1. General Cautions - When preparing to collect air samples, determine whether the sampling site is in a potentially explosive atmosphere. Follow all guidelines in the health and safety plan for the test. Use appropriate safety equipment as required by conditions at the sampling site.
2. Equipment and Supplies - Use sampling equipment constructed of materials consistent with the analytes of interest. Refer to Tables 12 and 13 for material selection. Select equipment based on the analytes of interest, the specific equipment use and the available equipment. For information on sampling equipment cleaning requirements, see Appendix C. Sampling events will most frequently employ the Tedlar bag sampling system.
3. Air Sampling Techniques - Use the following protocols when collecting air samples. Adhere to all general protocols applicable to air sampling when following the sampling procedures addressed below. Alternate sampling procedures may be considered an adequate alternative to the Tedlar bag sample collection, if the recovery study for the alternate sample collection procedure meets the recovery criteria of between 70 and 130 percent recovery for all target compounds listed above.

A. Grab Sampling with Tedlar bags

1. With the flexible bag collection technique, the bags are filled by evacuating the rigid air-tight container holding the bags in a direct interface system. Collect triplicate samples from each sample location.
 - a) Assemble the sample train as required in EPA Method 18 (see Figure 6 p. 45).
 - b) Leak-check both the bag and the container.
 - c) Connect the vacuum line from the needle valve to the Teflon sample line from the probe.
 - d) Place the end of the probe in the sample collection port, and start the pump.
 - e) Set the flow rate so that the final volume of the sample is approximately 80 percent of the bag capacity.
 - f) After allowing sufficient time to purge the line several times, connect the vacuum line to the bag, and evacuate until the rotameter indicates no flow.
 - g) Position the sample and vacuum lines for sampling and begin the actual sampling.
 - h) At the end of the sample period, shut off the pump, disconnect the sample line from the bag, and disconnect the vacuum line from the bag container.
 - i) Record the source temperature, sampling flow rate, and initial and final sampling time.
 - j) Protect the Tedlar bags and containers from sunlight.
2. Other Modified Bag Sampling Procedures - Sampling with an alternative method may be necessary if condensation is observed in the bag while collecting the sample. See EPA Method 18 for additional details.

- a) Heated sample collection requires the box that contains the sample bag to be heated to 120° C ($\pm$ 5° C), followed by transport to the laboratory while maintaining the heating or by insulating the box.
 - b) Sample collection in Tedlar bags prefilled with a known quantity of inert gas.
3. Adsorption Tube Procedure. This sampling procedure must be justified and shown to be an adequate alternative to grab sampling with Tedlar bags. Any commercially available adsorbent is allowed for the purposes of EPA Method 18 sample collection as long as the recovery criteria of between 70 and 130 percent recovery for all target compounds are met. Reimbursement by the State Trust Fund will be no greater than the maximum amount allowed for air sampling with the EPA Method 18 bag procedure included in the price list of the Reasonable Rates Document. However, solid adsorbent tubes have some limitations in that most analytical instruments. GC and GCMS with volatile organic concentrators have limited dynamic ranges (approximately 1-200 ppb for ambient air). If the sample is not in this range, and you have used the entire sample tube for the first analysis, the option of taking a portion of the sample or diluting the sample is not available. High level samples can cause the systems to become contaminated.
4. Summa Canister Procedure. This sampling procedure must be justified and shown to be an adequate alternative to grab sampling with Tedlar bags. Any commercially available precleaned summa canister is allowed for the purposes of EPA Method 18 sample collection as long as the recovery criteria of between 70 and 130 percent recovery for all target compounds are met. Reimbursement by the State Trust Fund will be no greater than the maximum amount allowed for air sampling with the EPA Method 18 bag procedure included in the price list of the Reasonable Rates Document. When collected in canisters, samples can be screened for high levels prior to low level analysis.

