GUIDELINES FOR

THE INVESTIGATION AND REMEDIATION OF

SOIL AND GROUNDWATER CONTAMINATION IN BERMUDA

RISK BASED CORRECTIVE ACTION (RBCA) GUIDELINES

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

MINISTRY OF HEALTH, SENIORS & ENVIRONMENT

GOVERNMENT OF BERMUDA

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TABLE OF CONTENTS

Page

Forward **4**

1. Purpose and Application of the Guidelines **5**

2. Definitions (as used in these guidelines) **6**

3. Acronyms (as used in these guidelines) **8**

4. Regulatory Requirements **10**
- 4.1 Applicability 10
- 4.2 Initial Site Actions 10
  - Soil Contamination Report 11
  - Limited Site Assessment Report (LSA) 11
- 4.3 Site Priority Ranking 11
- 4.4 Land Use Classification 13
- 4.5 Site Characterization and Cleanup 13
- 4.6 Reporting Requirements for Assessment and Remediation of Contamination 14
- 4.7 Other Requirements 16

5. Underground Storage Tank Closure Guidelines **17**
- 5.1 General UST Closure Information 17
- 5.2 Procedures for Excavating Soil During UST Removal 17
- 5.3 Backfilling Excavations and Reuse of Excavated Soil 18
- 5.4 UST Closure Sampling 18
- 5.5 Submitting Reports 20

6. Site Assessment **21**
- 6.1 Limited Site Assessment 21
  - Phase I – Receptor Information 21
  - Phase II - Sampling Activities 22
- 6.2 Comprehensive Site Assessment (Tier II) 23

7. Cleanup Requirements for Soil Contaminated with Petroleum Products **25**
- 7.1 Guidelines for Determining Soil Cleanup Levels 25
- 7.2 Soil Cleanup Levels Effective August 1, 1999 25
  - A. Maximum Soil Contaminant Concentrations 25
  - B. Cleanup Requirements 26
  - C. Public Notice 26

8. Soil Sampling Guidelines and Analytical Requirements **35**
- 8.1 Field Screening 35
- 8.2 Sample Preparation 35
- 8.3 Soil Sample Collection Procedures 35
- 8.4 Sampling Stockpiled Soil 41
- 8.5 Analytical Requirements for Disposal of Contaminated Soil 43
- 8.6 Sample Storage and Transport 43
- 8.7 Laboratory Analytical Methods 43
- 8.8 Laboratory Reports 44

9. Cleanup Requirements for Groundwater **45**
- 9.1 Public Notice 45

10. Groundwater Sampling Guidelines **46**
- 10.1 Field Screening 46

10.2 Sample Preparation 46
10.3 Groundwater Sample Collection Procedures....51
A. Water Supply Wells 51
B. Monitoring Wells 52
10.4 General Decontamination Procedures 54
10.5 Sample Storage and Transport 54
10.6 Laboratory Analytical Methods 55
10.7 Laboratory Reports 55

11. Tier II Cleanup Requirements for Soil and Groundwater....57
11.1 Points of Compliance 57
11.2 Engineering and Administrative Controls 57
11.3 Public Notice 58

12. Public Notice 59
12.1 Public Notice Required Prior to Performing Remediation of Groundwater and/or Soil....59
12.2 Public Notice Required After Receiving Notification of Site 60
12.3 Format of Public Notice....61

13. Site Closure 64

Appendix A – Report Format Summary....65
A.1 24-Hour Notice Report to Dept. Environment and natural Resources....66
A.2 Soil Contamination Report (30d)....67
A.3 Limited Site Assessment Report (60d) 70
A.4 UST Closure Report, (UST sites only)....80
A.5 Comprehensive Site Assessment Report (90d) 84
A.6 Remedial Action Plan....92
A.7 Monitoring Reports 99
A.8 Site Closure Report....104

Appendix B – Whole RBCA Process Flow Diagram 109

List of Tables:

Table 1A. Tier 1 Risk Based Screening Levels (RBSL) for Soil for land areas classed as Residential and Industrial/Commercial and also Soil-To-Groundwater levels where soil depth is comparable to water table height....28
Table 1B. Tier 1 Risk Based Screening Levels (RBSL) for Groundwater. 30
Table 2. Analytical fractions to be analysed for petroleum contaminated soils. 32
Table 3. Example: A sample from a gasoline release is analyzed for VPH. 33
Table 4. Example: A sample from a diesel fuel release is analyzed for VPH and EPH. 34
Table 5. Required Analyses for Petroleum-Contaminated Soil for Releases....37
Table 6. Required Analyses for Other (non-petroleum) Soil Contamination 39
Table 7. Container and Preservation Protocol for Soil Analyses 40
Table 8. Required Analyses for Petroleum-Contaminated Groundwater 48
Table 9. Required Analyses for Other (non-Petroleum) Contaminated Groundwater 50
Table 10. Container and Preservation Protocol for Groundwater Analyses....51

Forward

This document is prepared to aid in the decision-making process when conducting investigations and remediation of contaminated sites in Bermuda and is the basis for the Voluntary Cleanup Program. The Voluntary Cleanup Program (VCP) provides a frame work in which a responsible party can remediate a site to an acceptable standard with the oversight of the Ministry of the Environment in the absence of enforcement action. This guidance incorporates the principles of risk-based corrective action (RBCA), which is a consistent decision-making process for the assessment and response to a contaminant release, based on protection of human health and the environment. Guidance on each phase of a response action is included from the initial response actions upon discovery of a spill or release through to the requirements for site closure.

The sections of the document are arranged as follows. Section 1 provides a general outline of the Voluntary Cleanup Program and the risk based corrective action process. Sections 2 and 3 contain definitions of key words and acronyms used throughout this guidance. Section 4 describes the regulatory process including initial site characterisation to assess any imminent risks to public safety or sensitive habitats, establishing land use classifications and initial risk characterisation, and reporting requirements. Since one of the greatest potential sources of contaminant releases is petroleum storage tanks, Section 5 provides guidelines for proper closure of underground storage tank systems. Section 6 describes the more detailed site characterisation required if the initial response action does not abate all the contamination. The Tier I cleanup requirements for contaminated soil and proper sampling and analytical techniques are contained in Section 7 and 8 respectively. Sections 9 and 10 contain the Tier I cleanup requirements for groundwater and proper sampling and analytical techniques for groundwater characterisation and remediation.

The requirements for a Tier II site specific evaluation of the risk to human health posed by residual contamination are given in Section 11. This includes the application of alternative exposure points and measures to limit exposure to contaminants. Section 12 contains information on providing public notice in cases where cleanup is not to the Tier I generic risk based screening level. Section 13 contains the requirements for site closure. Site closure represents the end of the Ministry's regulatory oversight at an impacted site. The appendices to this guidance contain additional useful information on cleanup technologies, report formats, required permits and aquifer testing.

A flow diagram of the whole RBCA process is provided in Appendix B.

This document is intended to serve as regulatory guidance. All inquiries on the policy put forth in this document should be addressed to:

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1. Purpose and Application of the Guidelines

This document provides instructions for those involved in the investigation and remediation of discharges or releases regulated by the Ministry of the Environment. Included is information on the policies (statutes and rules) governing soil and groundwater investigations, along with the actual step-by-step process required to comply with the Ministry's requirements for the remediation of contaminated soil and groundwater.

The guidance covers activities involving all sources of contamination, such as petroleum underground storage tank (UST) systems, non-petroleum USTs, above-ground storage tanks (ASTs), surface spills, and other potential sources of contamination that could affect human health and the environment in Bermuda.

This document contains guidance on methods, procedures and requirements for identifying the source of a discharge or release, determining the nature and extent of contamination, characterising the risk posed to human health and the environment, and performing corrective action to reduce levels of contamination and thereby risk. It also includes information on soil and groundwater remediation technologies and on UST closures (petroleum and non-petroleum).

This guideline establishes the terms of a voluntary clean-up program for the potentially contaminated sites (the "Voluntary Clean-up Program"). The premise of the Voluntary Clean-up Program is that responsible parties will satisfy the requirements of regulatory agencies in performing remediation in a non-enforcement capacity. The Ministry of Environment (the "Ministry") shall be the regulatory body for the implementation of the Voluntary Clean-up Program.

The Ministry is responsible for environmental protection and will work with the responsible parties in their remediation of contaminated areas in a timely manner, by approving appropriate remedial action plans and ensuring the remediation takes place to a level that adequately protects human health and the environment.

These guidelines establish minimum requirements for remediation by establishing a tiered approach to assessing the risk to human health and the environment, and establishing cleanup standards for contaminants. The Tier I Risk Based Screening Levels (RBSL) are generic risk based standards which are protective of human health for specified types of land use (i.e. residential or commercial/industrial). RBSLs have been developed based on direct exposure to contaminants of concern (COCs) on site. Under a Tier II assessment, site specific standards may be developed by the responsible party. Tier II standards assume the receptor is onsite, while taking into account site specific conditions affecting fate and transport of contaminants to the point of exposure. Applying site specific standards typically requires a far greater effort in terms of time and expense during the site characterisation phase of the remediation.

2. Definitions (as used in these guidelines)

Aquifer: a body of rock that is sufficiently permeable to conduct groundwater and to yield economically significant quantities of water to wells.

Bedrock: a general term for describing solid rock that underlies soil or other unconsolidated, superficial material.

Cleanup Level: the concentration of a contaminant at which no further cleanup actions are required based upon the risk of harm posed by the contaminant.

Confining Layer: a layer having very low hydraulic conductivity, in relationship to adjacent stratigraphic units, that restricts the movement of water into and out of an aquifer (i.e., dense unfractured clay).

Confirmed Release: a release for which a laboratory result shows any contaminant level above the Method Detection Limit.

Contaminant: includes any solid, liquid, gas, waste, or a combination of any of them that is foreign to or in excess of the natural constituents of the environment into which it is being introduced and

(i) adversely affects the aesthetic, natural, physical, chemical or biological quality of the environment,

(ii) is or may be injurious to the health or safety of persons, or injurious or damaging to property or to plant or animal life, or

(iii) interferes with or is likely to interfere with the comfort, well-being, livelihood or enjoyment of life by a person.

Discharge: a release

Environment: includes (i) air, land and water, (ii) plant and animal, including human, life, and any feature, part, component, resource or element thereof.

Environmental Engineer: shall mean the Government Environmental Engineer at the Ministry of the Environment.

Ex Situ Soil: refers to 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).

Hazardous Waste: discarded material which, due to its quantity, concentration, or physical or chemical characteristics, may cause, or significantly contribute to, an increase in mortality, irreversible or incapacitating reversible illness, or pose a substantial threat or potential hazard to human health or the environment when improperly treated, stored, transported, disposed, or otherwise managed. US Federal regulations defines 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.

In Situ Soil: soil or fill material that is in the ground and has not been disturbed.

Land Application: the process of remediating contaminated soil by spreading soil over land. Land application may include remediating soil by natural biological methods, enhanced biological methods, or volatilization.

Maximum Soil Contaminant Concentration: the concentration of a soil contaminant at which no further cleanup actions are required based upon the risk of harm posed by the contaminant.

Method Detection Limit: the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

Ministry: refers to the Ministry of the Environment.

Petroleum Underground Storage Tank System: means an underground storage tank system that contains petroleum or a mixture of petroleum with *de minimis* quantities of other regulated substances. Such systems include those containing motor fuels, jet fuels, distillate fuel oils, residual fuel oils, lubricants, petroleum solvents and used oils.

Petroleum or Petroleum Product: crude oil or any fraction thereof which is liquid at standard conditions of temperature (60 degrees Fahrenheit) and pressure (14.7 pounds per square inch absolute) but excluding substances defined as a hazardous substance.

Public Water: all waters of Bermuda as defined in the Water Resources Act 1975, Title 20 Item 14 Part 1.1, including sea water.

Receptor: any human, plant or animal that is or has the potential to be adversely affected by the release or migration of contaminants.

Regulated Substance: any substance which in defined as a Hazardous substance, or petroleum distillate, or controlled chemical under the Schedule to the Clean Air Regulations.

Release: any spilling, leaking, emitting, discharging, escaping, leaching or disposing of a substance into public water (including groundwater, surface water and sea water), soil, or bedrock.

Responsible Party: the owner and/or operator of the property and/or device from which a release has occurred, and any other person determined by the Ministry to be responsible for cleaning up contamination.

Rock Structures: the three-dimensional features of a geologic mass such as bedding, jointing, banding, cleavage, faulting or brecciation. The term may also apply to the sum of these features.

Rock Texture: the geometric arrangement of the rock's components and crystals, such as crystallinity, grain size, grain shape and the external and internal arrangement of the rock constituents.

Sedimentary Structure: a description of a geologic structure in a sedimentary formation, formed at the time of deposition or by sedimentary processes subsequent to deposition.

Soil: a general term for the unconsolidated geologic material and limestone in the unsaturated zone above the water table.

Total Petroleum Hydrocarbons (TPH): the concentration of petroleum fuel contamination present in soil as measured by the California Gas Chromatograph method.

Transmissivity: the ability of geologic material to transmit water.

Underground Storage Tank (UST) System: any one or combination of tanks, including underground pipes connected thereto, that is used to contain an accumulation of regulated substances, and the volume of which (including the volume of underground pipes connected thereto) is 10 percent or more beneath the surface of the ground.

Waste Oil: any used non-hazardous petroleum product. Crankcase oil is considered to contain non-hazardous petroleum product and therefore is considered waste oil unless otherwise demonstrated.

Zone of Contamination: the volume of soil or groundwater having contaminant concentrations in excess of regulatory levels, or which may pose a threat to the environment or human health.

3. Acronyms (as used in these guidelines)

AFVR Aggressive Fluid-Vapor Recovery
AS Air Sparging
ASPT Air Sparging Pilot Test
ASSVE Air Sparging with Soil Vapor Extraction
AST Aboveground Storage Tank
RAP Remedial Action Plan
COC Chain-of-Custody
CSA Comprehensive Site Assessment
DENR Department of Environment and Natural Resources
DEP Previous Department name – Dept of Environmental Protection
DPE Dual-phase Extraction
DPEPT Dual-phase Extraction Pilot Test
EDB Ethylene Dibromide (1,2 Dibromoethane)
EPA The United States Environmental Protection Agency
EPH Extractable Petroleum Hydrocarbons
GC and GC/MS Gas Chromatography and Gas Chromatography/Mass Spectrometry
HCl Hydrochloric Acid
HNO3 Nitric Acid
IPE Isopropyl Ether
LSA Limited Site Assessment
LUST Leaking Underground Storage Tank
MADEP Massachusetts Department of Environmental Protection
MDL Method Detection Limit
MTBE Methyl Tertiary Butyl Ether
NORR Notice of Regulatory Requirements
NOV Notice of Violation
P.E. Professional Engineer
POTW Publicly Owned Treatment Works
PTDPE Pump and Treat with Dual-phase Extraction
PTR Pump and Treat with Re-injection
PTSVE Pump and Treat with Soil Vapor Extraction
QA/QC Quality Assurance/Quality Control
RBSL Risk Based Screening Level
RNA Remediation by Natural Attenuation
SAPT Stand-alone Pump and Treat
SCS Soil Conservation Service
SHWT Seasonal High Water Table
SSE Site Sensitivity Evaluation
SVE Soil Vapor Extraction
SVEPT Soil Vapor Extraction Pilot Test
SVOC Semi-volatile Organic Compounds
TCLP Toxicity Characteristic Leaching Procedure, EPA Method SW-846 1311
TOC Total Organic Carbon
TPH Total Petroleum Hydrocarbons (sometimes referenced as TPFH - “F” for fuels)
UST Underground Storage Tank
VOA Volatile Organic Analysis
VOC Volatile Organic Compounds
VPH Volatile Petroleum Hydrocarbons

WMS Waste Management Section of the Ministry of Works and Engineering

4. Regulatory Requirements

4.1 Applicability

Contamination incidents discussed in these guidelines include discharges or releases from any sources. This includes all contamination, both petroleum and non-petroleum, from UST sources, ASTs and surface spills. Activities related to these contamination incidents are governed by the Water Resources Act and the Clean Air Act. Persons who shall comply with these guidelines include owners and operators of USTs and ASTs for petroleum and other chemical storage, and anyone who is responsible for a discharge or release of petroleum or other chemical. For purposes of these guidelines, the persons listed above are collectively referred to as the "responsible party."

4.2 Initial Site Actions

Once evidence of a discharge or release is discovered, a responsible party shall comply with the release response and corrective action requirements of these guidelines. Any detectable amount of a contaminant is considered to be a discharge or release. A flowchart summarizing the regulatory requirements is provided as Figure 1. Immediately upon discovery of a spill or release the responsible party shall perform the following initial response actions:

1. Take immediate action to prevent any further release of the regulated substance into the environment;
2. Identify and mitigate fire, explosion, and vapor hazards; and
3. Report the release to the Ministry of the Environment within 24 hours (e.g., by telephone, fax, or electronic mail).

After initial response activities, the responsible party shall confirm the presence of contamination, investigate for free product, and identify and map water supply wells within 1,500 feet of the release. The measurement methods, sample types and sample locations chosen shall be those that would best identify the presence and extent of contamination. Unless directed to do otherwise by DENR, owners and operators shall perform the following abatement measures:

1. Remove as much of the regulated substance from the source of the release (UST system, or other storage vessel) as is necessary to prevent further release to the environment;
2. Visually inspect any aboveground releases or exposed below ground releases and prevent further migration of the released substance into surrounding soils and ground water;
3. Continue to monitor and mitigate any additional fire and safety hazards posed by vapours or free product that have migrated from the release area or UST excavation zone and entered into subsurface structures (such as utility trenches or basements);
4. Remedy hazards posed by contaminated soils that are excavated or exposed as a result of release confirmation, site investigation, abatement, or corrective action activities. If these remedies include treatment or disposal of soils, the owner and operator shall obtain permission from the Ministry of the Environment and comply with any applicable local requirements;
5. Measure for the presence of a release where contamination is most likely to be present at the site, unless the presence and source of the release have been confirmed during UST closure site assessment. In selecting sample types, sample locations, and measurement methods, the owner and operator shall consider the nature of the stored substance, the type

of backfill, depth to groundwater and other factors as appropriate for identifying the presence and source of the release; and

6. Investigate to determine the possible presence of free product, and begin free product removal as soon as practicable.