APPENDIX E
EXAMPLE PERIODIC MONITORING REPORT

SECTION 1.0
OF THE
PERIODIC MONITORING REPORT
MCB CAMP LEJEUNE UST MANAGEMENT PROGRAM
FOR UST SITES

MONITORING EVENT:

SECOND SEMESTER 2004
(JULY 2004 THROUGH DECEMBER 2004)

SITE-SPECIFIC MONITORING REPORT
FOR

SITE AS-840

NCDENR INCIDENT NO. Pending

1.0 EXECUTIVE SUMMARY

SITE AS-840

1.1 Site Information

- 1.1.1 Site Location:** MCB Camp Lejeune (MCAS New River)
- 1.1.2 Incident Number(s):** Pending
- 1.1.3 UTM Coordinates (WGS84, Meters):** Easting = 277124, Northing = 3843490
- 1.1.4 Risk Classification:** Pending. However, due to the presence of free-phase product an Intermediate Risk Classification is most likely applicable.
- 1.1.5 Land Use Classification:** Industrial/Commercial
- 1.1.6 Source Type(s):** Diesel and Gasoline

1.2 Monitoring Event Information

- 1.2.1 Sampling Performed By:** CATLIN
- 1.2.2 Date(s) of This Monitoring Event:** 10/09/03 and 10/23/03
- 1.2.3 Date(s) of Previous Monitoring Event:** 06/22/01

1.2.4 Reason(s) for This Monitoring Event:

Track migration and attenuation of dissolved-phase plume.
Track migration and/or volume reduction of free product plume.

1.2.5 Site Monitoring Status at Time of This Event:

Interim and product recovery monitoring.

1.3 Groundwater Hydraulics

- 1.3.1 Hydraulic Conductivity:** 30 feet/day
- 1.3.2 Effective Porosity:** 0.40
- 1.3.3 Hydraulic Gradient:** 0.0047 feet/feet
- 1.3.4 Average Linear Groundwater Flow Velocity:** 0.353 feet/day
- 1.3.5 Groundwater Flow Direction:** Northeast towards the New River (See Figure 1.1)
- 1.3.6 Range of Measured Water Table Elevations:** See Table 1.1
- 1.3.7 Significant Changes from Previously Reported Data:** None.

1.4 Free Product Plume

1.4.1 Free Product Present?: Yes

1.4.2 Free Product Thickness Measured: See Table 1.1

1.4.3 Plume Size and Location: See Figure 1.1

1.4.4 Free Product Removed from Site This Period: 11.9 gallons removed during AFVR on 07/23/02

1.4.5 Significant Changes from Previously Reported Data: None. See Charts 1.1

1.5 Dissolved-Phase Plume

1.5.1 Plume Concentrations: See Tables 1.1 and 1.2

1.5.2 Plume Size and Location: See Figures 1.1 and 1.2

1.5.3 Significant Changes from Previously Reported Data: None.

1.6 Remedial System Air Monitoring Data

1.6.1 Contaminant Concentrations: Not Applicable

1.7 Potential Receptors

1.7.1 Contaminated Water Supply Well(s)?: None

1.7.2 Potable Water Supply Well Within 1,000 Feet of Source Area?: No

1.7.3 Any Water Supply Well Within 250 Feet of Source Area?: No

1.7.4 Surface Water Body Within 500 Feet?: No

1.7.5 Past Evidence of Vapors?: No

1.7.6 Significant Changes from Previously Reported Data?: None

1.8 Remediation

1.8.1 Status: AFVRs have been conducted historically

1.8.2 Type: AFVR

1.8.3 Progress: Ongoing

1.8.4 Construction Contractor: Not Applicable

1.8.5 Operating Contractor: Shaw

1.9 Observations and Comments

A Corrective Action Plan (CAP) is being developed for this site to evaluate remediation alternatives.



CAMP LEJEUNE
PERIODIC MONITORING
REORT



LEGEND

- Well by Type
- Potable Well
 - Industrial Well
 - Product Recovery Wells
 - ⊕ Surface Water
 - ⊙ T-I
 - ⊕ T-II
 - ⊙ T-III
 - ⊗ Unknown
 - No Measurable Product
 - Product Detected
 - Small Tributaries
 - ▬ Rivers and Creeks
 - ▬ Treeline
 - ▭ Building
 - ▨ Free Product Plume
 - ↑ Groundwater Flow