Within 20 days after release confirmation, or within another reasonable period of time determined by DENR, owners and operators shall submit a report summarizing the initial abatement steps taken and any resulting information or data.

Next, a responsible party shall prepare either a Soil Contamination Report or a Limited Site Assessment (LSA) Report, whichever is applicable as follows:

Soil Contamination Report

A Soil Contamination Report is appropriate for sites where the initial site action is sufficient to remediate the site. Within 30 days of discovery of a discharge or release, the responsible party shall submit a Soil Contamination Report demonstrating the soil remaining in the sidewalls and at the base of the excavation are in the unsaturated zone and do not exceed either the soil-to-groundwater or the residential maximum soil contaminant concentrations, whichever are lower. (See Section 7.3) The sidewalls and base of the excavation must be within the unsaturated zone to meet this criteria. If this can be demonstrated to the satisfaction of the Ministry, then the release will be classified as low risk and the responsible party may request that the Ministry issue a notice of no further action. Whenever possible for UST sites, the Soil Contamination Report should be incorporated into the UST Closure Report to expedite risk classification and site closure.

NOTE: *The intent of the Soil Contamination Report is to allow sites with very minor soil contamination (no more than five feet around the sides and bottom of the UST or source of the release) in the unsaturated zone that does not come in contact with groundwater and that is excavated during initial site activities or UST closure, to be closed early in the regulatory process without further site assessment. A Soil Contamination Report is* ***not*** *appropriate for sites where contamination is situated directly on top of the bedrock surface in an area with Karst geology. A Limited Site Assessment Report shall be submitted instead.*

Limited Site Assessment Report (LSA)

If a responsible party cannot demonstrate that soil contamination has been cleaned up to meet either the soil-to-groundwater or the residential or commercial/industrial (as appropriate) maximum soil contaminant concentrations, whichever are lower, a LSA report must be submitted to the Ministry within 60 days of the discovery of the discharge or release. This report shall contain all of the information needed by the Ministry to classify the level of risk posed to human health and the environment by the discharge or release. The report should also contain a discussion of site-specific conditions or possible actions that could result in lowering the risk classification that will be assigned to the release.

Based on a review of the LSA report, the Ministry will classify the site of the discharge or release according to the risk to human health and the environment, higher risk sites having a greater priority ranking. The Ministry will then notify the responsible party of the risk classification.

4.3 Site Priority Ranking

The Ministry prioritises sites according to the threat they pose to human health and the environment. Sites are classified as A, B, C, or D depending on the impact or potential impact contamination may have to any public or private water supply, the presence of vapours in confined spaces, and the potential impact on sensitive ecological receptors. Listed below are the criteria that shall be used to determine the risk posed by a discharge or release. If the

criteria for more than one priority category apply, the discharge or release shall be classified as the highest applicable priority classification. Risk classification of a discharge or release is an on-going process. As new site information concerning the potential exposure of receptors to contamination or changed site conditions becomes available, the Ministry may reclassify the risk posed by the discharge or release.

Category A - High Risk (one or more of the following conditions are present)

1. the vapors from the release are present in confined areas at levels which pose a serious human health concern or an explosion hazard;
2. an existing water supply well, has been contaminated by the discharge or release;
3. a water supply well is located within 1000 feet of the source area of a confirmed discharge or release;
4. the known extent of contamination extends off of the property controlled by the responsible party and onto adjacent land;
5. free product has been detected on site;
6. a sensitive habitat or sensitive resources are impacted and affected; or
7. the discharge or release poses an imminent threat to public health, public safety, or the environment.

Category B - Intermediate Risk (one or more of the following conditions are present)

1. one or more water supply wells are in use between 1,000 feet and 1,500 feet of the discharge, release or known extent of contamination, and the wells are not contaminated;
2. vapours are present in confined areas but do not currently pose a threat to human health or an explosion hazard.
3. 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 standard and criteria by a factor of 10;
4. the source area of a confirmed discharge or release is located within a designated groundwater protection area, as defined in 1992 Development Plan or where recharge is to an aquifer which the Ministry determines is being used or may be used as a source of drinking water;
5. Shallow contaminated surface soils **are** open to public access, and dwellings, parks, playgrounds, day-care centers, schools or similar use facilities **are** within 500 feet of these soils.

Category C - Low Risk (both of the following conditions are present)

1. Groundwater has been impacted, however, no water supply wells are present within 1,500 feet of the discharge, release or known extent of contamination, and no known water supply wells are contaminated.
2. Shallow contaminated surface soils are **not** open to the public access, and dwellings, parks, playgrounds, day-care centers, schools or similar use facilities are **more than** 500 feet away.

Category D – No demonstrable Long-term Risk

A Category D classification means that the risk posed by a discharge or release does not meet any of the high, intermediate, or low risk criteria or that based on site-specific information

received by the Ministry, the discharge or release is shown to pose no significant risk. Category D scenarios encompass all other conditio ns not described in Categories A, B, and C.

1. impacted soils are not within 3 feet of the surface and are not in an area of public access.
2. groundwater has not been impacted and the subsurface soil concentrations are below the soil-to-groundwater cleanup level.

4.4 Land Use Classification

At the time the Ministry determines the risk posed by a discharge or release, the Ministry shall also determine the land use classification (residential or industrial/commercial) of a site. A site will be presumed residential unless sufficient site-specific information is submitted demonstrating that exposure to the soil contamination is limited in time due to the use of the site and does not involve exposure to children. Information submitted in the LSA Report will be used for the initial land use classification determination. If after the submittal of the LSA Report additional information becomes available that may change the land use classification, it shall be submitted to the Ministry.

4.5 Site Characterization and Cleanup

If soil and/or groundwater are found to be contaminated, the responsible party shall proceed with further site assessment. The sampling phase of the Limited Site Assessment documents investigation activities performed to characterize the cause, significance and extent of contamination from a discharge or release. The responsible party shall document the full vertical and horizontal extent of both soil and groundwater contamination. During the LSA the extent of contamination shall be delineated to the Tier I RBSL. Receptor information needed to establish the threat that the contamination poses to human health and the environment must also be submitted to the Ministry.

When assessing the vertical and horizontal extent of contamination, the responsible party shall consider the nature of the contaminant and site-specific conditions. Groundwater monitoring wells should be installed and sampled if contamination is suspected to exist at or the water table or in groundwater. Wells shall also be installed if contaminated soil is inaccessibly located adjacent to or beneath a building foundation. To determine groundwater flow direction, a minimum of three monitoring wells is required. A minimum of one well should be installed within 10 feet of the point of the release, located in an estimated down-gradient direction. If no contamination is detected in the initial sampling, the Ministry may require monitoring hydraulically down gradient of the source.

Should the responsible party determine either during or at the conclusion of the LSA that restoring the site to Tier I RBSLs is not feasible, they shall notify the Ministry in writing and proceed with the Comprehensive Site Assessment (CSA). During the CSA, site specific physical and chemical data shall be collected in order to develop Tier II Site Specific Target Levels (SSTLs). The CSA involves determining the soil and groundwater characteristics on site that affect the fate and transport of the contaminants.

When contamination of soil or groundwater is found to exceed appropriate action levels, a plan for remediating the contamination must be submitted to the Ministry in the form of a Remedial Action Plan (RAP). The plan must describe proposed actions to clean up soil contamination and propose appropriate strategies to restore and maintain groundwater quality. Soil and groundwater cleanup requirements are discussed in Sections 6, 7 and 9.

Periodic groundwater monitoring may be required to evaluate changes in groundwater contaminant concentration over time at specific locations. This information can be used for purposes such as to monitor plume migration and evaluate the effectiveness of the corrective action. Periodic groundwater monitoring may be requested by DENR or may be required as part of an approved Remedial Action Plan. The Ministry encourages responsible parties to

proceed with soil and groundwater cleanup as soon as possible. Although RAP approval is required, it should not hinder the initiation or progress of a cleanup.

4.6 Reporting Requirements for Assessment and Remediation of Contamination

The responsible party is required to report activities concerning the discovery of a release or discharge, initial abatement activities, site assessment and remediation to the Ministry. The specific reports that are required is determined by the nature of the source of the release (e.g., surface spill versus UST). Often, information required will be specified in notice from the Ministry in response to the 24 Hour Notice Report. In these cases, the time frame for response will also be indicated in the Ministry's notification. Site priority ranking information for sites may be provided to the Ministry using the appropriate portions of the LSA Report. Additional information may be required by the Ministry. CSA, RAP, monitoring and system enhancement recommendation information shall be submitted by following the report formats described in Appendix A.

Below is an outline of the required reports, the time frame for submitting the reports and a brief description of report contents. Refer to Appendix A for detailed lists of items that shall be included in each type of report.

A. 24-Hour Report

Notify the appropriate Ministry within 24 hours of discovering a release or discharge. Notification may be verbal followed by a written report.

B. Soil Contamination Report

A Soil Contamination Report should be submitted only if the responsible party can demonstrate that remaining soil in the sidewalls and at the base of an excavation is in the unsaturated zone and does not contain contaminant levels exceeding either the soil-to-groundwater maximum contaminant concentrations or the residential maximum contaminant concentrations, whichever are lower. If these conditions cannot be met, the responsible party shall submit a Limited Site Assessment Report. The Soil Contamination Report shall be submitted to the Ministry within 30 days of discovery of a discharge or release. Whenever applicable, the Soil Contamination Report should be incorporated into a UST Closure Report (also due within 30 days after the UST closure has been completed) to expedite risk classification and site closure.

C. UST Closure Report (UST sites only)

A UST Closure Report following prescribed format shall be submitted to the Ministry within 30 days after closure of a UST has been completed. All required forms are included in a Closure of Underground Storage Tanks package, which can be obtained from the Ministry Office.

A release discovered during closure or removal of a UST system must be reported to the Ministry within 24 hours.

D. Limited Site Assessment (LSA)

If the conditions to submit a Soil Contamination Report cannot be met then a limited site assessment must be performed. The Limited Site Assessment (LAS) Report shall be submitted to the Ministry within 60 days of discovery of a discharge or release. The LSA documents activities performed to characterize the cause, significance, and extent of contamination at a site to the Tier I RBSLs. The LSA report format addresses both soil and groundwater contamination, therefore, submit only one LSA report per site.

E. Comprehensive Site Assessment (CSA)

Submit a Comprehensive Site Assessment (CSA) to the Ministry within 90 days of release confirmation if cleanup to Tier II SSTLs is proposed. The Comprehensive Site Assessment documents the site specific conditions at a site, that affect the fate and transport of

contaminants. A responsible person must, within 5 working days after submittal of the CSA to the Environmental Engineer, submit a copy of the CSA to the Environmental Health Officer and the Government Hydrogeologist.

The CSA report format addresses both soil and groundwater contamination, therefore, submit only one CSA report per site. All sections described in Appendix A.5 must be addressed for groundwater contamination. At sites where only soil contamination exists, the hydrogeologic investigation may be omitted. The Environmental Engineer may request additional information to aid in his review of the CSA, and may deny the CSA if all relevant report elements are not addressed.

F. Remedial Action Plan (RAP)

The Remedial Action Plan describes proposed actions to clean up contamination caused by a discharge or release. A RAP is required when the LAS and/or CSA indicate that remedial action is necessary, and should describe in detail the proposed remedial actions at the site.

Approval of a RAP is conditional upon approval of any required permits. Innovative technologies must be approved by the Environmental Engineer before the RAP is written. To acquire a list of approved innovative technologies, contact the Environmental Engineer and request the Innovative Technology Roster. If the responsible party wants to initiate groundwater or soil remediation before RAP approval, they should contact the Ministry for guidance. Since the RAP report format addresses both soil and groundwater contamination, submit only one RAP per site. Address all the sections described in Appendix A.6 that apply to the site. The Environmental Engineer may request additional information in support of the RAP to aid in their review, and may deny the RAP if all relevant report elements are not addressed. The RAP will remain unapproved until it is resubmitted in its complete form. Although RAP approval is required, it should not hinder the initiation or progress of a cleanup.

NOTE: The DENR encourages anyone with questions regarding technical aspects of site assessment or corrective action to contact the Environmental Engineer.

G. Monitoring Reports

Prepare and submit Monitoring Reports to the Ministry, if applicable. Groundwater monitoring may be requested by the Environmental Engineer or may be required as part of an approved Remedial Action Plan. Pre-RAP monitoring involves sampling monitoring wells at the site prior to implementing a RAP. The Environmental Engineer may instruct the responsible party to conduct this type of monitoring specifying the monitoring frequency, sample parameters and reporting frequency.

RAP monitoring is conducted after the RAP has been approved, and monitors the cleanup of active remediation systems, remediation by natural attenuation, or a combination of remediation systems. This type of report shall also be submitted to verify that cleanup levels have been achieved. If a combination of active treatment and remediation by natural attenuation is being used to remediate contaminated groundwater, monitoring results should be included in a single monitoring report. Submit reports as indicated in the chart below, or as specified by the Ministry.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	3	3	3	3
2nd Year and after	3	No report	3	No report

NOTE: *If permits require more frequent system sampling, this data shall be compiled until the next monitoring report is due. Sample monitoring wells on the same schedule as the reporting schedule. The Environmental Engineer may modify the sampling and reporting schedule as necessary.*

H. System Enhancement Recommendation Report

A System Enhancement Recommendation Report should be submitted to the Environmental Engineer if the responsible party wishes to change the design of a remediation system after the RAP has been submitted. The report should explain why a change in system design would enhance the system's effectiveness or decrease the cost of remediation. All changes to a RAP must be approved by the Environmental Engineer.

4.7 Other Requirements

A. Hazardous Waste

The Ministry of Works and Engineering Waste Management Section (WMS), Hazardous Waste Section must be contacted if a release from a hazardous waste transport, storage or disposal facility has been detected. The Hazardous Waste Officer must be contacted for guidance at (441) 295-5151.

B. Solid Waste

Discharges and releases associated with storage tanks or residue from areas subjected to multiple discharges will be assumed to be unacceptable for disposal at either Tynes Bay Waste Treatment Facility or the Airport Waste Management Facility until laboratory analysis indicates otherwise. The DWM, must be contacted for guidance at (441) 295-5151.

C. Pesticide Contamination

The Pesticide Section of Department of Agriculture and Fisheries must be contacted when pesticide contamination of soil or groundwater at any concentration is known or suspected. Their phone number is (441) 236-4201. The Environmental Engineer must also be notified.

5. Underground Storage Tank Closure Guidelines

5.1 General UST Closure Information

Before closure of a regulated UST is initiated, the responsible party should contact the fire chief and/or city municipality (Corporation) for special closure or permit requirements. The responsible party must submit a Notice of Intent: UST Permanent Closure or Change-in-Service to the Ministry at least 15 days prior to commencement of closure activities.

Within 30 days after closure has been completed, a UST Closure Report (Appendix A.4) following the prescribed format must be completed and submitted to the Ministry. These forms, as well as other pertinent information concerning UST closure, are contained in a Closure of Underground Storage Tanks Package, which can be obtained from the Ministry.

All closure activities, including the removal, cleaning, transport and disposal of USTs, should be accomplished according to the applicable codes and industry standards. The United States National Institute for Occupational Safety and Health "Criteria for a Recommended Standard…Working in Confined Space" may be used as guidance for conducting safe closure procedures at most petroleum produce and hazardous substance tanks.

In addition during UST closures, the following documents concerning cleaning, removal and safety should be adhered to:

- American Petroleum Institute Recommended Practice 1604, "Removal and Disposal of Used Underground Petroleum Storage Tanks," third edition, 1996;
- American Petroleum Institute Publication 2015, "Cleaning Petroleum Storage Tanks";

A release discovered as a result of closure or removal of any UST must be reported to the Ministry within 24 hours. In addition, the responsible party is required to comply with the requirements of Section 4.2 Initial Site Actions. *These requirements are applicable to all petroleum and hazardous material USTs.*

5.2 Procedures for Excavating Soil During UST Removal

For sites where a release is discovered prior to or during the closure of a UST system, conduct the following recommended excavation procedures:

1. If the UST closure involves excavating soil to remove the UST system (i.e., tanks, dispensers, distribution lines, etc.), only excavate soil that is necessary to remove the system. The excavation walls should be cut no deeper than the bottom of the UST and sloped or shored to prevent collapse according to the Health and Safety Office Guidelines (Ontario Occupational Health and Safety Act and Regulations for Construction Projects and Construction Health & Safety Manual). Stockpile soil as described in Section 8.4.

2. Do not excavate any soil below the bottom of the UST system until the required closure samples have been taken. These soil samples must be taken directly beneath the UST system once the system has been removed. See Section 5.4 for soil sample locations. Analytical requirements are discussed in Section 8.

3. After closure samples have been taken, the responsible party may excavate contaminated soil. If groundwater or bedrock are encountered, other remediation options should be considered. There are no limitations on soil excavation for sites, however any material excavated must be properly managed as contaminated soil until sampling and analysis show otherwise. Any excavated soil that shows contamination above the action levels is a waste and must be disposed of properly.

NOTE: *If dewatering of the tank pit or excavation is required, contaminated water shall be properly treated to below acceptable discharge levels for a discharge permit from the Environmental Authority, or properly disposed at a permitted facility.*

If the tank closure activities (soil excavated to remove the tank) are sufficient to reduce the residual contamination to below either the soil-to-groundwater or the residential maximum soil contaminant concentrations, whichever are lower, the responsible party should proceed with a Soil Contamination Report as per Section 4.2. If the residual contamination is above the soil-to-groundwater or the residential maximum soil contaminant concentrations, whichever are lower, a Limited Site Assessment (LSA) Report must be prepared by the responsible party.

A Soil Cleanup Plan presenting a proposal for remediation of the excavated soil must be prepared in either case. Once the Soil Cleanup Plan is approved, soil must be remediated to applicable levels. Prior to closure, the responsible party must submit a Soil Cleanup Report with Site Closure Request documenting soil remediation activities and requesting that the Ministry issues a notice of no further action.

5.3 Backfilling Excavations and Reuse of Excavated Soil

The excavation should be filled with clean compacted fill, similar to the native material that was removed from the excavation. If gravel or some other permeable material is to be used for fill, the fill should be capped with a low permeability material to prevent preferential pathways to groundwater. Keep in mind that gravel and some sands can cause caving problems when trying to perform soil borings or when trying to install monitoring wells. Additionally, if future excavation is required and the fill material becomes contaminated, it may need to be treated prior to reuse.

Excavations shall not be backfilled with contaminated soil. Soil is considered contaminated if analytical results show contamination above the method detection limits. Once contaminated soil is excavated, it is considered a waste, and must be managed appropriately. Contaminated soil must be treated or disposed of under the authority of a permit issued by the Ministry. Permitting requirements for the treatment of contaminated soil are discussed in Appendix B.

5.4 UST Closure Sampling

NOTE: *Soil sample collection requirements and analytical methods are discussed in Section 8.0.*

These requirements must be adhered to for all UST closure sampling.

<u>A. Sampling Directly Underneath the Tank</u>

After the tank(s) have been removed and prior to excavating any deeper, samples should be collected in the excavation pit directly beneath the mid-line location of the former tank. The number of samples required depends on the length (longest dimension) of the tank. These samples should be collected at evenly spaced intervals along the length of the tank, no deeper than two feet into the soil or rock. The sampling locations should be biased towards areas where stained soil is encountered, or wherever contamination is suspected.

less than 6 feet ----------1 sample
6 to 20 feet ---------- 2 samples
20 to 30 feet ---------- 3 samples
30 to 40 feet ---------- 4 samples
40 to 50 feet ---------- 5 samples
greater than 50 feet ----------1 sample per 10 ft of tank length

B. Sampling At Fill Pipes

Collect samples from around each fill pipe to document overfills/spills. This is only applicable if the fill pipes were not removed during excavation of the overburden to remove the USTs.

C. Sampling Underneath Product Lines

Collect samples at all fittings (especially joints), where stained soil is encountered, or wherever contamination is suspected. In all cases, collect not less than one sample per twenty linear feet, or portion thereof. Samples should be taken no deeper than two feet into the soil directly beneath the lines.

D. Sampling Underneath Dispensers or Dispenser Islands

Samples collected beneath dispensers or dispenser islands should be from the area nearest the suspected contamination source. Samples should be collected at ten-foot intervals (i.e., 1 sample for 0 -10 ft, 2 samples for 0 - 20 ft, etc.). Sample points should be at evenly distributed intervals along the length of the island and should be from no deeper than two feet into the native soil directly beneath the dispensers or midline of an island. If there has been an excavation, the samples should be taken from native soil no deeper than two feet below the base of the excavation. Samples should also be taken from beneath coupling joints.

NOTE: Upon encountering groundwater in an excavation, it is best not to grab a water sample. This water may not represent the true quality of the groundwater (i.e., fluids that have leaked from the tanks, perched water table, etc.). To obtain a sample from groundwater, install a monitoring well or extract a sample with a mechanical pushprobe. The groundwater should be sampled at an estimated down-gradient location from the source and as near the excavation as possible.

E. Sampling Around Concrete Pads

If the UST(s) rest on a concrete pad, samples should be collected around the outside edges of the concrete pad at each tank end. The minimum number of samples required along the concrete pad both along its length and width, are as follows:

less than 6 feet ----------1 sample
6 to 20 feet ---------- 2 samples
20 to 30 feet ---------- 3 samples
30 to 40 feet ---------- 4 samples
40 to 50 feet ---------- 5 samples
greater than 50 feet ----------1 sample per 10 ft of pad length

NOTE: *All soil samples should be collected vertically from no deeper than 2 feet into the native soil below the base of the tank(s) and samples taken from the ends of each tank should be as close as possible to that tank.*

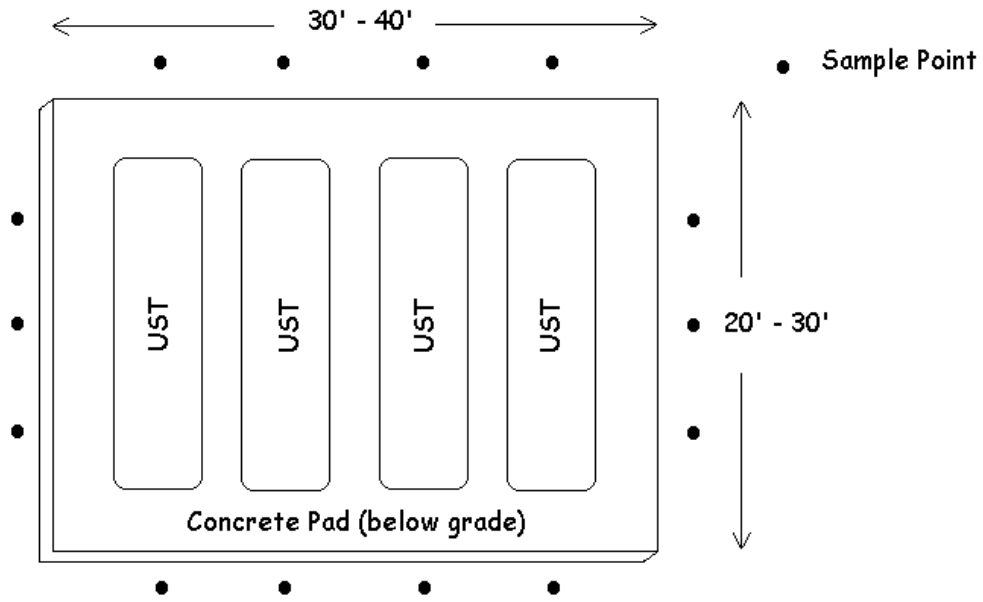


Figure 1. Typical sampling around concrete pads used for Underground Storage Tanks.

F. Sampling Procedures For Underground Storage Tanks Closed In-Place

If the tank(s) are to be closed in-place, then samples should be collected according to the sample spacing as outlined under Section 5.4E "Sampling Around Concrete Pads". Samples must be collected as close to the UST(s) or concrete pad (if present) as possible. The practice of collecting samples by boring through the bottom of a tank that is to be closed in-place should be avoided whenever possible due to the hazardous nature of the activity. However, if it is not possible to bore around the perimeter of the tank or concrete pad due to access limitations (i.e., tank located partially under a building) samples may be collected using this technique. The tank must be completely cleaned out and the sampling conducted in a proper manner by qualified personnel. OSHA requirements for confined space entry must be followed when entering a tank. If samples are collected by boring through the bottom of a tank during an in-place closure, this fact must be noted in the closure report. The samples should be collected according to the sample spacing outlined under Section 5.4A.

5.5 Submitting Reports

Upon completion of the UST closure, submit the Closure Report following the prescribed format to the Ministry within 30 days. A Closure of Underground Storage Tanks package which contains the appropriate forms and other pertinent closure information is available from the Ministry. If contamination is suspected and/or confirmed by analytical results, further actions and reports are required (see Section 4). Detailed report formats are presented in Appendix A.

6. Site Assessment

Site assessment activities are performed to identify the source of a discharge or release, determine the presence and extent of environmental contamination, and characterize the risk that the discharge or release poses to human health and the environment. The responsible party for any discharge or releases, with the exception of those who are able to request closure after submitting a UST Closure Report, Soil Contamination Report, or certain existing discharges or releases (if expressly exempted upon application to the Ministry), must perform a Limited Site Assessment (LSA). The LSA seeks to obtain all of the information (source identification, nature and maximum concentrations of contamination, contaminant migration pathways and receptor characterization) needed to classify the level of risk posed by the discharge or release. Specific reporting requirements for the LSA are provided in Appendix A.3.

The responsible party of the discharge or release may continue with additional assessment activities and perform a Comprehensive Site Assessment (CSA) if remediation to Tier I RBSLs is not feasible. The purpose of the CSA is to collect site specific data on contaminant transport in the environment and further assess the potential for contamination to affect receptors. The CSA report will document assessment activities, identify site-specific soil and groundwater characteristics and propose Tier II cleanup goals (SSTLs) commensurate with the risk classification of the discharge or release and land use classification. Specific reporting requirements for the CSA are provided in Appendix A.5.

6.1 Limited Site Assessment

Phase I – Receptor Information

The LSA consists of two phases of work. In a first phase of work, the responsible party for discharges or releases shall perform a receptor survey. Even if the responsible party makes application to the Ministry to proceed to a Tier II assessment, they must also collect information on possible receptors:

1. Private and Public Water Supply Wells
The responsible party is required to identify all active water supply wells (omit only those that have been properly abandoned by filling with grout) within 1500 feet of the source area of the discharge or release. For each well, the responsible party must provide (to the extent available) the water right number (and/or assessment number), well owner and user names, addresses and telephone numbers, use of the well, and distance from the source area of the release.

2. Surface Water
The responsible party shall identify all surface water bodies (e.g., ditch, pond, marsh, canal, inshore waters, etc.) within 1500 feet of the source area of the discharge or release.

3. Sensitive Habitats and Groundwater Protection Areas
Certain areas of Bermuda are recognised as being of particular environmental sensitivity. Some have been formally identified, such as ground water protection areas and cave conservation areas (1992 Development Plan produced by the Department of Planning). Other sites are especially sensitive by virtue of their location relative to the coastline or proximity to a marsh or inland surface water body. Extra precautionary measures may be required in these areas, such as the identification of water supply wells over a wider area and the monitoring of cave or surface waters for contamination.

The party shall determine the level of sensitivity of the specific site both from the point of view of potential impact on natural resources and from the point of view of the level of mobility of contaminants as determined by the rock type. The Ministry of the Environment shall be consulted for sensitivity information.

4. Karst Geology
The responsible party must determine whether the spill or release is in an area characterized by Karst geology. The presence of caves and secondary solution channels permits rapid and wide spread transport of contaminants.

5. Subsurface Structures
The responsible party must obtain information on the locations of all subsurface structures (e.g., sewers, utility lines, conduits, basements, septic tanks, leach fields, floor and storm drains) located on and adjacent to the site. In addition, the responsible party must determine whether vapors pose a threat of explosion based on the accumulation of vapors in a confined space or any other serious health threat to public, public safety, or the environment.

6. Land Use
For purposes of determining the land use (residential or industrial/commercial) classification of the site, the responsible party should gather information on the uses and activities (involving possible human exposure to contamination) that could occur at the site and in the area within 1500 feet of the source area of the discharge or release. Examples of such activities and uses include but are not limited to use of a property for an office, light industry, residence, store, school, gardening or farming activities, recreational activities, or undeveloped land. This evaluation must include a consideration of activities which may not be occurring at the time of evaluation, but which are consistent with the current use of the site and area surrounding the site.

For this evaluation, it will be necessary to determine:

- Whether children and/or adults live/work/visit the site;
- Potential for exposure to the contaminated soil (e.g., Is the contaminated soil capped by pavement or a building? Is access to the site reliably restricted?);
- Distance of the source area to the nearest residence (primary or secondary), school, daycare center, hospital, park recreation area, church, nursing home or other place of public assembly; and
- Projected future use of the site and surrounding area.

The evaluation should also include the zoning status of the site and of the area within 1500 feet of the source area of the discharge or release.

NOTE: To obtain information on the possible future use of the site and surrounding area, the responsible party should check with the municipal offices (Corporations) and the Department of Planning.

7. Property Owners and Occupants
The responsible party must determine the names and addresses of 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.

<u>Phase II - Sampling Activities</u>

During Phase II of the LSA, the responsible party shall characterize the source of the release and to the extent possible, delineate the extent of soil and groundwater contamination to the limits of the Tier I RBSL. The responsible party for discharges or releases shall construct one monitoring well in the source area of the discharge or release to characterize the source of the contamination. An additional three monitoring wells shall be installed to determine the extent of groundwater contamination. The monitoring wells should be installed: as best as can be determined, one upgradient of the source of contamination, and two downgradient of the source

of contamination. The up-gradient and down-gradient wells should be located such that groundwater flow direction can be determined.

Soil samples shall be collected for laboratory analysis as follows from the source area monitoring well: every five feet in the unsaturated zone between the land surface and a water table. If a water table is encountered at a depth greater than 25 feet from the land surface, soil samples should only be collected every ten feet in the unsaturated zone. Soil samples shall be collected from suspected worst case locations exhibiting visible contamination or elevated levels of volatile organic compounds in the borehole. The samples shall be analyzed in accordance with the methods and procedures specified in Section 8.0. Additional soil samples shall be collected from various locations on site to determine the vertical and horizontal extent of soil contamination above the Tier I RBSLs.

Groundwater samples shall be collected from the remaining monitoring wells and analyzed in accordance with the methods and procedures specified in Section 10.0. If free product is present in a well, the responsible party shall record the thickness of free product in the monitoring well using an oil-water interface probe or product paste and initiate free product recovery.

*NOTE: The responsible party shall delineate soil contaminant concentrations to 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, it will only be necessary to delineate soil contamination concentrations above the industrial/commercial maximum soil contaminant c*oncentration*.* The responsible party shall obtain the elevations of the water table in each monitoring borehole at a frequency and over a duration, which shall be sufficient to allow correction for tidal effects. For those not familiar with ground water conditions in Bermuda, it is recommended that the Ministry of the Environment be consulted before making the required interpretation of hydraulic gradients and ground water flow directions.

6.2 Comprehensive Site Assessment (Tier II)

CSA activities are performed to characterize the cause, significance, and extent of contamination from a discharge or release as well as to collect site specific physical and chemical data needed to develop Tier II Site Specific Target Levels (SSTLs). A CSA shall be conducted for all discharges or releases where remediation to Tier I RBSLs is not feasible. The CSA involves assessing the soil and groundwater characteristics on site that affect the fate and transport of the contaminants.

<u>CSA Investigation</u>

For the CSA, the responsible party should provide a detailed history of the location, use, ownership, and operation of the current and previous potential sources of contamination at the site (e.g. UST systems). In addition, the responsible party should verify the source(s) of the discharge or release including any off-site contributions to the contamination and contributions from any other on-site sources.

As part of the CSA, all of the receptor information provided in the LSA should be updated as necessary. Additional soil and groundwater sampling shall be conducted to delineate the horizontal and vertical extent of contamination including free product, if this was not possible during the LSA. Samples shall be collected and analyzed in accordance with methods and procedures specified in Sections 8.0 and 10.0. The site geology should be characterized from information obtained during the drilling of soil borings and construction of monitoring wells. A hydrogeologic investigation shall be conducted. This investigation shall involve the collection of groundwater elevation data and the determination of both groundwater flow direction and hydraulic gradient. Slug tests or a pump test shall be performed as appropriate to determine hydraulic conductivity and transmissivity. The linear groundwater velocity shall also be determined. For further guidance on groundwater characterization refer to Appendix B.

The CSA shall include an evaluation of the rate of contaminant movement and its potential to affect receptors. The responsible party should also evaluate site-specific conditions (e.g., a domestic water supply well located more than 200 feet upgradient of the source area of a discharge or release) or possible actions (e.g., proper abandonment of a water supply well, capping the source area to limit infiltration) that could affect the site risk priority classification. The CSA shall also include a comparison of the sampling results to the applicable cleanup standards as well as propose Tier II SSTLs based on site specific conditions. More information on Tier II cleanup requirements can be found in Section 11.

REFERENCES

Vacher, H.L., Rowe, M.P. and Garrett, P., 1989. *The Geological Map of Bermuda.* Scale 1:25,000. Oxford Cartographers, London. Bermuda Gov., Ministry of Works & Engineering.

7. Cleanup Requirements for Soil Contaminated with Petroleum Products

7.1 Guidelines for Determining Soil Cleanup Levels

Effective August 1, 1999, new chemical-specific soil cleanup levels will be implemented for soil contaminated with petroleum products. These cleanup levels replace the total petroleum hydrocarbon (TPH) action levels of 200 mg/kg (ppm). The new soil cleanup levels are discussed in the following sections.

7.2 Soil Cleanup Levels Effective August 1, 1999

A. Maximum Soil Contaminant Concentrations

Three categories of soil cleanup levels have been established: residential, industrial/commercial, and soil-to-groundwater maximum soil contaminant concentrations. 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 soil contamination for a limited period of time. The soil-to-groundwater maximum soil contaminant concentrations were established to protect groundwater from the leaching of contaminants from soil, and are intended to be protective of the groundwater standards.

The maximum Tier I risk-based soil contaminant concentrations are provided in Tables 1A and 1B.

The exposure factors used in calculating the residential 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 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. 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;
- Agency for Toxic Substances and Disease Registry, "Toxicological Profile for [individual chemical]." U.S. Public Health Service;
- 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.

B. Cleanup Requirements

Soil must be remediated to the maximum soil contaminant concentrations or as closely thereto as economically or technologically feasible (e.g., soil below an occupied permanent structure and is not a health hazard). The maximum soil contaminant concentrations apply to the entire unsaturated soil column.

Category A and B Discharges or Releases - For Category A and B discharges or releases, soil contamination must be remediated to the lowest of:

1) Residential or industrial/commercial maximum soil contaminant concentrations, whichever are applicable; or

2) Soil-to-groundwater maximum soil contaminant concentrations.

Category C and D Discharges or Releases - For Category C and D discharges or releases, soil contamination must be remediated to the residential or industrial/commercial maximum soil contaminant concentrations, whichever are applicable.

C. Public Notice

The responsible party who proposes to cleanup contaminated soil to a standard other than to the Tier I residential or soil-to-groundwater maximum soil contaminant concentration, whichever is lower, must comply with the requirements for public notice, and administrative controls. Refer

to Section 12.0 for further guidance on public notices, administrative controls and Tier II Standards.

Table 1A. Tier 1 Risk Based Screening Levels (RBSL) for Soil for land areas classed as Residential and Industrial/Commercial and also Soil-To-Groundwater levels where soil depth is comparable to water table height.