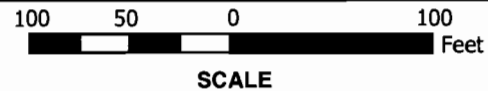
NOTES



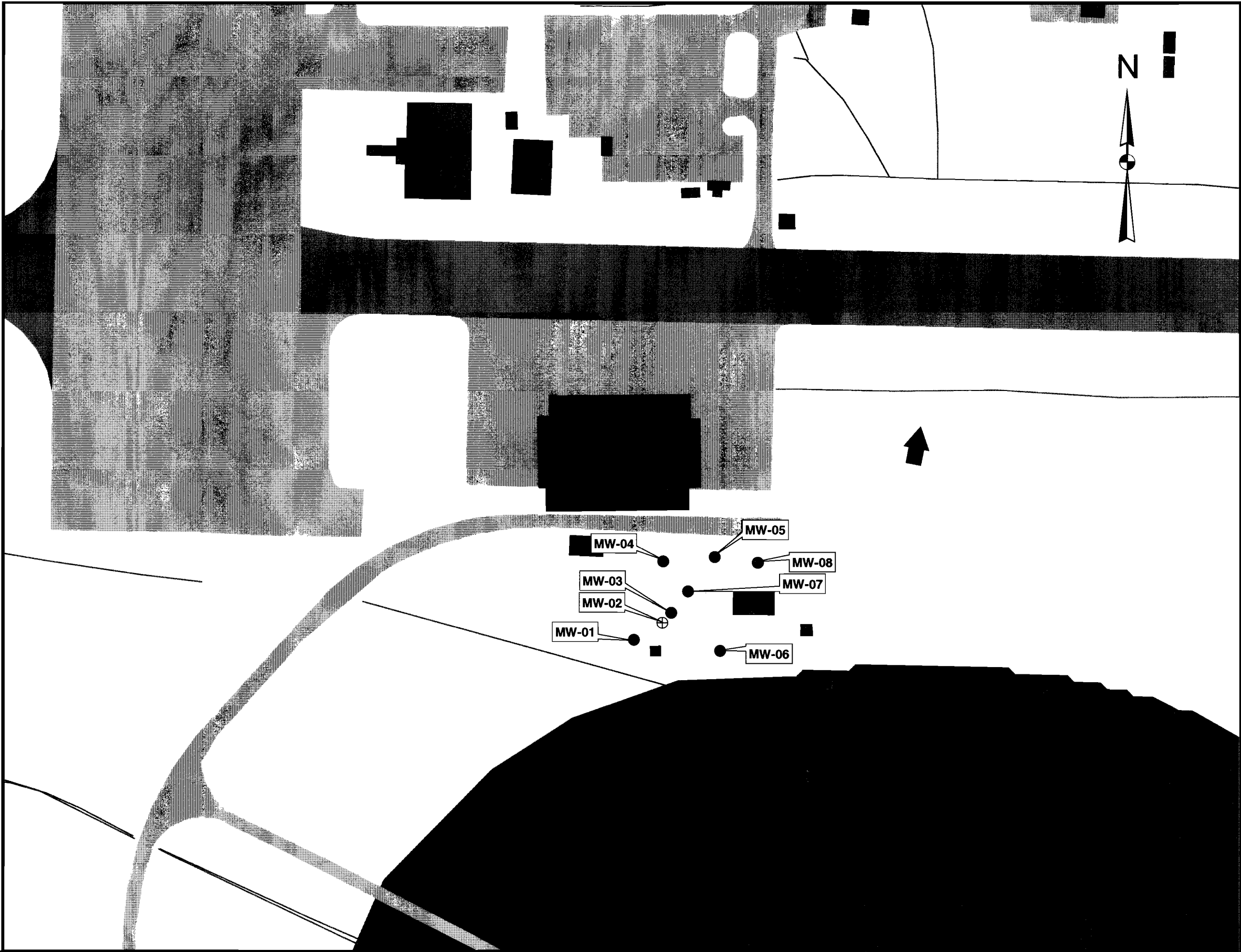
SITE AS-840
FREE PRODUCT MAP
(Sample Map Only)

FIGURE
1.1

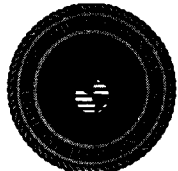
Well Number	Date	Product Thickness (ft.)
MW-02	10/23/2003	0.48



Job No.: 204-080	Date: NOV 2004	Scale: AS SHOWN	Drawn By: THW	Checked By: MEM
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CAMP LEJEUNE PERIODIC MONITORING REORT



LEGEND

- Well by Type**
- Potable Well
 - Industrial Well
 - Product Recovery Wells
 - ⊕ Surface Water
 - T-I
 - ⊕ T-II
 - ⊙ T-III
 - ⊠ Unknown
- MADEP VPH/EPH Compliant
 - MADEP VPH/EPH Non-Compliant
 - Small Tributaries
 - Rivers and Creeks
 - Treeline
 - Building
 - MADEP VPH/EPH Plume
 - ↑ Groundwater Flow