Compound	CAS #	Residential		Industrial/ Commercial		Soil-to-Groundwater	
		(mg/kg)		(mg/kg)		(mg/kg)	
Alkanes (Aliphatic Hydrocarbons)							
C5-C8		939	N	24528	N	72	N
C9-C12		9386	N	245280	N	3255	N
C9-C18		9386	N	245280	N	424799	N
C19-C36		93860	N	> 100%	N	Immobile	N
Aromatic Hydrocarbons							
C9-C10		469	N	12264	N	34	N
C11-C22		469	N	12264	N	206	N
Organic Compounds							
Acenaphthene	83-32-9	13000	P	170000	P	2700	P
Acenapnthylene	208-96-8	13000	P	170000	P	38	R
Acetone	67-64-1	10000	P	10000	P	2.4	R
Acrlyamide (propenamide)	79-06-1	3.2	R	13	R	0.00052	R
Anthracene	120-12-7	66000	P	190000	P	230	P
Benzene	71-43-2	19	R	33	R	0.0093	R
Benzo(a)anthracene	56-55-3	6	R	12	R	80	P
Benzo(a)pyrene	50-32-8	0.6	R	11	P	46	P
Benzo(b)fluoranthene	205-99-2	6	R	12	R	120	P
Benzo(g,h,i)perylene	191-24-2	13000	P	170000	P	180	P
Benzo(k)fluoranthene	207-08-9	250	P	1100	P	600	P
Bromoform (tribromomethane)	75-25-2	71	R	120	R	0.54	R
Carbon disulfide	75-15-0	10000	P	10000	P	14	R
Carbon tetrachloride	56-23-5	4.3	R	7.5	R	0.07	R
Chlorobenzene	108-90-7	4400	P	10000	P	0.83	R
Chloroethane	75-00-3	10000	P	10000	P	54	R
Chloroform (trichloromethane)	67-66-3	73	R	160	R	0.3	R
Chloromethane	74-87-3	44	R	75	R	0.038	P
2-Chlorophenol	95-57-8	330	P	920	P	2	R
Chrysene	218-01-9	2500	P	11000	P	220	P
Cumene	98-82-8	170	P	480	P	1.9	R
Dibenz(a,h)anthracene	53-70-3	0.6	R	11	P	41	P
1,2-Dichlorobenzene (-o)	95-50-1	3800	P	10000	P	33	R
1,4-Dichlorobenzene (-p)	106-46-7	750	P	3300	P	4.2	R
1,1 Dichloroethane	75-34-3	200	P	1000	P	28	R
1,2 Dichloroethane	107-06-2	6.1	R	11	R	0.011	R
1,2-Dichloroethene (cis)	156-59-2	670	P	1900	P	0.18	R
1,2-Dichloroethene (trans)	156-60-5	1300	P	3700	P	0.16	R
2,4-Dimethylphenol (m-xylenol)	105-67-9	4400	P	10000	P	31	P
Ethylbenzene	100-41-4	10000	P	10000	P	2.4	R
Ethylene glycol	107-21-1	48000	R	48000	R	130	R
bis-2-Ethylhexyl phthalate	117-81-7	1300	P	5700	P	25	R
Fluoranthene	206-44-0	8800	P	110000	P	3300	P

Compound	CAS #	Residential		Industrial/ Commercial		Soil-to-Groundwater	
		(mg/kg)		(mg/kg)		(mg/kg)	
Fluorene	86-73-7	8800	P	100000	P	380	P
n-Hexane	110-54-3	3800	P	10000	P	510	P
Indeno(1,2,3-cd)pyrene	193-39-5	6	R	12	R	3400	R
Methylene chloride	75-09-2	75	R	130	R	0.0061	R
Methyl ethyl ketone (MEK, 2-butanone)	78-93-3	10000	P	10000	P	43	R
3-Methylphenol (m-cresol)	108-39-4	1100	P	14000	P	15	R
4-Methylphenol (p-cresol)	106-44-5	1100	P	14000	P	1.4	R
Methyl t-butyl ether (MTBE)	1634-04-4	120	R	170	R	0.51	R
Naphthalene	91-20-3	8800	P	110000	P	14	R
n-Nitrosodimethylamine	62-75-9	0.26	R	0.69	R	0.000037	R
PCBs	1336-36-3	4.4	P	44	P	2.1	R
Phenanthrene	85-01-8	66000	P	190000	P	11000	P
Phenol	108-95-2	130000	P	190000	P	84	R
Pyrene	129-00-0	6600	P	84000	P	220	P
1,1,2,2-Tetrachloroethane	79-34-5	2.8	R	4.9	R	0.011	R
Tetrachloroethylene (PCE)	127-18-4	11	R	19	R	0.043	R
Toluene	108-88-3	7600	P	10000	P	4.4	R
1,2,4-Trichlororbenzene	120-82-1	240	R	350	R	15	R
1,1,1-Trichloroethane	71-55-6	10000	P	10000	P	1.7	R
1,1,2-Trichloroethane	79-00-5	9.8	R	17	R	0.0036	R
Trichloroethylene (TCE)	79-01-6	51	R	88	R	0.0077	R
Vinyl chloride	75-01-4	0.3	R	0.51	R	0.0084	R
Xylene (mixed isomers)	1330-20-7	10000	P	10000	P	72	R
Inorganic Compounds							
Arsenic	7440-38-2	9.7	R	33	R	76	
Barium	7440-39-3						
Cadmium	7440-43-9	>		>		16	
Chromium	16065-83-1	5.40E+05		1.20E+06		4.60E+01	
Copper	7440-50-8	2.70E+04		7.60E+04		5.00E+03	
Cyanide	57-12-5						
Lead	7439-92-1						
Mercury	7439-97-6						
Nickel	7440-02-0	>		>		86	
Selenium	7782-49-2	>		>		6.2	
Silver	7440-22-4						
Zinc	7440-66-6	>		>		10000	

Notes:

R = Value is based on ASTM RBCA Tier I Model for generic sites in Bermuda

N = Value is based on the North Carolina Guidelines for the Investigation and Remediation of Soil and Groundwater

P = Value is based on the Pennsylvania Act 2 Land Recycling Program

B = Value is based on mean concentrations measured at sites throughout Bermuda (Mean Value + 2 std.dev.)

Table 1B. Tier 1 Risk Based Screening Levels (RBSL) for Groundwater.

Compound	CAS #	Groundwater RBCA (mg/l)	
Alkanes (Aliphatic Hydrocarbons)			
C5-C8		0.42	N
C9-C12		4.2	N
C9-C18		4.2	N
C19-C36		42	N
Aromatic Hydrocarbons			
C9-C10		0.21	N
C11-C22		0.21	N
Organic Compounds			
Acenaphthene	83-32-9	2.2	R
Acenapnthylene	208-96-8	0.15	R
Acetone	67-64-1	3.7	R
Acrlyamide (propenamide)	79-06-1	1.90E-04	R
Anthracene	120-12-7	0.043	P
Benzene	71-43-2	0.005	M
Benzo(a)anthracene	56-55-3	0.0012	R
Benzo(a)pyrene	50-32-8	1.20E-04	R
Benzo(b)fluoranthene	205-99-2	0.0012	R
Benzo(g,h,i)perylene	191-24-2	2.60E-04	P
Benzo(k)fluoranthene	207-08-9	5.50E-04	P
Bromoform (tribromomethane)	75-25-2	0.11	R
Carbon disulfide	75-15-0	0.46	R
Carbon tetrachloride	56-23-5	0.005	M
Chlorobenzene	108-90-7	0.1	M
Chloroethane	75-00-3	15	R
Chloroform (trichloromethane)	67-66-3	0.1	M
Chloromethane	74-87-3	0.0026	N
2-Chlorophenol	95-57-8	0.18	R
Chrysene	218-01-9	2.00E-04	M
Cumene	98-82-8	0.73	R
Dibenz(a,h)anthracene	53-70-3	1.20E-04	
1,2-Dichlorobenzene (-o)	95-50-1	0.6	M
1,4-Dichlorobenzene (-p)	106-46-7	0.035	R
1,1 Dichloroethane	75-34-3	3.7	R
1,2 Dichloroethane	107-06-2	0.005	M
1,2-Dichloroethene (cis)	156-59-2	0.07	M
1,2-Dichloroethene (trans)	156-60-5	0.1	M
2,4-Dimethylphenol (m-xylenol)	105-67-9	0.14	N
Ethylbenzene	100-41-4	0.7	M
Ethylene glycol	107-21-1	73	R
bis-2-Ethylhexyl phthalate	117-81-7	0.006	M
Fluoranthene	206-44-0	0.27	P
Fluorene	86-73-7	1.5	R
n-Hexane	110-54-3	0.74	R

Compound	CAS #	Groundwater RBCA (mg/l)	
Indeno(1,2,3-cd)pyrene	193-39-5	0.0012	R
Methylene chloride	75-09-2	0.005	M
Methyl ethyl ketone (MEK, 2-butanone)	78-93-3	22	R
3-Methylphenol (m-cresol)	108-39-4	1.8	R
4-Methylphenol (p-cresol)	106-44-5	0.18	R
Methyl t-butyl ether (MTBE)	1634-04-4	0.18	R
Naphthalene	91-20-3	0.15	R
n-Nitrosodimethylamine	62-75-9	1.70E-05	R
PCBs	1336-36-3	1.10E-04	R
Phenanthrene	85-01-8	0.15	R
Phenol	108-95-2	22	R
Pyrene	129-00-0	0.013	P
1,1,2,2-Tetrachloroethane	79-34-5	0.0043	R
Tetrachloroethylene (PCE)	127-18-4	0.005	M
Toluene	108-88-3	1	M
1,2,4-Trichlororbenzene	120-82-1	0.07	M
1,1,1-Trichloroethane	71-55-6	0.2	M
1,1,2-Trichloroethane	79-00-5	0.005	M
Trichloroethylene (TCE)	79-01-6	0.005	M
Vinyl chloride	75-01-4	4.50E-04	R
Xylene (mixed isomers)	1330-20-7	10	M
Inorganic Compounds			
Arsenic	7440-38-2	4.90E-04	R
Barium	7440-39-3	2	M
Cadmium	7440-43-9	0.005	M
Chromium	16065-83-1	0.1	M
Copper	7440-50-8	1.4	R
Cyanide	57-12-5	0.154	N
Lead	7439-92-1	0.005	M
Mercury	7439-97-6	0.002	M
Nickel	7440-02-0	0.1	M
Selenium	7782-49-2	0.05	M
Silver	7440-22-4	0.18	R
Zinc	7440-66-6	11	R

Notes:
R = Value is based on ASTM RBCA Tier I Model for generic sites in Bermuda
N = Value is based on the North Carolina Guidelines for the Investigation and Remediation of Soil and Groundwater
P = Value is based on the Pennsylvania Act 2 Land Recycling Program
M = Value is based on the USEPA Maximum Contaminant Level (MCL)

7.3 Soil Cleanup Levels for Petroleum Aliphatic and Aromatic Hydrocarbon Fractions

The toxicity of petroleum-contaminated media can be adequately characterized by four petroleum hydrocarbon fractions (C5-C8 aliphatics, C9-C18 aliphatics, C19-C36 aliphatics and C9-C22 aromatics) as shown on Table 2. However, two analytical methods (VPH and EPH) are needed to quantify the large carbon range incorporated by the four toxicologically defined fractions. To eliminate the need to use both methods on all samples and to reduce analytical costs, the aliphatic C9-C18 fraction has been split into two fractions (C9-C12 and C9-C18) and the aromatic C9-C22 fraction has been split into two fractions (C9-C10 and C11-C22) (See table 2 below).

Table 2. Analytical fractions to be analysed for petroleum contaminated soils.

Toxicologically Defined Hydrocarbon Fractions	Analytical hydrocarbon fractions	Analytical Method
C5-C8 Aliphatics	C5-C8 Aliphatics	VPH
C9-C18 Aliphatics	C9-C12 Aliphatics	VPH
	C9-C18 Aliphatics	EPH
C19-C36 Aliphatics	C19-C36 Aliphatics	EPH
C9 –C22 Aromatics	C9-C10 Aromatics	VPH
	C11-C22 Aromatics	EPH

This allows for the detection of all low boiling point fuels (gasoline-range hydrocarbons) using only the VPH method. Medium/high boiling point fuels (diesel-range hydrocarbons) will still require analysis using both VPH and EPH methods. Heavy fuels (e.g., #4 ,#5 and #6 fuel oils, hydraulic fluid) can be detected using only the EPH method. To determine whether cleanup of soil contamination is necessary for a gasoline release (and all other releases of low boiling point fuels), samples should be analyzed for VPH. (*Reminder*: *the VPH analysis is in addition to the required target compound analysis EPA Method 8260 with isopropyl ether and methyl-tert-butyl-ether.*) The analytical laboratory will report results for the C5-C8 and C9-C12 aliphatic fractions and the C9-C10 aromatic hydrocarbon fraction.

The results must be directly compared to the RBSL cleanup levels (Table 1) for the appropriate toxicologically defined hydrocarbon fractions (i.e., C5-C8 and C9-C18 aliphatic fractions and the C9- C22 aromatic fraction). An example is provided in Table 3.

Comparing the results for the analytical hydrocarbon fractions to the residential MSCCs for the toxicologically defined hydrocarbon fractions shows that contamination is above the residential levels for the C5-C8 aliphatic fraction and for the C9-C10 aromatic fraction. Therefore, cleanup of soil contamination would be required.

Breaking up the four toxicologically defined hydrocarbon fractions into six analytical fractions requires some additional data manipulation for the diesel-range hydrocarbons prior to comparing the analytical results to the cleanup levels. For a diesel release (and all other medium/high boiling point fuels), samples should be analyzed both VPH and EPH methods. (Reminder: the VPH and EPH analyses are in addition to the required target compound analyses EPA Methods 8260 and 8270.)

Table 3. Example: A sample from a gasoline release is analyzed for VPH. For the purpose of this example, the residential maximum soil contaminant concentrations (MSCCs) apply. The results are as follows:

Toxicologically Defined Hydrocarbon Fractions	Analytical Hydrocarbon Fractions	Analytical Method	Laboratory Results Concentration (mg/kg)	Residential MSCC (mg/kg)
C5-C8 Aliphatics	C5-C8 Aliphatics	VPH	2000	939
C9-C18 Aliphatics	C9-C12 Aliphatics	VPH	1000	9386
	C9-C18 Aliphatics	EPH	NR	
C19-C36 Aliphatics	C19-C36 Aliphatics	EPH	NR	93860
C9 –C22 Aromatics	C9-C10 Aromatics	VPH	600	469
	C11-C22 Aromatics	EPH	NR	

NR = No Result

The analytical laboratory will report results for all six analytical hydrocarbon fractions. To determine whether cleanup of soil contamination is necessary, the analytical results for the C5-C8 and the C19-C36 aliphatics should be directly compared to the cleanup levels for the appropriate toxicologically defined fractions (i.e., C5-C8 and C19-C36 aliphatics). However, for the C9-C12 and C9-C18 aliphatics, the VPH and EPH results must be added together and the sum of the results compared to the cleanup levels for the C9-C18 aliphatics. Similarly, the VPH and EPH concentrations for the C9-C10 and C11-C22 aromatics must be added together and the sum of results compared to the cleanup levels for the C9-C22 aromatics. An example is provided in table 4 below.

Comparing the results for the analytical hydrocarbon fractions to the residential MSCCs for the toxicologically defined hydrocarbon fractions shows that contamination is below the residential levels for the aliphatic fractions (C5-C8, C9-C18 and C19-C36) but exceeds the MSCCs for the aromatic fraction (C9-C22). Therefore, cleanup of soil contamination would be required based on the results for the aromatic hydrocarbon fraction. Results for groundwater samples analyzed using the MADEP VPH and EPH methods should be compared to the appropriate interim groundwater standards for the petroleum hydrocarbon fractions in the same manner.

Table 4. *Example*: A sample from a diesel fuel release is analyzed for VPH and EPH. *For the purpose of this example, the residential maximum soil contaminant concentrations (MSCCs) apply. The results are as follows:*

Toxicologically Defined Hydrocarbon Fractions	**Analytical Hydrocarbon Fractions**	**Analytical Method**	**Laboratory Results Concentration (mg/kg)**	**Sum of VPH and EPH Concs. (mg/kg)**	**Residential MSCC (mg/kg)**
C5-C8 Aliphatics	C5-C8 Aliphatics	VPH	400	NA	939
C9-C18 Aliphatics	C9-C12 Aliphatics	VPH	2000	7000	9386
	C9-C18 Aliphatics	EPH	5000		
C19-C36 Aliphatics	C19-C36 Aliphatics	EPH	6000	NA	93860
C9 –C22 Aromatics	C9-C10 Aromatics	VPH	300	800	469
	C11-C22 Aromatics	EPH	500		

NA = Not Applicable

8. Soil Sampling Guidelines and Analytical Requirements

The quantity and locations of samples specified in this guidance are intended 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). Final determination of soil contamination must be made by the laboratory analytical methods presented in Tables 5 or 6, depending on the type of contamination. All analyses are required to be performed using DEP-approved analytical methods and the laboratories used must be certified to run the approved methods.

8.1 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 lab analysis. However, because of the lack of specificity, accuracy, precision and quality assurance/quality control, 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 or 6.

8.2 Sample Preparation

The type of sample containers to be 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 Table 5 or 6. Then refer to Table 7 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 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, the DENR 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. Also prepare the storage and transport containers (ice chest, etc.) prior to taking any samples so that each collected sample can be placed in a chilled environment immediately after collection.

8.3 Soil Sample Collection Procedures

Soil samples should be collected under the responsible charge of an environmental professional 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 taking samples of 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. At a minimum, a clean, stainless steel spoon 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. Primary samples are to be disturbed internally as little as possible during acquisition. 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.

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 7 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).

Samples for volatile organic compound (VOC) analysis should be collected with minimal handling and agitation. The volatile samples that will be analyzed by the MADEP VPH method 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 at a rate of 1-mL methanol per gram of soil. This is a critical part of the analytical method. A methanol trip blank must also accompany each batch of samples.

Table 5. Required Analyses for Petroleum-Contaminated Soil for Releases (Laboratories must be certified by the USEPA to perform the following methods)

Suspected Contaminants	Analytical Method (See Notes)	Reportable Concentrations
1. Low Boiling Point Fuels: gasoline, aviation gasoline, gasohol, etc.	1. EPA 8260 or 8021 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 8260 or 8021 AND 2) MADEP VPH: Aliphatics/Aromatics AND 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 8260 or 8021 AND 2) MADEP VPH: Aliphatics/Aromatics AND 3) EPA 8270 & EPA 8080 (pesticides/PCBs)* AND 4) MADEP EPH: Aliphatics/Aromatics AND 5) EPA 3050 or 3051 Preparation: Total Metals (Chromium and Lead)	Any Amount Above the MDL

** EPA 8080 has been replaced by a combination of EPA 8081 and EPA 8082 in the SW 846 test methods. Continue to analyze for EPA 8080 until laboratories are certified for EPA 8082. Laboratory certification is available for EPA 8081.*

NOTES: (1) Report all results on a “dry weight” basis. (2) Submit copies of original lab reports. (3) 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 certified laboratory and prior approval is obtained from the Ministry. (4) 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, and see Appendix B for permit requirements. If TCLP metals exceed TCLP limits, then contact the Works & Engineering Hazardous Waste Section at 295-5151 for storage, shipping and disposal requirements.