NOTES

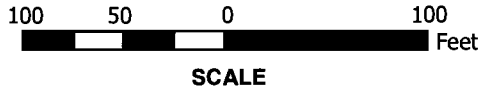


SITE AS-840
MADEP VPH/EPH COLORIMETRY AND
PLUME IN EXCESS OF INTERIM STANDARD
(Sample Map Only)

FIGURE

1.2

Sample ID	Date	Method	Parameter	Results	Units	Interim Standard
MW-07	10/9/2003	MADEP	C9-C22 Aromatics	3,100	ug/L	210



Job No.: 204-080	Date: NOV 2004	Scale: AS SHOWN	Drawn By: THW	Checked By: MEM
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TABLE 1.1

MONITORING WELL CONSTRUCTION AND WATER LEVEL GAUGING DATA

Date: Oct-03

Incident Number and Name: Pending - AS-840

Facility ID#: N/A

Well ID	Well Type	Date Installed (m/dd/yy)	Date Water Level Measured (m/dd/yy)	Top of Casing Elevation (ft.)	Depth to Water from Top of Casing (ft.)	Free Product Thickness** (ft.)	Ground Water Elevation* (ft.)	Comments
MW-01	T-II	06/19/01	10/23/03	13.70	4.20	NMT	9.50	
MW-02	T-II	06/19/01	10/23/03	13.83	5.22	0.48	9.02	
MW-03	T-III	06/20/01	10/23/03	13.97	4.92	NMT	9.05	
MW-04	T-II	06/20/01	10/23/03	14.70	5.75	NMT	8.95	
MW-05	T-II	06/20/01	10/23/03	14.20	5.56	NMT	8.64	
MW-06	T-II	06/20/01	10/23/03	13.84	4.97	NMT	8.87	
MW-07	T-II	10/06/03	10/23/03	14.88	6.04	NMT	8.84	
MW-08	T-II	10/06/03	10/23/03	14.94	6.53	NMT	8.41	

* Reference Point for Elevation Measurements: MCAS geodetic monuments Heinz and Flyboy.

** If free product is present in a well, ground water elevation should be calculated by: [Top of Casing Elevation - Depth to Water] + [free product thickness x 0.8581]

ft BGS = feet below ground surface

NMT = no measurable thickness

TABLE 1.2 SUMMARY OF GROUNDWATER LABORATORY RESULTS

Date: October 2003

Incident Number and Name: Pending - AS-840

Facility ID#: N/A

Analytical Method: MADEP VPH/EPH AS COMPARED TO NCDENR IGWQS

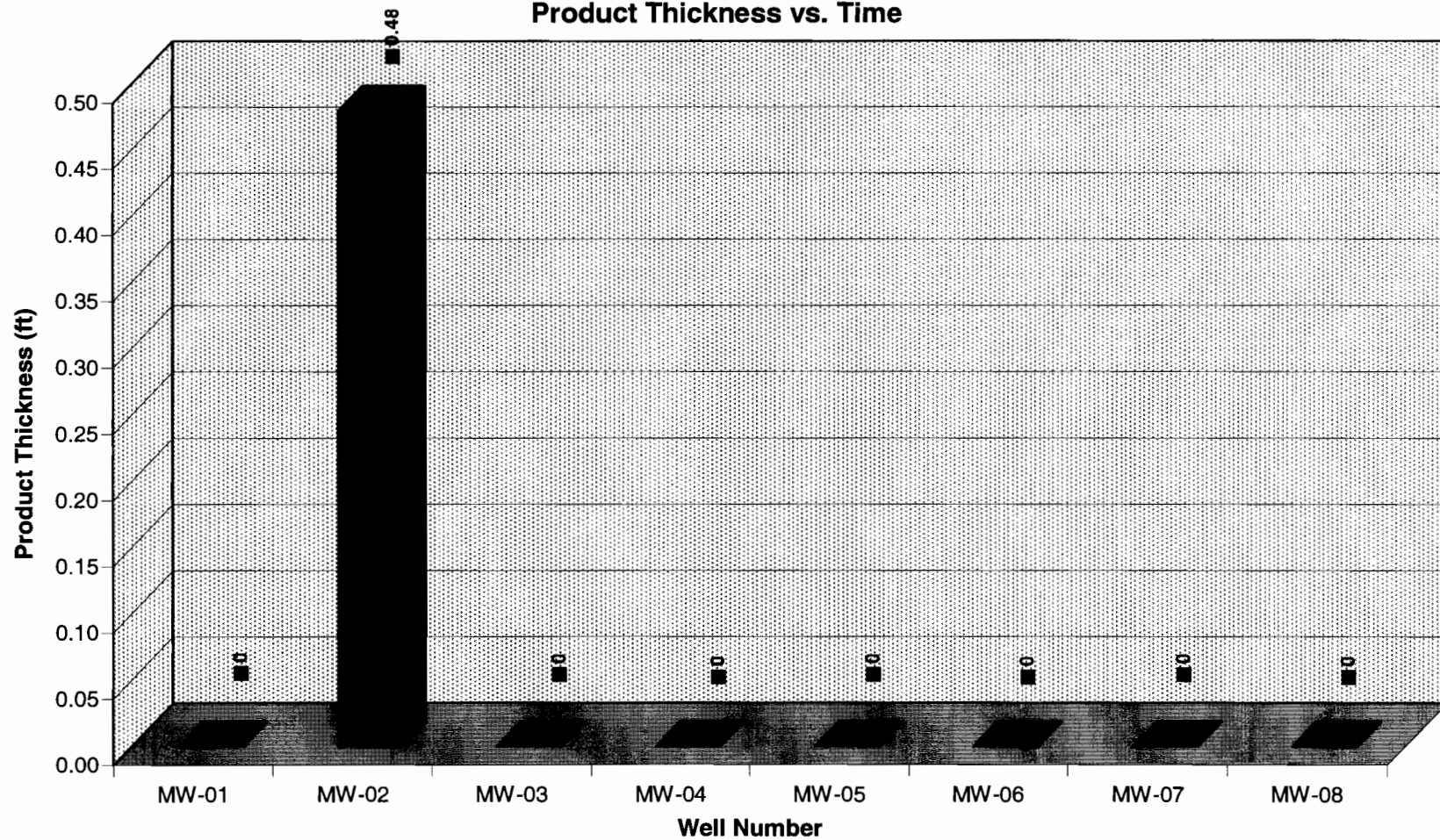
Well ID	Contaminant of Concern →		C5-C8 Aliphatics	C9-C18 Aliphatics	C19-C36 Aliphatics	C9-C22 Aromatics
	Sample ID	Date Collected				
IGWQS(µg/L)			420	4,200	42,000	210
MW-01	MW-01	6/22/2001	<100	<200	<100	<200
MW-03	MW-03	6/22/2001	<100	<200	<100	<200
MW-04	MW-04	6/22/2001	100	330	120	<300*
MW-05	MW-05	6/22/2001	<100	<200	<100	<200
MW-06	MW-06	6/22/2001	<100	<200	<100	<200
MW-07	MW-07	10/9/2003	<100	970	280	<3,100*
MW-08	MW-08	10/9/2003	<100	<200	<100	<200

All results in µg/L.

* = Result equals the sum of the C11-C22 fraction result and the C9-C10 fraction quantitation limit (<100 µg/L).