Abbreviations

EPA = US Environmental Protection Agency

EPH = Extractable petroleum hydrocarbons

IPE = Isopropyl ether

MADEP = Massachusetts Department of Environmental Protection

MDL = Method Detection Limit

MTBE = Methyl tertiary butyl ether

PCBs = Polychlorinated biphenyls

VPH = Volatile petroleum hydrocarbons

REFERENCES FOR TPH ANALYSIS

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.

REFERENCES FOR JANUARY 1998 APPROVED METHODS

Massachusetts Department of Environmental Protection. To Be Finalized. Method for the Determination of Extractable Petroleum Hydrocarbons. Final method to be listed on internet at www.magnet.state.ma.us/dep/bwsc/vph_eph.htm

Massachusetts Department of Environmental Protection. To Be Finalized. Method for the Determination of Volatile Petroleum Hydrocarbons. Final method to be listed on internet at www.magnet.state.ma.us/dep/bwsc/vph_eph.htm

U.S. 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 6. Required Analyses for Other (non-petroleum) Soil Contamination (Laboratories must be certified by the USEPA to perform all of the following methods)

Suspected Contaminant	**Analytical Method (See Notes)**	**Reportable Concentrations**
1. Metals	Total Metals	Any Amount Above the MDL
2. Halogenated Solvent 3. Non-Halogenated Solvents	EPA Method 8021, 8240, or 8260 EPA Method 8021, 8240, or 8260 (8015 if appropriate for known solvent)	Any Amount Above the MDL
4. Non-Petroleum -Unknown	8240 or 8260 (volatiles), 8270 (semi-volatiles), 8080 (pesticides /PCBs)*, AND Total Metals	Any Amount Above the MDL
5. Pesticides	EPA Method 8080 (organochlorine pesticides) AND Contact Ministry of the Environment / Environmental Engineer (441) 297-7793	Any Amount Above the MDL
6. For substances not covered in 1 through 5	Contact Ministry of the Environment / Environmental Engineer (441) 297-7793	Any Amount Above the MDL

* EPA 8080 has been replaced by a combination of EPA 8081 and EPA 8082 in the SW 846 test methods. Continue to analyze for EPA 8080 until laboratories are certified for EPA 8082. Laboratory certification is available for EPA 8081.

NOTES: (1) Report all results on a “dry weight” basis. (2) Submit copies of original lab reports. (3) 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 certified laboratory and prior approval is obtained from the Ministry. (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, and see Appendix B for permit requirements. (6) If TCLP metals exceed TCLP limits, then contact the Ministry of Works & Engineering Hazardous Waste Section at (441) 295-5151 for storage, transport and disposal requirements (Keep DENR notified of all communications and developments).

Abbreviations

EPA = US Environmental Protection Agency

MDL = Method Detection Limit

PCBs = Polychlorinated biphenyls

TCLP = Toxicity Characteristic Leaching Procedure

Table 7. Container and Preservation Protocol for Soil Analyses
(Laboratories must be certified by the USEPA 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 8240 EPA 8021 EPA 8015	4-oz glass jar with Teflon-lined septa screw cap	Cool to 4 °C	14 days
MADEP VPH	Triplicate VOC vials with Teflon-lined screw caps 60mL vials; add 25g soil **OR** 40-mL vials; add 15g soil 1-mL methanol for every gram of soil; add before or at the time of sampling	Cool to 4 °C	14 days
EPA 3550/TPH California Method EPA 8270 EPA 8080	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.
MADEP EPH	4-oz (120-mL) wide-mouth amber glass jar with Teflon-lined screw cap	Cool to 4 °C	Samples must be extracted within 7 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.

8.4 Sampling Stockpiled Soil

When excavating soil to remove a UST, every effort should be made to segregate clean soil from contaminated soil. This will help reduce the amount of contaminated soil requiring disposal. If excavation is being performed as part of an approved corrective action, then defining the vertical and horizontal extent of soil contamination should be performed prior to excavation. The sampling of contaminated soil stockpiles is primarily intended for the development of acceptable disposal alternatives.

Sampling of the stockpile should be performed immediately prior to applying for a permit or disposal. Samples should be collected and handled as described in Section 8.3. Specific analytical methods may be required (see Section 8.5). Check with the disposal facility concerning analytical requirements for disposal, and contact the Ministry for further information about the treatment of contaminated soil.

A. Number of Samples

The following sampling protocol 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 the specific geometry of the pile or the excavation, or by approximating the general geometry of the pile as specified in Figure 5. If the volume is approximated, use the maximum dimensions as indicated by the sketches for the different shapes of stockpiles in Figure 5. Once the volume is determined, lay out a grid that divides the pile into square blocks with equal surface area.

To obtain one composite sample, three primary soil samples must be collected from each of two randomly selected borings. Two borings must be installed for each 200 cubic yard grid block of stockpiled soil. Primary samples should be collected from the boring as shown in Figure 6. 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 8.3.

B. Primary Samples

Primary samples must be mixed into a composite sample by an approved laboratory under controlled conditions. 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 all of the component primary samples. Because homogenization will, by its very nature, allow some loss of the most volatile 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 Tables 5 or 6. Additional methods may be required for the disposal or treatment of contaminated soil (see Section 8.5).

Figure 5: Volumes of Stockpiles

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

H = Height

L = Length W = Width Conical Stockpiles:

Volume = **a a** x H x L x W

Rectangular Stockpiles - pointed crest:

Volume = **2 2** x H x L x W

Rectangular Stockpiles - flat topped:

Volume = H x [(L x W) - (2 x H x W)]

H = Height

L = Length W = Width

H = Height

L = Length W = Width

L > W > H

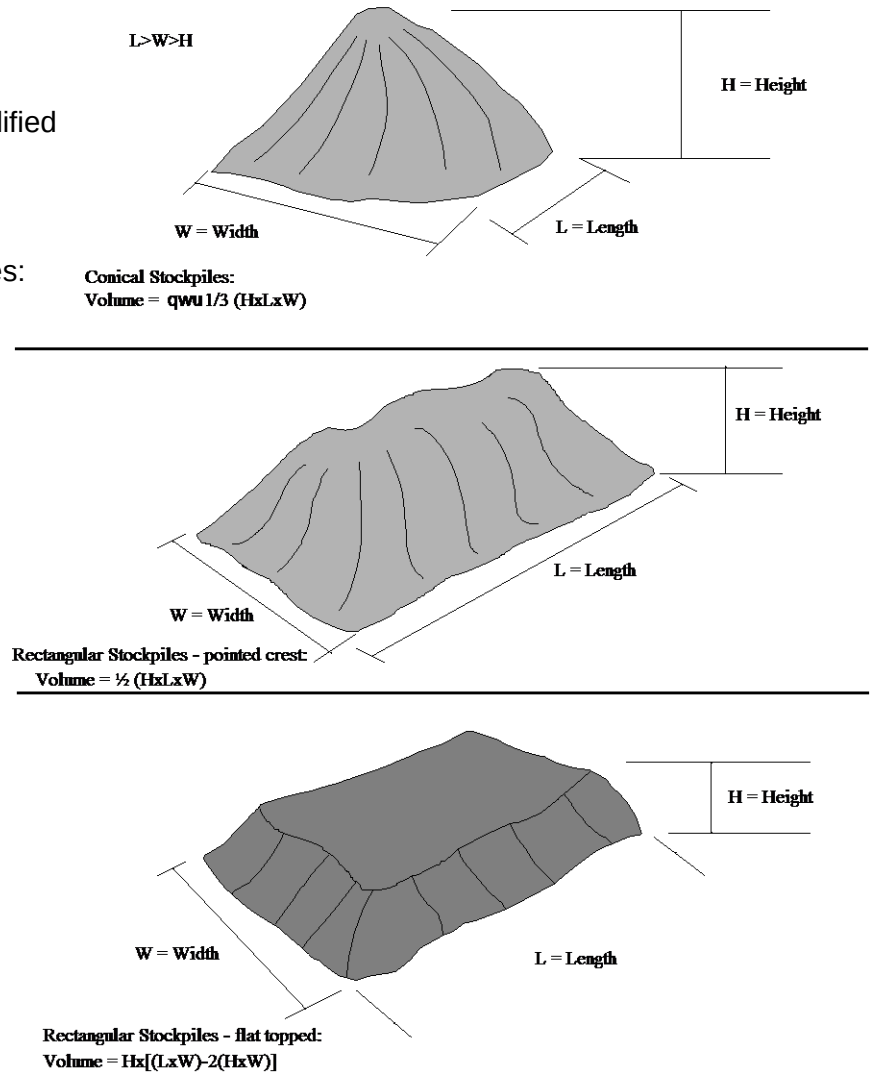


Figure 6: Soil Stockpile Sampling Map (Example)

Stockpile Type: Rectangle, Flat Topped

Volume = 4 x [(21 x 11) - (2 x 4 x 11)] = 572 cubic yards

where: Height (maximum) = 12 feet = 4 yards

Length (maximum) = 63 feet = 21 yards

Width (maximum) = 33 feet = 11 yards

Composite Samples 3 Primary

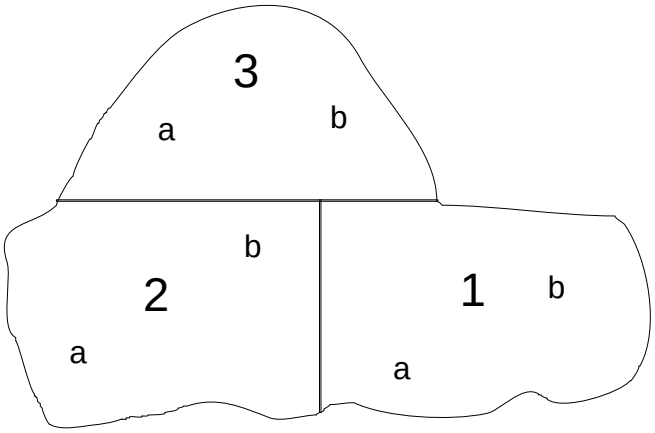
Samples per core Sample Depths

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”.



8.5 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 approved methods for soil analysis for a permit and other permit requirements contact the Ministry. For disposal 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 (TCLP). The TCLP is designed to determine the mobility of both organic and inorganic analytes through the soil matrix holding the contaminants. For petroleum based spills benzene is expected to be the applicable chemical of concern at a regulatory limit of 0.5 mg/l using EPA Method 1311. If any contaminant exceeds the regulatory limits established by the USEPA for TCLP, the contaminated soil must be stored, transported and disposed of as a hazardous waste. Contact the Ministry of Works & Engineering Hazardous Waste Section at (441) 295-5151 for more information.

Excavated soil that has been treated by bioremediation or other processes can be returned to the ground provided it is below the respective 'Industrial', 'Residential' or 'Soil to Groundwater' pollutant thresholds for the area. Soil to be placed in either 'Industrial' or 'Residential' areas must be placed at an elevation greater than 4 feet above the maximum water table level otherwise the more stringent 'Soil to Groundwater' thresholds must apply.

8.6 Sample Storage and Transport

Add any prescribed preservatives before filling the sample containers. After filling the containers, firmly seal to eliminate headspace, and 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 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 Tables 7 and 10).

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.

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

1. each sample including the number of containers and the sampling location;
2. the 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;
7. signatures of all persons relinquishing and receiving custody of samples; and
8. the dates and times of custody transfers.

8.7 Laboratory Analytical Methods

The required laboratory analyses and reportable concentrations for contaminated soil are listed in Tables 5 and 6. Discharges of virgin gasoline and fuel oil (e.g., kerosene, diesel, etc.) which are not blended from used oil, are assumed to be free of metals, or at concentrations less than

the allowable limits. Discharges of used/waste oil or fuel oil blended with used /waste oil (both motor oil and industrial oil) will be assumed to be in excess of all limits for hazardous waste unless laboratory analysis indicates otherwise.

A. UST Closure

Sampling locations for UST closures are provided in Section 5.4. All samples must be analyzed using the EPA methods specified in Table 5. However, analyses using the MADEP VPH and EPH (alkanes/aromatics) methods should be limited to one sample from below each tank one sample from below each pipe trench, and one sample from below each pump/dispenser island. These samples should be collected from the most contaminated areas, if known. If contamination is not evident at the time of sampling, these samples should be taken from areas where releases are most likely to have occurred, such as below the fill pipe or below the pipe joints.

B. Limited Site Assessment

Soil sampling locations and frequency are provided in Section 6.1. All samples collected in the Phase I investigation must be analyzed using the methods (including MADEP VPH and EPH) specified in Tables 5 and 6. For the Phase II investigation, metals and the acid extractable organic compounds portion of EPA Method 8270 should be eliminated from the analytical requirements if these parameters were not detected in previous analyses.

C. Further Assessment, Corrective Action, and Monitoring Activities

Samples must be analyzed in accordance with the methods specified in Table 5 and 6. 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 to be analyzed if certain other targeted contaminants were not detected in previous sampling events. For example, if only polycyclic aromatic hydrocarbons (PAHs) were detected in LSA samples using EPA Method 8270, it is not necessary to continue in subsequent sampling events to analyze and report any of the other base neutral organic compounds detected by EPA Method 8270. The responsible party should request that the laboratory report only the PAHs.

8.8 Laboratory Reports

Analytical results must be compiled in the appropriate report or as specified by a permit and submitted to the Ministry. 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 Ministry in appropriate reports:

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

9. Cleanup Requirements for Groundwater

Groundwater contaminated by all sources must be cleaned up to the levels of the Tier I screening levels shown in Table 1B. These standards are the maximum allowable concentrations resulting from any discharge of contaminants to the land or waters of Bermuda, which may be tolerated without creating a threat to human health, or which could render the groundwater unsuitable for its intended best usage. Final determination of groundwater contamination must be made by the laboratory analytical methods presented in Table 8 for petroleum-derived contamination and Table 9 for non-petroleum sources using the sampling and preservation steps detailed in Table 10.

If the DENR confirms the classification of the site of a discharge or release as Category A or B following receipt of the CSA report, a RAP must be submitted. The RAP must propose appropriate remediation strategies to remove free product and restore groundwater quality to the level of the interim standards or as closely thereto as economically and technologically feasible.

A RAP for a Category A or B discharge or release must contain a proposal for actively treating groundwater contamination (e.g., air sparging, pump and treat, etc.), remediating groundwater contamination through natural processes (remediation by natural attenuation (RNA)) or a combination of active treatment and RNA. Further guidance on preparing a RAP is provided in Appendix A.6.

Once all site contamination, including soil contamination, is remediated to applicable cleanup levels, the responsible party must submit a Site Closure Report (Appendix A.8) documenting all cleanup activities and requesting that the DENR issue a notice of no further action.

9.1 Public Notice

A responsible party who proposes remediation by natural attenuation or not to cleanup groundwater contamination to the interim standards, must comply with the public notice requirements. Refer to Section 12.0 for further guidance on public notice.

10. Groundwater Sampling Guidelines

Groundwater samples are collected to investigate, assess, and monitor the concentration of dissolved constituents. To properly assess the groundwater contaminant plume, install monitoring wells, collect groundwater samples and perform specific laboratory analyses. The number and location of sampling points will depend upon specific site conditions and the goals of the investigation. All wells should be constructed in accordance with the Government Hydrogeologist (Water Section Policies) and sampled as outlined in this section. Follow proper sampling procedures to obtain representative samples.

10.1 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 certified mobile laboratory to perform on-site soil and groundwater analyses while performing the probe survey. As with any laboratory, a mobile laboratory must be 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, Geoprobing, 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 number of monitoring wells.

When using the pushprobe technology, the consultant should determine its site-specific feasibility by evaluating the soil permeability and depth to groundwater. It may be difficult to recover samples from sites with a shallow water table and sandy soil. Using this technology on a site with poor site-specific conditions could result in failed attempts.

10.2 Sample Preparation

Always select a certified laboratory to perform the required groundwater analyses, and ask the laboratory about any specific sample handling procedures required by the analytical method(s). Decide whether to do your own sampling or negotiate a contract for sampling and analysis.

First determine the type(s) of contaminants expected and the proper analytical method(s) for the contaminants as established in Tables 8 and 9. The type of sample containers to be used depends on the type of analysis needed. If doing your own sampling, consult with the selected laboratory about the specific requirements of the analytical method(s). Sample containers, volumes, procedures, and preservation vary among methods. Table 10 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.

Sampling kits for sample collection and transport may be purchased from some commercial laboratories and 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, the DENR 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 a chilled environment 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 8. Required Analyses for Petroleum-Contaminated Groundwater
(Laboratories must be certified by the USEPA 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. MADEP VPH: Aliphatics/Aromatics 3. 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. MADEP VPH: Aliphatics/Aromatics **AND** 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 **AND** 2. MADEP VPH: Aliphatics/Aromatics **AND** 3. 625** plus 10 largest non-target peaks identified **AND** 4. MADEP EPH: Aliphatics/Aromatics **AND** 5. Metals (Standard Methods 3030C** prep.): lead and chromium.	Any Amount Above the MDL

* 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 analyse 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 DEP. (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 certified laboratory and prior approval is obtained from the DEP. (3) All MDLs must be performed at or below the interim standards.

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.

Massachusetts Department of Environmental Protection. To Be Finalised*. Method for the Determination of Extractable Petroleum Hydrocarbons*. Final method to be listed on internet at www.magnet.state.ma.us/dep/bwsc/vph_eph.htm

Massachusetts Department of Environmental Protection. To Be Finalised*. Method for the Determination of Volatile Petroleum Hydrocarbons*. Final method to be listed on internet at www.magnet.state.ma.us/dep/bwsc/vph_eph.htm

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 9. Required Analyses for Other (non-Petroleum) Contaminated Groundwater (Laboratories must be certified by the USEPA to perform the following methods)

Suspected Contaminant	Analytical Method (See Notes)	Reportable Concentrations
1. Metals	Metals (Standard Methods 3030C*prep).	Any Amount Above the MDL
2. 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
3. Non-Petroleum - Unknown	1. EPA 624** or 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
4. Pesticides	Contact Department of Environment and Natural Resources (441) 236 4201	Not Applicable
5. For substances not covered in 1 - 4	Contact Department of Environment and Natural Resources (441) 236 4201	Not Applicable

* 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 subsequently be used. (For example, if no “Acids” were detected by GC/MS Method 625, subsequently analyse by 625 for “Base/Neutrals” only, or use GC Methods 610.)