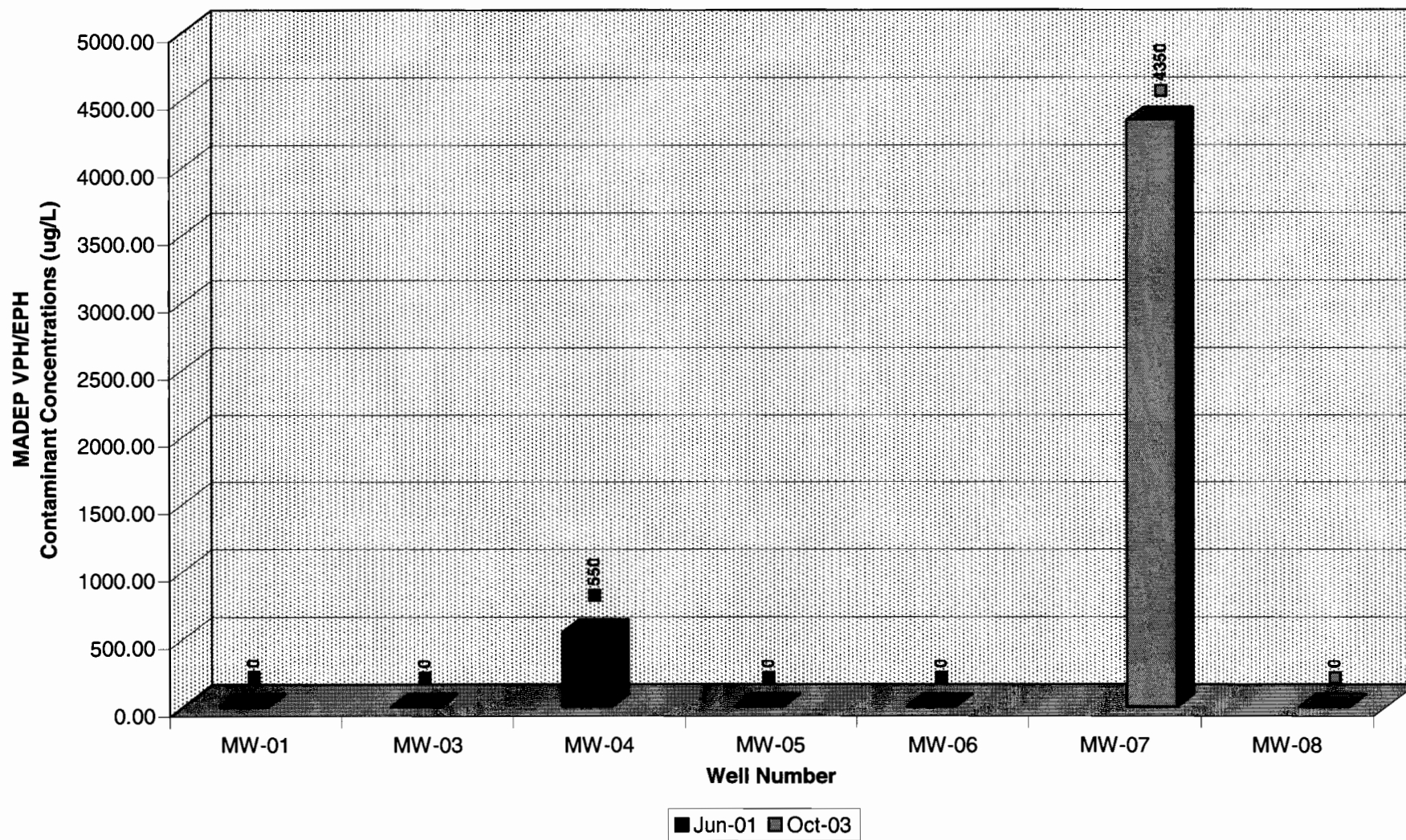
Bold result indicates concentration is greater than the IGWQS.

CHART 1.1
SITE AS-840
Product Thickness vs. Time



■ Oct-03

CHART 1.2
Site AS-840
MADEP VPH/EPH Concentrations vs. Time



APPENDIX F

EXAMPLE MANAGEMENT RECOMMENDATIONS REPORT

SECTION 1.0

Of The

MANAGEMENT RECOMMENDATIONS REPORT

MCB CAMP LEJEUNE UST MANAGEMENT PROGRAM

SECOND SEMESTER 2004
(JULY 2004 – DECEMBER 2004)

SITE-SPECIFIC MANAGEMENT RECOMMENDATIONS REPORT
FOR

SITE AS-840

1.0 SITE AS-840

1.1 Site Information

Location:	MCB Camp Lejeune (MCAS New River), North Carolina
Incident No.:	Pending
Estimated Risk Classification:	Pending – Estimated Intermediate due to presence of Free Product
Land Use Classification:	Industrial/Commercial
Source Type(s):	Diesel Fuel and Gasoline
Free Product:	Yes

1.2 Monitoring Schedule for this Event

Well gauging and sampling completed by CATLIN in October 2003.

1.3 Recommended Monitoring Schedule Modifications

The recommended monitoring schedule for the Second Semester 2004 event is provided in APPENDIX A of this document. The next monitoring event is scheduled to occur between December 1, 2004 and December 15, 2004. The monitoring contractor for the next event will be Shaw.

Modifications to the schedule include:

- Add monitoring wells to the gauging and sampling schedule for plume geometry.

1.4 Site Remediation Method

Historically AFVR events have been performed to remove free-phase product. The long term remediation method is currently being evaluated as part of preparation of the Corrective Action Plan (CAP).

1.5 Recommended Remediation Modifications

A CAP is currently being developed for the subject site.

1.6 Recommended Steps Toward Site Closure

1.6.1 Elimination of Secondary Sources

An excavation is planned to remediate contaminated soil and remove free-phase product.

1.6.2 Groundwater Remediation

It is recommended that groundwater contaminant concentrations be reduced to below the Groundwater Quality Standards. The CAP will evaluate the benefits of using in-situ chemical treatment methods to accelerate natural attenuation.