NOTE: 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 DEP.

Table 10. Container and Preservation Protocol for Groundwater Analyses (Laboratories must be certified by the USEAP 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 VOC 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 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 HNO3 (to pH<2) Cool to 4 °C Submit to lab within 48 hours of collection	3030C prep within 72 hours of collection and analyse within 6 months of prep.

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

10.3 Groundwater Sample Collection Procedures

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 and 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 the building or house.

Prior to 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 (pressure tank). When collecting samples for volatile organic compounds, the flow rate must be reduced to a minimum to avoid aerating the sample.

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 depth to submersible pump, depth of casing, and static water level.

NOTE: Water supply wells will not be considered a substitute for monitoring wells.

1. Uncontaminated Water Supply Wells

Initially, residential or public water supply wells which are located within 500 feet of the source area of the discharge or release should be sampled. If the closest wells become impacted by the release, then the next closest wells should be sampled and so forth. Sampling and

reporting the results for each uncontaminated well should be repeated semi-annually or as otherwise specified by the DENR.

If contamination is detected, copies of the lab report must be submitted to the well user, well owner, DENR, and the Health Department. Questions regarding effects to the health of individuals should be directed to the Chief Medical Officer at the Health Department. However, if no contamination is detected, the analytical results only need to be submitted to the person utilizing the well and to the DENR.

2. Contaminated Water Supply Wells

If analysis of samples extracted from a residential or public water supply well has previously indicated contamination and the Chief Medical Officer has determined the well is still useable to some degree, samples should be collected at the frequency advised by the epidemiologist. A summary of historical analytical results may be requested with each laboratory analysis submitted to the epidemiologist. If the epidemiologist does not recommend a time interval for re-sampling, the well should be sampled semi-annually or as otherwise specified by the DENR.

NOTE: Toxicological evaluations should be forwarded to the well user and Chief Medical Officer.

3. Reduction of Sampling Activities

Resampling 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 DENR once an active groundwater remediation system is in place minimizing 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 DENR prior to eliminating any sampling efforts.

4. Sampling Methodology

Samples should be analyzed in accordance with groundwater analytical methods specified in Tables 8, 9 and 10.

5. Alternate Water

The DENR 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 drinking water may be discussed with the DENR.

NOTE: The DENR should be contacted prior to the abandonment of water supply wells and the connection to municipal water supplies.

B. Monitoring Wells

1. Measuring Water Levels

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 an inch 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. 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.

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.

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 such time as the field parameters (pH, specific conductivity, and temperature) stabilize, by purging three well volumes from the well, or 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 containing 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)] * 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 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.

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

3. Handling Purged Water

All contaminated purged water must be disposed of in an environmentally sound manner. Contact the DENR for disposal procedures.

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 or cleaned reusable 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. Sample wells beginning at the known or suspected least contaminated well and proceeding to the known or suspected most contaminated well. 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 A).

1. Pumps

To purge standing well water and to avoid silt locking the 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 collecting samples for volatile contaminants, 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.

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 water to create an upper meniscus above the top of the vial to help 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.

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

The volatile samples that will be analyzed by the MADEP VPH method (when approved) should be collected in duplicate without agitation or headspace in 40mL vials preserved with HCl, similar to the procedure used in sampling EPA601/602. The semi-volatile samples that will be analyzed using MADEP EPH method should be collected in a 1-liter amber bottle preserved with HCl.

10.4 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.

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 each 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 each use.

10.5 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 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 10).

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 be completed and accompany the samples to the laboratory. The COC must include the following:

1. each sample including the number of containers and the sampling location;
2. the 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 program(i.e., UST; Voluntary Action Program);
7. signatures of all persons relinquishing and receiving custody of samples; and
8. the dates and times of custody transfers.

10.6 Laboratory Analytical Methods

The laboratory analyses for potentially contaminated groundwater are listed in Tables 8 and 9. The MADEP VPH and EPH methods must be used for groundwater contaminated by petroleum releases. 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 DENR.

Results of analyses must be compiled in the appropriate report and submitted to the attention of the Environmental Engineer at the DENR 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.

10.7 Laboratory Reports

Results of analyses must be compiled in the appropriate report or as specified by a permit and submitted to the DENR. 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 DENR in the appropriate reports:

1. Laboratory Certification Number
2. Facility Name
3. Date of Report Preparation
4. Chain-of-Custody
5. Analytical Result Summary sheets including QA/QC information
6. Laboratory Chronicle and Methodology including holding time checks
7. Summary of Calibration Information (date calibrated, ranges, etc.)

8. Blank Results (method, field, trip, etc.)
9. Method Detection Limits

11. Tier II Cleanup Requirements for Soil and Groundwater

The goal of site restoration is to ensure that soil and groundwater contamination does not pose an unacceptable risk to human health and the environment. Tier I cleanup standards were developed to restore the source area of contamination to a level protective to human health and the environment. At sites where it is not technically or economically feasible to restore the source area to the Tier I cleanup standards, a Tier II risk assessment may be completed by the responsible party. Tier II risk based cleanup standards may be developed for soil and groundwater contaminated based on site-specific information. The responsible party must propose a cleanup level that will be protective of human health and that will not result in a violation of the groundwater quality standards or interim standards at the point of compliance. Naturally-occurring background levels may be considered in determining a cleanup level for some constituents (e.g. metals in soil).

11.1 Points of Compliance

In a Tier I evaluation, the point of compliance (POC) is set as the entire site and all sampling locations (in the source area and on the remainder of the site) must meet the cleanup standards. The underlying premise is that the point of exposure is the point of maximum contaminant concentration. For soils, the top three feet must meet the residential or commercial/industrial direct contact standard or the soil-to-groundwater protection standard, which ever is more restrictive. For sub-surface soils, the concentrations of COCs must meet the soil-to-groundwater protection standard.

In a Tier II evaluation, the point of exposure is removed from the source area to an actual or probably point of exposure. The POC for groundwater under Tier II is the closest groundwater extraction point or interface with surface water if located on the same property, or the property boundary, which ever is closest to the source. For soil contamination, the Tier II standard must be protective of groundwater at the revised POC and of human receptors by direct contact.

The DENR will consider all responsible 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 DENR recommends using the contaminant fate and transport models utilized for Tier II in the ASTM Standard E1739-95 Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.

The use of these contaminant transport models will likely be necessary to demonstrate that the concentration of a contaminant in soil will not result in a violation of groundwater standards at the POC. 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 models.

Biodegradation may be factored into a fate and 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 biodegradation is occurring and the site specific rate of biodegradation hasbeen be determined.

NOTE: All assumptions and estimated values used in contaminant transport modeling, including biodegradation rates, shall be conservative (predict reasonable-worst case scenario) and shall be well documented.

11.2 Engineering and Administrative Controls

The use of engineering controls to reduce exposure to COCs may be utilized and factored into a Tier II assessment. Engineering controls may include installing an impermeable cap (asphalt or

concrete) to prevent direct contact with contaminated soil and reduce infiltration; or erecting a fence to limit public access and limit direct contact to onsite commercial/industrial receptors.

If engineering controls are used to develop Tier II standards, then they shall be maintained until such time as it can be shown that they are no longer needed to prevent a violation of the groundwater standards or Tier I direct contact residential soil standards. In conjunction with engineering controls, administrative controls are required to prevent an inadvertent compromise of the engineering control. For example, a concrete slab installed to cap an area of contaminated soil, would require a deed notice with a survey of the location and construction of the slab, restricting the future use and development of the property to activities that would not disturb the concrete slab. In addition, zoning and Planning restrictions might be required to limit the use of the property to non-residential activities.

11.3 Public Notice

Responsible parties who propose remediation to Tier II standards must comply with the public notice requirements. Refer to Section 12.0 for further guidance on public notice.

12. Public Notice

12.1 Public Notice Required Prior to Performing Remediation of Groundwater and/or Soil

Public notice is required prior to performing remediation of groundwater and/or soil in any of the following circumstances:

- The responsible party submits a RAP proposing remediation by natural attenuation (RNA). (Public notice is required even if the RAP proposes a combination of active treatment and RNA);
- The responsible party submits a RAP proposing to cleanup groundwater contamination to a standard other than the groundwater standard or interim standard;
- The responsible party submits a plan proposing to cleanup soil contamination to a standard other than the residential or soil-to-groundwater maximum contaminant concentration, whichever is lower; or
- The responsible party is proposing to utilize a Tier II assessment or implement engineering and institutional controls.

Concurrent with the submittal of a RAP, the responsible party must provide notice to the following:

- the Chief Medical Officer at the Health Department;
- the chief administrative officer of each municipality (city Corporation) in which the contamination occurs (if applicable);
- 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.

The notice must be made by registered mail. The notice must describe the nature of the remediation proposal and the reasons supporting it.

NOTE: The chief administrative officer is considered to be the Mayor, or Corporation Manager, or other official of equal or similar position.

It may be impractical to provide notice by registered mail to the occupants of apartment buildings, condominiums, office buildings, etc. In these cases, the responsible party may give notice by posting the notice in a prominent place where the building occupants are most likely to see it. Approval of the RAP will be postponed for a period of thirty (30) days following receipt of the submittal so that the DENR may consider comments submitted by interested persons. All comments received within this time frame will be considered in approving the RAP. A public meeting may be held should the Environmental Engineer find a significant degree of public interest in the proposed activities.

Within 30 days of submitting the RAP, the responsible party must provide the DENR with proof of receipt of the notice or of refusal by the addressee to accept delivery of the notice. If notice is made by posting, the responsible party must provide the DENR with a description of the manner in which the posted notice was given.

The notice must describe the nature of the proposed remediation and the reasons supporting it. The format of the notice is provided in Section 12.3.

12.2 Public Notice Required After Receiving Notification of Site

Once a discharge or release is classified as Category D and soil contamination has been cleaned up to applicable cleanup levels, the DENR will issue a notice to the responsible party specifying that no further action is required. If the discharge or release has not been remediated to the standards or interim standards or to the lower of the residential or soil-to-groundwater maximum soil contaminant concentrations, the responsible party must provide public notice.

Within 30 days of receiving a no further action notice, the responsible party must provide a copy of the notice to the following:

- the Chief Medical Officer at the Health Department;
- the chief administrative officer of each municipality (city Corporation) in which the contamination occurs (if applicable);
- 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.

The notice must be made by registered mail.

NOTE: The chief administrative officer is considered to be the Mayor, or Corporation Manager, or other official of equal or similar position.

It may be impractical to provide the no further action notice by registered mail to the occupants of apartment buildings, condominiums, office buildings, etc. In these cases, the responsible party may post the notice in a prominent place where the occupants are most likely to see it. A public meeting may be held should the Environmental Engineer find a significant degree of public interest in the proposed closure.

Within 60 days of receiving the no further action notice, the responsible party must provide the DENR 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 is posted, the responsible party must provide the DENR with a description of the manner in which the posted notice was given. Site closure will be conditional until proper notice has been made.

12.3 Format of Public Notice

A. Public Notice to an Individual

The following is the format to be used by a responsible party for providing individual public notice

Date

REGISTERED MAIL (Give number of receipt)

RETURN RECEIPT REQUESTED
[Name and address of person
Required to be notified]

Subject: Notice of Request for Approval of a ***Remedial Action Plan,***
Site name
Address
Parish
Incident No.

Dear (Name of Property Owner/Occupant):

This letter is to inform you that the Department of Environment and Natural Resources, Ministry of Health, Seniors & Environment has received a request for approval of a proposal to cleanup a discharge or release of petroleum or other hazardous substance located in your area. Because the property that you own or occupy is located within or contiguous to an area containing contamination or within or contiguous to an area where the contamination is expected to migrate, you are required to be informed of the proposed activities.

(Name of responsible party) is providing notice of the request for approval of a Remedial Action Plan, that proposes: ***(Choose all that apply)***

- To use natural processes of degradation and attenuation as a method to cleanup contaminated groundwater;
- ***To cleanup groundwater contamination to a standard other than the groundwater standard or interim standard;***
- ***To cleanup soil contamination to a standard other than the residential or soil-to-groundwater maximum contaminant concentration, whichever is lower; and***
- ***The responsible party is proposing to utilize a Tier II assessment or implement engineering and institutional controls.***

The source area of the contamination is located at [Give the location of the source area of the discharge or release using at least two street names/numbers. If this is not feasible, use the name/number of one road and the distance to an identified landmark (e.g., named body of water, historic site, or park), include the Ordnance Survey sheet number (Series E811) and grid reference number.] Please see the attached map showing the location of the source area of the discharge or release and the location of your property.

(Describe the cleanup proposal and provide the reasons supporting it. Include a discussion of how the public health and environment is protected and cite any additional reasons why this proposal should be relied on to reduce the risk posed by the discharge or release.)

If you would like to examine the plan, please contact (contact person for the proponent of the plan) at (area code and telephone number). A copy will be mailed to you promptly. In addition, the DENR has the Remedial Action Plan along with other site information on file and available for public review. You may make copies of this information for a small fee. Any written

comments concerning this request should be submitted to the following address within thirty (30) days of the date that this letter was issued:

Environmental Engineer
Ministry of Health Seniors & Environment
Department of Environment and Natural Resources
Government of Bermuda
Botanical Gardens
169 South Road, Paget
Bermuda DV-04
(441) 236 4201

All comments received within this time frame will be considered in approving the Remedial Action Plan. A public meeting may be held should the Environmental Engineer find a significant degree of public interest in the proposed activities.

The Environmental Engineer may be contacted during normal weekday business hours to answer questions or to arrange an appointment to review the information on file pertaining to the discharge or release. Notification of this request for approval of a Remedial Action Plan is also being made by certified mail to ***(name and title of director of the Health Department)***, ***(name and title of Chief Administrative Officer)***, and other property owners and occupants within or near the source area of the discharge or release.

Sincerely,

(Responsible Party Contact name and title)

Attachment: Scaled site map showing source area of discharge or release and location of property owned or occupied by person being notified.

B. Public Notice by Posting

The following is the format to be used by a responsible party posting notice.

PUBLIC NOTICE

NOTIFICATION OF
PROPOSED CLEANUP OF A DISCHARGE OR RELEASE OF PETROLEUM OR OTHER HAZARDOUS SUBSTANCE

Site name
Address
Parish
Incident No.

Public notice is hereby given of receipt of a request for approval by the Department of Environment and Natural Resources, Ministry of Health, Seniors & Environment of a Remedial Action Plan for the above-referenced site. The Remedial Action Plan proposes: ***(Choose all that apply)***

- To use natural processes of degradation and attenuation as a method to cleanup contaminated groundwater;
- ***To cleanup groundwater contamination to a standard other than the groundwater standard or interim standard; and***
- ***To cleanup soil contamination to a standard other than the residential or soil-to-groundwater maximum contaminant concentration, whichever is lower.***
- ***The responsible party is proposing to utilize a Tier II assessment or implement engineering and institutional controls.***

Interested parties may examine the Remedial Action Plan by contacting ***(contact person for the proponent of the plan)*** at ***(area code and telephone number)***. In addition, the DENR has the Remedial Action Plan along with other site information on file and available for public review. You may arrange to review this information by contacting the DEP.

Any written comments concerning this request should be submitted to the following address within thirty (30) days of the date that this notice was posted:

Environmental Engineer
Ministry of Health, Seniors & Environment
Department of Environment and Natural Resources
Government of Bermuda
Botanical Gardens
169 South Road, Paget
Bermuda DV-04
(441) 236 4201

_____ _____
Date Name of Responsible Party

_____
Signature of Responsible Party

13. Site Closure

Site Closure is the termination of regulatory oversight activities related to a discharge or release. It may occur when information is provided to document that site remediation has achieved the cleanup levels or standards specified by the regulatory agency. The following paragraph outlines the procedures for discontinuance of remedial action for sites which have a documented violation of the groundwater standards.

Sites that have been undergoing active remediation must show that groundwater has been remediated to below groundwater standards. Four consecutive quarters of data documenting no contamination above the standards or interim standards while the remediation system is operational, **and** four consecutive quarters of data documenting no contamination above the standards or interim standards after the remediation system has been shut down are required.

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

Appendix A – Report Format Summary

The assessment and remediation of a site with groundwater and/or soil contamination should be documented by following the reporting requirements presented below. A UST Closure Report should only be submitted for USTs activities associated with the closure of a UST system.

A1. Notify the Department of Environment and Natural Resources, Ministry of the Environment of the release within 24 hours of discovering the release (**24-Hour Notice Report**).

A2. Soil Contamination Report. *A Soil Contamination Report should be submitted only if the responsible party can demonstrate that remaining soil in the sidewalls and at the base of the excavation is in the unsaturated zone and does not contain contaminant levels exceeding either the soil-to-groundwater maximum contaminant concentrations or the residential maximum contaminant concentrations, whichever are lower.* If these conditions cannot be met, the responsible party must submit a Limited Site Assessment Report. The Soil Contamination Report should be submitted to the Ministry within 30 days of discovery of a discharge or release. Whenever applicable, the Soil Contamination Report should be incorporated into a UST Closure Report (also due within 30 days after the UST closure has been completed) to expedite risk classification and site closure.

A3. Limited Site Assessment Report - If the conditions to submit a Soil Contamination Report cannot be met then a limited site assessment must be performed. The Limited Site Assessment Report should be submitted to the Ministry within 60 days of discovery of a discharge or release.

A4. UST Closure Report (UST sites only). This report applies to **all** USTs sites. It may be prepared prior to the above reports, if a release was discovered during the UST closure. The UST Closure Report should be submitted within 30 days after the UST closure has been completed.

A5. Comprehensive Site Assessment Report - If applicable, prepare and submit a Comprehensive Site Assessment (CSA) Report to the Ministry within 90 days of following release confirmation.

A6. Remedial Action Plan - If applicable, prepare and submit a Remedial Action Plan (RAP) within the timeframe specified by the Ministry.

A7. Monitoring Reports - If required by the Ministry, prepare and submit a Monitoring Reports as required by the RAP approval

A8. Site Closure Report - shall be submitted to the Ministry to document achievement of the remedial objectives.

NOTE: *A Competent Environmental Professional Certification is generally required for all reports submitted. The only report that will not require such a certification is a UST Closure Report where the sampling results indicate that no release has occurred. All plans and specifications intended for use in construction of or for obtaining regulatory authorization to construct an active remediation system must be prepared under responsible charge of a Competent Environmental Professional.*

A.1 24-Hour Notice Report to Dept. Environment and Natural Resources

The Ministry of the Environment must be notified within 24 hours of the discovery of a discharge or release. Though a form is not necessary, the following information should be provided.

- Date and time of release discovery;
- Facility ID number (if applicable);
- Phone number of person to be contacted concerning the release;
- Responsible party's name, address, location, phone number, and directions to site of release;
- Nature of release: type of product released, quantity released, and if applicable, size and age of tank(s) (if known);
- Document the presence of free product (if known);
- State how the release was discovered (e.g., odors, sample results, staining, etc.);
- Document the action taken to stop the release and if applicable indicate if the UST or UST system will be removed;
- Document the quantity of water supply wells in use within 1500 feet of the release; and
- Any other relevant information pertaining to the release or suspected release.

A.2 Soil Contamination Report (30d)

The Soil Contamination Report is appropriate for sites where the initial site action is sufficient to remediate the site. Within 30 days of discovery of a discharge or release, the responsible party shall submit a Soil Contamination Report demonstrating the soil remaining in the sidewalls and at the base of the excavation are in the unsaturated zone and do not exceed either the soil-to-groundwater or the residential maximum soil contaminant concentrations, whichever are lower.

If these conditions cannot be met, the responsible party must submit a Limited Site Assessment Report (Appendix A.3). **The Soil Contamination Report shall be submitted to the Ministry within 30 days of discovery of a discharge or release.** Whenever possible for UST sites, the Soil Contamination Report should be combined with the UST Closure Report, to expedite risk classification and site closure.

Minimum elements of the Soil Contamination Report:

A. Title Page

- Site name, location, Groundwater Incident number, and, if applicable Facility I.D. number;
- Date of report;
- Persons responsible for release or discharge including addresses and phone numbers;
- Current property owner including address and phone number;
- Consultant/contractor including address and phone number;
- Release information including date discovered, estimated quantity of release, cause of release, source of release, and, if applicable, the size and contents of UST system(s) from which release occurred;
- Latitude and longitude of the release (or grid reference number); and
- Signature of certifying Environmental Professional.

B. Site History

In table format, list all sources of contamination including, UST systems currently or previously located at the site including UST system number, product, capacity, date installed, date removed or closed, and whether a release was discovered. UST system numbers should correspond to the site map information requested below.

List the names, addresses, telephone numbers, and dates of ownership/operation of all previous property owners and operators of the UST system(s).

C. Site Investigation

Use maps and tables whenever possible and provide the rationale for sampling performed. Describe all soil sampling performed to date including:

- location of soil samples;
- type of soil samples (from excavation, borehole, geoprobe, etc.);
- date of sampling;
- soil sample collection procedures (split spoon, grab, hand auger, etc.);

- depth of soil samples below land surface;
- soil sample identification;
- soil sample analyses; and
- soil sample analytical results (list any contaminant above MDL).

Describe any groundwater sampling performed to date including:

- location of groundwater samples/monitoring wells/water supply wells;
- date of sampling;
- groundwater sample collection procedures (bailer, pump, etc.);
- groundwater sample identification;
- groundwater sample analyses; and
- groundwater sample analytical results (list any contaminant above MDL).

Describe any excavation, treatment and/or disposal of contaminated soil.

D. Figures

- 1:25,000 scale Bermuda topographic map (copy) showing an area within a 1500-foot radius of source of release.
- Site map with source location(s) including and SUT system, piping and pump islands, site boundaries, buildings, named roads, subsurface utilities, basements, adjacent properties, and any on-site water supply well, ditches, or adjoining surface waters.
- Site map(s) showing the results of all sampling conducted to date. Indicate sample identifications, sample locations, sampling depths, and analytical results.
- Site map showing the results of all soil sampling conducted. Indicate sample identifications, sample locations, sampling depths, and analytical results.
- Site map showing the results of all groundwater sampling conducted. Indicate sample identifications, sample locations/monitoring well identifications, and analytical results.

NOTE: *If possible, use a single base map to prepare site plans using a map scale of 1 inch = 40 feet (or a smaller scale for large sites, if necessary). Maps and figures should include conventional symbols, notations, labeling, legends, scales, and north arrows and should conform to generally accepted practices of map presentation.*

E. Tables

- Site history;
- Soil sampling results; and
- Groundwater sampling results.

F. Appendices

- Boring logs and lithologic descriptions;
- Well construction records (if applicable);

- Field measurements (e.g., pH, dissolved oxygen, specific conductivity, temperature) made during groundwater sampling;
- Standard procedures used for sampling, field equipment decontamination, field screening, etc.;
- Disposal manifests (if applicable); and
- Laboratory reports and chain-of-custody documents

A.3 Limited Site Assessment Report (60d)

The Limited Site Assessment Report documents initial site assessment activities and risk characterization performed on site. This report should be completed and submitted to the Ministry of the Environment within 60 days of the discovery of a discharge or release.

Minimum elements of the Limited Site Assessment Report

A. Title Page

- Site name, location, Groundwater Incident number, and Facility I.D. number;
- Date of report;
- Responsible party for the release or discharge including addresses and phone numbers;
- Current property owner including address and phone number;
- Consultant/contractor including address and phone number;
- Release information including date discovered, estimated quantity of release, cause of release, source of release (piping/UST), and, if applicable, size and contents of UST system(s) from which release occurred;
- Latitude and longitude of the release (or grid reference number); and
- Signature of certifying Environmental Professional.

B. Site History

In table format, list all sources of contamination including, UST systems currently or previously located at the site including UST system number, product, capacity, date installed, date removed or closed, and whether a release was discovered. UST system numbers should correspond to the site map information requested below.

List the names, addresses, telephone numbers, and dates of ownership/operation of all previous property owners and operators of the UST system(s).

C. Risk Characterization

Submit the following four page questionnaire in its entirety. Answer all questions completely. Attach additional pages as needed to fully explain answers. Base answers/explanations on information known or required to be obtained during the Limited Site Assessment.

NOTE: *Source area means point of discharge or release for a spill or from a UST system.*

Limited Site Assessment Risk Classification and Land Use Form

Part I – Groundwater/Surface water/Vapor Impacts

High Risk

1. Has the discharge or release contaminated any water supply well including any used for non-drinking purposes? YES/NO

If yes, explain. _____

_____

_____

_____

2. Is a water supply well used for drinking water located within 1000 feet of the source area the discharge or release? YES/NO

Explain. _____

_____

_____

3. Is a water supply well used for any purpose (e.g., irrigation, washing cars, industrial cooling water, filling swimming pools) located within 250 feet of the source area of the release or discharge? YES/NO

Explain. _____

_____

_____

_____

4. Does groundwater within 500 feet of the source area of the discharge or release have the potential for future use in that there is no other source of water supply other than the groundwater? YES/NO

Explain. _____

_____

_____

_____

5. Do vapors from the discharge or release pose a threat of explosion because of accumulation of the vapors in a confined space or pose any other serious threat to public health, public safety or the environment? YES/NO

If yes, explain. _____

6. Are there any other factors that would cause the discharge or release to pose an imminent danger to public health, public safety, or the environment? YES/NO

If yes, explain. _____

Intermediate Risk

7. Is a surface water body located within 500 feet of the source area of the discharge or release? YES/NO

8. Is the source area of the discharge or release located within a designated groundwater protection area as defined in the 1992 Development Plan? YES/NO

If yes, explain. _____

9. Is the discharge or release located in an area in which there is recharge to an aquifer which is being used or may be used as a source of drinking water? YES/NO

Part II - Land Use

Property Containing Source Area of Discharge or Release

The questions below pertain to the property containing the source area of the release.

1. Does the property contain one or more primary or secondary residences (permanent or temporary)? YES/NO

Explain. _____

2. Does the property contain a school, daycare center, hospital, playground, park, recreation area, church, nursing home, or other place of public assembly? YES/NO

Explain. _____

3. Does the property contain a commercial (e.g., retail, warehouse, office/business space, etc.) or industrial (e.g., manufacturing, utilities, industrial research and development, chemical/petroleum bulk storage, etc.) enterprise, an inactive commercial or industrial enterprise, or is the land undeveloped? YES/NO

Explain. _____

4. Do children visit the property? YES/NO

Explain. _____

5. Is access to the property reliably restricted consistent with its use (e.g., by fences, security personnel or both)? YES/NO

Explain.

6. Do pavement, buildings, or other structures cap the contaminated soil? YES/NO

Explain.

If yes, what mechanisms are in place or can be put into place to ensure that the contaminated soil will remain capped in the foreseeable future?

7. What is the zoning status of the property?

8. Is the use of the property likely to change in the next 20 years? YES/NO

Explain.

Property Surrounding Source Area of Discharge or Release

The questions below pertain to the area within 1500 feet of the source area of the discharge or release (excludes property containing source area of the release):

1. What is the distance from the source area of the release to the nearest primary or secondary

   Residence (permanent or temporary)?

2. What is the distance from the source area of the release to the nearest school, daycare center, hospital, playground, park, recreation area, church, nursing home or other place of public assembly?

3. What is the zoning status of properties in the surrounding area?

4. Briefly characterize the use and activities of the land in the surrounding area

D. Receptor Information

1. Water Supply Wells

In a table, list all water supply wells (omit only those that have been properly abandoned) within 1500 feet of the source area of the discharge or release. For each well, include the well number (can use the assessment number), well owner and user names, addresses and telephone numbers, use of the well, and distance from the source area of the release. Key well numbers to water supply well map requested below. Discuss methods used to obtain well survey information. This information should correspond to the map required below.

2. Public Water Supplies

Discuss the availability of public water supplies within 1500 feet of the source area of the discharge or release including the location of the nearest public water lines and the source(s) of the public water supply.

3. Surface Water

Identify all surface water bodies (e.g., ditch, pond, canal, inshore water) within 1500 feet of the source area of the discharge or release. This information must be shown on the topographic map requested below.

4. Groundwater Protection Areas

Determine whether there are designated groundwater protection areas as defined in the 1992 Development Plan within 1500 feet of the source area of the discharge or release.

5. Subsurface Structures

Describe all subsurface structures (e.g., sewers, utility lines, conduits, basements, septic tanks, leach fields, floor and storm drains, etc.) located on the site. This information must be shown on the site plan requested below. Discuss whether vapors pose a threat of explosion due the accumulation of vapors in a confined space. Also, discuss whether vapors may pose any other serious health threat to public health, public safety or the environment.

6. Land Use

Discuss the uses and activities, involving possible human exposure to contamination that could occur at the site and in the area within 1500 feet of the source area of the discharge or release. Examples of such activities and uses include but are not limited to use of a property for an office, manufacturing operation, residence, store, school, gardening or farming activities, recreational activities, or undeveloped land. This evaluation must include a consideration of activities which may not be occurring at the time of evaluation but which are consistent with the current use of the site and area surrounding the site. The discussion must also include the zoning status of the site and surrounding properties. The information provided should be consistent with the map required below.

7. Property Owners and Occupants

In a table, list the names and addresses of 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.

E. Site Geology and Hydrogeology

Describe the soil and geology encountered at the site. Discuss the effects of soil and geological characteristics on the migration and attenuation of contaminants. Include information obtained during assessment activities (e.g., lithologic descriptions made during drilling, probe surveys, initial abatement activities, tank closure, etc). Include a discussion of groundwater flow direction and hydraulic gradient.

F. Groundwater Sampling Results

A minimum of one monitoring well shall be installed in the source area of a discharge or release. Soil samples are to be collected every five feet in the unsaturated zone and should be analyzed in accordance with the methods specified in Tables 5 or 6 (Approved Methods for Soil Analyses). If the water table is encountered at 25 feet or greater from the land surface, samples for laboratory analysis should be collected every 10 feet in the unsaturated zone.

Discuss the sampling results and include the following information:

- In a table, provide for each soil sample the sampling depth, sample identification, date of sampling, sample collection procedures (split spoon or hand auger), sample analyses, and analytical results. List any contaminant detected above the method detection limit. Identify the samples that exceed the soil-to-groundwater or the residential or commercial/industrial (as appropriate) maximum contaminant concentrations, whichever are lower.
- In a table, provide the groundwater sample identification, date of sampling, sample analyses, and analytical results. List any contaminant detected above the method detection limit. Identify the samples that exceed the groundwater standards.
- Specify the total depth of the source area monitoring well (from land surface), depth of the water level, depths of the screened interval, and the date that the water level was measured.
- If free product is present, do not sample the monitoring well. Report the estimated thickness, type, and quantity of free product present.

A minimum of three additional monitoring wells shall be installed as follows: one upgradient of the source of contamination, and two downgradient of the source of contamination. The up- and downgradient wells shall be placed so that groundwater flow direction can be determined.

Discuss the sampling results and include the following information:

- In a table, list the monitoring well identification numbers, groundwater sample identification numbers, date of sampling, sample analyses, and analytical results. List any contaminant detected above the method detection limit.
- Identify the groundwater samples that exceed the groundwater standards.
- If the discharge or release is within 500 feet of a surface water body, identify the samples with groundwater contaminant concentrations exceeding the applicable surface water standards or criteria by a factor of 10. Also list the surface water standards and criteria that apply.
- In a table, list for each monitoring well, the monitoring well identification numbers, date water levels were obtained, and elevations of the water levels, the land surface, top of the well casing, screened interval, and bottom of the well.

G. Soil Sampling Results

Using figures and tables to the extent possible, describe all soil sampling performed to date and provide the rationale for sample locations, number of samples collected, etc. Include the following information:

- Location of soil samples;
- Date of sampling;
- Type of soil samples (from excavation, borehole, geoprobe, etc.);
- Soil sample collection procedures (split spoon, grab, hand auger, etc.);
- Depth of soil samples below land surface;
- Soil sample identification and during what phase the sampling occurred (e.g., tank closure, initial abatement, LSA, etc.);
- Soil sample analyses; and
- Soil sample analytical results (list any contaminant detected above the method detection limit).
- Identify the samples that exceed the lowest of:
    - the residential or industrial/commercial maximum soil contaminant levels, whichever are applicable; or
    - the soil-to-groundwater maximum soil contaminant concentrations.

NOTE: This information should correspond to the sampling location and sampling results maps required below.

H. Conclusions and Recommendations

Discuss the risk criteria that apply to the discharge or release and identify any other site-specific factors related to the release or discharge that may pose a risk to human health and the environment. Also, discuss any site-specific conditions or possible actions that could result in lowering the level of risk posed by the discharge or release. If the contaminant concentrations on site exceed the applicable RBSLs, include a discussion of the proposed remediation strategy and additional data required to design the remediation program.

I. Free Product Investigation/Recovery (if applicable)

1. Estimate quantity, type, and thickness of free product observed or measured in all wells.
2. Estimate the rate of return of free product in monitoring wells.
3. Justification for the type of free product recovery method selected.
4. Discharge information (if applicable)
    - a) On-site or off-site;
    - b) Location of discharge (use scaled maps);
    - c) Permitting requirements; and
    - d) Treatment type applied to and effluent quality expected from discharge.
5. The amount (in gallons) of free product recovered, if any. This number should represent the amount of free product recovered from wells, drains, or trenches.

J. Figures

- 1:25,000 scale Bermuda topographic map (copy) showing an area within a 1500-foot radius of source of release and depicting the site location, all water supply wells, public water supplies, surface water intakes, surface water bodies, and designated well head protection areas.
- 1:25,000 scale Bermuda topographic map (copy) showing an area within a 1500-foot radius of the source area of the release and depicting the site location as well as all schools, daycare centers, hospitals, playgrounds, parks, recreation areas, churches, nursing homes, or other places of public assembly. Also identify the zoning status of the area within the 1500-foot radius.
- Site map with all potential contaminant sources location(s) including UST systems, piping and pump islands, site boundaries, buildings, named roads, subsurface utilities, basements, adjacent properties, scale, and north arrow.
- Site map showing the results of all soil sampling conducted. Indicate sample identifications, sample locations, sampling depths, and analytical results.
- Site map showing the results of all groundwater sampling conducted. Indicate sample identifications, sample locations, monitoring well identifications, and analytical results.
- Site map showing the elevation of groundwater in the monitoring wells and the direction of groundwater flow.

NOTE: If possible, use a single base map to prepare site maps using a map scale of 1 inch = 40 feet (or a smaller scale for large sites, if necessary). Maps and figures should include conventional symbols, notations, labeling, legends, scales, and north arrows and should conform to generally accepted practices of map presentation.

K. Tables

- Site history;
- Property owners/occupants within or contiguous to the contaminated area and property owners/occupants within or contiguous to the area where contamination is expected to migrate;
- Water supply wells;
- Soil sampling results;
- Groundwater sampling results; and
- Water level elevations.

L. Appendices

- Boring logs and lithologic descriptions;
- Well construction records;
- Field measurements (e.g., pH, dissolved oxygen, specific conductivity, temperature) made during groundwater sampling);
- Standard procedures used at site for sampling, field equipment decontamination, field screening, etc.;
- Disposal manifests (if applicable); and
- Laboratory reports and chain-of-custody documents

A.4 UST Closure Report, (UST sites only)

Minimum elements of the UST Closure Report are:

A. General Information

1. Facility information:

- Facility name, ID number, telephone number, address and county;
- Date of report;
- UST Owner name, address and telephone number; and
- UST Operator name, address and telephone number.

2. Contacts:

- Name, address and telephone number and job title of primary contact person;
- Name, address and telephone number of closure contractor;
- Name, address and telephone number of primary consultant; and
- Name, address, telephone number and certification numbers of laboratory.

3. UST information in table format:

- Tank number;
- Installation dates;
- Size in gallons;
- Tank dimensions;
- Last contents of tank; and
- Previous contents of tank (if any).

4. Site characteristics:

- Describe any past releases at the site;
- Indicate if the facility is active or inactive. If inactive, note last date the USTs were in operation;
- Describe surrounding property use;
- Describe site geology and hydrogeology; and
- If a release has occurred, describe results of receptor survey within 1,500 feet of the facility.

B. Closure Procedures

1. Describe preparations for closure including the steps taken to notify authorities, permits obtained, and the steps taken to clean and purge the tanks.
2. Note the amount of residual material pumped from the tank(s).

3. Describe the storage, sampling and disposal of the residual material.
4. Document soil excavation:
    - Describe excavation procedures noting the condition of the soil encountered and the dimensions of the excavation in relation to the tanks, piping, and/or pumps;
    - Note the depth of tank burial(s) from land surface to top of tank;
    - Note volume of soil excavated;
    - Describe soil type(s) encountered;
    - Describe type and source of backfill used;
    - Describe condition of UST system(s) (i.e., pitting, holes, etc.); and
    - Note if the excavation reached a water table or bedrock surface.
5. Document contaminated soil:
    - Describe how the extent of soil excavation was determined; and
    - Describe method of temporary storage, sampling, and treatment/disposal.

C. Site Investigation

1. Field screening:
    - Physical observation of samples;
    - Instrumentation; and
    - Instrument calibration.
2. Soil sampling:
    - Location of samples;
    - Type of samples (from excavation, stockpiled soil, etc.);
    - Sample collection procedures (grab, split spoon, hand auger, etc.);
    - Depth of soil samples (below land surface);
    - Sample identification; and
    - Sample analyses.
3. Groundwater sampling:
    - Location of samples;
    - Sample collection procedures (grab, bailer, etc.);
    - Sample identification; and
    - Sample analyses.
4. Quality-control measures:
    - Sample handling procedures including sample preservation and transportation;
    - Decontamination procedures;
    - Time and date samples were collected and submitted to lab;
    - Samples collected for quality control purposes (e.g., duplicates, field blanks, trip blanks, etc.); and
    - How results of quality control samples may have affected your interpretation of soil, groundwater or surface water analytical results.
5. Describe investigation results:

- Sample collection procedures (grab, bailer, etc.);
- Methods of analyses (include U.S. EPA method number); and
- Analytical results for samples; discuss in relation to site-specific cleanup levels or action levels, as appropriate.

D. Conclusions and Recommendation

Include probable sources of contamination, further investigation or remediation tasks, or whether no further action is required.

E. Signature of certifying Environmental Professional

F. Figures

1. Area map showing site, buildings, adjacent streets, roads, highways with names and numbers, surface water bodies, groundwater flow direction (if available), north arrow, scale.
2. If a release has occurred, include an area map showing public and private water supply well(s) within 1,500 feet of the site.
3. Site map of UST excavation area drawn to scale, showing:

    - Buildings;
    - Underground utilities, such as sewer lines and other conduits;
    - Orientation of current and former UST(s), pumps and product lines;
    - Length, diameter and volume of current and former UST(s);
    - Type of material(s) stored in UST(s) (currently and formerly);
    - Sample locations (identified by letter or number);
    - Groundwater well locations;
    - Groundwater flow direction, if available;
    - Final limits of excavation;
    - North arrow; and
    - Scale.

4. Maps depicting analytical results, to include:

    - orientation of UST(s), pumps and product lines;
    - sample locations, depths and identifications;
    - analytical results; and
    - final limits of excavation(s).

NOTE: If possible, use a single base map to prepare site maps using a map scale of 1 inch = 40 feet (or a smaller scale for large sites, if necessary). Maps and figures should include conventional symbols, notations, labeling, legends, scales, and north arrows and should conform to generally accepted practices of map presentation.

G. Tables

1. Field screening results;
2. Sample identification, depths and analyses; and
3. Sample identifications with results and the dates that samples were taken.

H. Appendices

1. Appendix A. Notification of Intent: UST Permanent Closure or Change-in-Service
2. Appendix C. Certificate of UST disposal
3. Appendix D. Soil, water and sludge disposal manifests
4. Appendix E. Complete chain-of-custody records
5. Appendix F. Copy of all laboratory analytical records
6. Appendix G. Photographs of closure activities (optional)
7. Appendix H. Geologic logs for excavation(s)/borings

A.5 Comprehensive Site Assessment Report (90d)

The Comprehensive Site Assessment (CSA) Report documents additional investigation activities performed to characterize the cause, and extent of contamination from a discharge or release of petroleum or hazardous material release as well as site specific physical and chemical data needed to develop Tier II Site Specific Target Levels (SSTLs). For high and intermediate risk releases, the responsible party shall document the vertical and horizontal extent of both soil and groundwater contamination. However, if a discharge or release is classified as high or intermediate risk and no groundwater contamination was detected during the Limited Site Assessment, the responsible party may only perform the soil investigation portion of the CSA after application to the Ministry. *The CSA Report shall be completed and submitted to the Ministry of the Environment within 90 Days of confirmation of the release.*

NOTE: *Environmental Officers may request additional information in support of the CSA to aid in their review and reserve the right to deny the CSA if any of the elements specified below have not been included or have not been sufficiently addressed. The CSA will remain unapproved until it is submitted in a complete form.*

Minimum elements of the Comprehensive Site Assessment (CSA) Report:

A. Title Page

- Site name, location, Groundwater Incident number, and, if applicable Facility I.D. number;
- Date of report;
- Risk Classification (high or intermediate) assigned by the Ministry;
- Land use category (residential or industrial/commercial) assigned by the Ministry;
- Persons responsible for release or discharge including addresses and phone numbers;
- Current property owner including address and phone number;
- Consultant/contractor including address and phone number;
- Release information including date discovered, estimated quantity of release, cause of release, source of release, and, if applicable, the size and contents of UST system(s) from which release occurred;
- Latitude and longitude of the release (or grid reference number); and
- Signature of certifying Environmental Professional.

B. Executive Summary

The Executive Summary should provide a brief overview of the pertinent site information (i.e., it should provide sufficient information to acquaint the reader with the who, what, when, where, why, and how of site activities to date.)

1. Source information
    - Type of contaminants (gasoline, diesel, etc.);
    - Source of the release (tank, line, etc.); and
    - Amount of release (gallons, estimated or known).

2. Initial abatement/emergency response information
    - Tank Closure;
    - Soil removal, quantity, and disposition; and
    - Amount of free product recovered and estimated amount (gallons) remaining

3. Receptor information
    - Water supply wells;
    - Availability of public water supplies;
    - Surface water bodies;
    - Groundwater Protection areas;
    - Subsurface structures; and
    - Land use.

4. Sampling/investigation results
    - Nature and extent of contamination;
    - Maximum contaminant concentrations;
    - Site hydrogeology; and
    - Applicable cleanup levels.

5. Site-specific conditions or possible actions that could result in lowering the risk classification.
6. Conclusions and Recommendations

C. Table of Contents

1. List of sections with page numbers.
2. List of figures (all referenced by number and placed in a single section following contents text).
3. List of tables (all referenced by number and placed in a single section following contents text).
4. List of appendices.

D. Site History and Source Characterization

1. In table format, list all UST systems currently or previously located at the site including UST system number, product, capacity, date installed, date removed or closed, and whether a release was discovered. UST system numbers should correspond to the site map information requested below. Provide information in LSA and update as necessary.
2. List the names, addresses, telephone numbers, and dates of ownership/operation of all previous UST owners and operators of the UST system(s). Provide information in LSA and update as necessary.
3. Discuss the source of the release including the date discovered, estimated quantity of release, cause of release, source of release (piping/UST), and size and contents of UST system(s) from which release occurred. Also, include information on any off-site source contributions to the contamination and contributions from any on-site non-petroleum UST sources.
4. Summarize assessment activities and corrective actions performed to date including emergency response/initial abatement, free product recovery, primary and secondary source removal, and LSA results (reference any reports).

E. Receptor Information

Provide information included in the Limited Site Assessment and update as necessary:

1. Water Supply Wells

In a table, list all water supply wells (omit only those that have been properly abandoned) within 1500 feet of the source area of the discharge or release. For each well, include the well number (can use water right number), well owner and user names, addresses and telephone numbers, use of the well, and distance from the source area of the release. Key well numbers to water supply well map required below. Discuss methods used to obtain well survey information. This information should correspond to the map required below.

2. Surface Water

Identify all surface water bodies (e.g., ditch, pond,) within 1500 feet of the source area of the discharge or release. This information must be shown on the topographic map required below.

3. Groundwater Protection Areas

Determine the location of any designated groundwater protection areas as defined in the 1992 Development Plan within 1500 feet of the source area of the discharge or release.

4. Subsurface Structures

Describe all subsurface structures (e.g., sewers, utility lines, conduits, basements, septic tanks, leach fields, floor and storm drains, etc.) located on and adjacent to the site. This information must be shown on the site plan required below. Discuss whether vapors pose a threat of explosion due the accumulation of vapors in a confined space. Also, discuss whether vapors may pose any other serious health threat to public health, public safety or the environment.

5. Land Use

Discuss the uses and activities (involving possible human exposure to contamination) that could occur at the site and in the area within 1500 feet of the source area of the discharge or release. Examples of such activities and uses include but are not limited to use of a property for an office, manufacturing operation, residence, store, school, gardening or farming activities, recreational activities, or undeveloped land. This evaluation must include a consideration of activities which may not be occurring at the time of evaluation, but which are consistent with the current use of the site and area surrounding the site. The discussion must also include the zoning status of the site and surrounding properties. The information provided should be consistent with the map required below.

6. Property Owners and Occupants

In a table, list the names and addresses of 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.

F. Site Geology and Hydrogeology

- Describe the soil and geology encountered at the site. Use the information obtained during assessment activities (e.g., lithologic descriptions made during drilling, probe surveys, tank closure, etc.). This information should correspond to the geologic cross-sections required below.
- Based on the results of the groundwater investigation, describe the site hydrogeology, including a discussion of groundwater flow direction, hydraulic gradient, hydraulic conductivity, and groundwater velocity. Discuss the effects of the geologic and hydrogeologic characteristics on the migration and attenuation of contaminants.

G. Soil Sampling Results

Using figures and tables to the extent possible, describe all soil sampling performed to date and provide the rationale for sample locations, number of samples collected, etc. Include the following information:

- Location of soil samples;
- Date of sampling;
- Type of soil samples (from excavation, borehole, geoprobe, etc.);
- Soil sample collection procedures (split spoon, grab, hand auger, etc.);
- Depth of soil samples below land surface;
- Soil sample identification and during what phase the sampling occurred (e.g., tank closure, initial abatement, LSA, CSA, etc.);
- Soil sample analyses; and
- Soil sample analytical results (list any contaminant detected above the method detection limit).
- Identify the samples that exceed the lowest of:

  (a) the residential or industrial/commercial maximum soil contaminant levels, whichever are applicable; or
  (b) the soil-to-groundwater maximum soil contaminant concentrations.

NOTE: This information should correspond to the sampling location and sampling results maps required below.

H. Groundwater Sampling Results

Using figures and tables to the extent possible, describe the groundwater sampling performed to date and provide the rationale for sample locations, number of samples collected, etc. Include the following information:

- Location of groundwater samples/monitoring wells/water supply wells;
- Date of sampling;
- Groundwater sample collection procedures (bailer, pump, etc.);
- Groundwater sample identification and during what phase the sampling occurred (e.g., tank closure, initial abatement, LSA, CSA, etc.);

- Groundwater sample analyses; and
- Groundwater sample analytical results (list any contaminant detected above the method detection limit).
- Identify the samples that exceed the groundwater standards or interim standards

NOTE: This information should correspond to the sampling location and sampling results maps required below.

I. Free Product Investigation/Recovery (if applicable)

1. Estimate the quantity, type, and thickness of free product observed or measured in all wells;
2. Calculate the rate of return of free product in monitoring wells;
3. Justify the type of free product recovery method selected;
4. Discuss discharge information (if applicable)

    a. On-site or off-site

    b. Location of discharge (use scaled maps)

    c. Permitting requirements

    d. Treatment type applied to and effluent quality expected from, discharge; and

5. The amount* (in gallons) of free product recovered, if any.

*This number should represent the amount of free product recovered from wells, drains, or trenches.

J. Hydrogeologic Investigation

Describe the hydrogeologic investigation performed including all methods, procedures, and calculations used to characterize site hydrogeologic conditions. The following information should be discussed and should correspond to the maps and figures required below:

- Groundwater flow direction;
- Hydraulic gradient (horizontal and vertical);
- Hydraulic conductivity;
- Groundwater velocity;
- Slug test results (see Appendix B1);
- Pump test results (see Appendix B2);

K. Groundwater Modeling Results

Groundwater modeling may be necessary at some high and intermediate risk releases (i.e., source area proximate to surface water, source area located within groundwater protection area) to verify, based on site-specific hydrogeologic conditions, that groundwater contamination poses a risk to receptors. For releases shown to pose a risk to receptors, groundwater modeling may be necessary to determine an appropriate cleanup level for contaminated groundwater.

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 analysis 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 scenarios) and must be well documented.

L. Discussion

- Nature and extent of contamination;
- Maximum contaminant concentrations;
- Contaminant migration and potentially affected receptors;
- Site-specific conditions or possible actions that would result in lowering the risk classification; and
- Suggested Tier II SSTLs.

The use of these contaminant transport models will be necessary to demonstrate that the concentration of a contaminant in soil will not result in a violation of the soil or groundwater standards at the point of compliance (POC). 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. shall be incorporated into the models.

Biodegradation may be factored into fate and transport models only if the 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 biodegradation is occurring and the site specific rate of biodegradation has been determined.

NOTE: All assumptions and estimated values used in contaminant transport modeling, including biodegradation rates, shall be conservative (predict reasonable-worst case scenario) and shall be well documented and included in the Appendices.

M. Conclusions and Recommendations

If corrective action will be necessary, provide a preliminary evaluation of remediation alternatives appropriate for the site. Discuss the remediation alternative likely to be selected.

N. Figures

1:25,000 scale Bermuda topographic map copy showing an area within a 1500-foot radius of the source area of the release and depicting the site location, all water supply wells, public water supplies, surface water intakes, surface water bodies, designated groundwater protection areas.

1:25,000 scale Bermuda topographic map copy showing an area within a 1500-foot radius of the source area of the release and depicting the site location, all schools, daycare centers, hospitals, playgrounds, parks, recreation areas, churches, nursing homes, and other places of public assembly. Also identify the zoning status of the area within the 1500-foot radius.

Site map with UST systems location(s) including piping and pump islands, site boundaries, buildings, named roads, subsurface utilities, basements, adjacent properties, scale, and north arrow.

At least two geologic cross-sections through the saturated and unsaturated zones intersecting at or near right angles through the contaminated area. Indicate monitoring well/soil boring/sample locations and analytical results for soil samples. Identify samples exceeding applicable soil cleanup levels. Identify the depth to a water table. Provide a site plan showing the locations of the cross-sections.

Site map(s) showing the results of all soil sampling conducted. Indicate sampling identifications, sampling depths, locations, and analytical results.

Site map(s) showing the results of all groundwater sampling conducted. Indicate sampling locations/monitoring well identifications, sample identifications, and analytical results.

Separate groundwater contaminant iso-concentration contour maps showing total volatile organic compound concentrations, total semi-volatile organic compound concentrations, and concentrations for the most toxic contaminants and the most extensive contaminants.

Site map(s) showing the elevation of groundwater in the monitoring wells and the direction of groundwater flow. Contour the groundwater elevations. Identify and locate the datum (arbitrary 100', ordinance datum) or benchmark. Indicate the dates that water the level measurements were taken. There should be one map for each round of water level measurements obtained.

Site map(s) showing the monitoring wells and the thickness of free product measured. Show the extent of the free product. Note the date and method of the free product measurements. **NOTE**: *Acceptable methods of free product measurement include interface probes, tape/paste, or other DENR pre-approved methods.*

NOTE: *If possible, use a single base map to prepare site maps using a map scale of 1 inch = 40 feet (or a smaller scale for large sites, if necessary). Maps and figures should include conventional symbols, notations, labeling, legends, scales, and north arrows and should conform to generally accepted practices of map presentation.*

O. Tables

List all water supply wells (omit only those that have been properly abandoned) within 1500 feet of the source area of the discharge or release. For each well, include the well number (can use the water right number), well owner and user names, addresses and telephone numbers, use of the well, well depth, well casing depth, well screen interval, and distance from the source area of the release.

List the names and addresses of 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.

List the results for soil samples collected including location, date of sampling, type of samples (from excavation, borehole, geoprobe, etc.), sample collection procedures (split spoon, grab, hand auger, etc.), depth of samples, sample identifications, sample analyses, and sample analytical results (list any contaminant detected above the method detection limit).

List the results for groundwater samples collected including sample location, date of sampling, sample collection procedures (bailer, pump, etc.), sample identifications, sample analyses, and sample analytical results (list any contaminant detected above the method detection limit).

List for each monitoring well the monitoring well identification numbers, date water levels were obtained, and elevations of the water levels, the land surface, the top of the well casing, the screened interval, and bottom of the well.

P. Appendices

- Boring logs and lithologic descriptions;
- Well construction records;
- Standard procedures used at site for sampling, field equipment decontamination, field screening, etc.;
- Disposal manifests (if applicable);
- Field measurements (e.g., pH, dissolved oxygen, specific conductivity, temperature) made during groundwater sampling;
- Laboratory reports and chain-of-custody documents;
- Copies of any permits obtained, permit number, permitting agency, and date issued;
- Slug/pump test data;
- Fate and Transport Modeling results and site specific data; and
- SSTL calculations.

A.6 Remedial Action Plan

The Remedial Action Plan (RAP) describes proposed actions to cleanup contamination caused by a discharge or release. A RAP is required when the CSA indicates that remediation is necessary. The RAP addresses both soil and groundwater contamination, separately within the same report. For discharges or releases involving **only** soil contamination, address the sections that are applicable **only** to soil contamination.

NOTE: *The Ministry Officers may request additional information in support of the RAP to aid in their review and reserve the right to deny the RAP if any of the elements specified below have not been included or have not been sufficiently addressed. The RAP will remain unapproved until it is submitted in a complete form*.

Minimum elements of the Remedial Action Plan:

A. Title Page

- Site name, location, Groundwater Incident number, and, if applicable Facility I.D. number;
- Date of report;
- Risk Classification (high or intermediate) assigned by the Ministry;
- Land use category (residential or industrial/commercial) assigned by the Ministry;
- Persons responsible for release or discharge including addresses and phone numbers;
- Current property owner including address and phone number;
- Consultant/contractor including address and phone number;
- Release information including date discovered, estimated quantity of release, cause of release, source of release, and, if applicable, the size and contents of UST system(s) from which release occurred;
- Latitude and longitude of the release (or grid reference number); and
- Signature of certifying Environmental Professional.

B. Executive Summary

The Executive Summary should provide a brief overview of the pertinent site information (i.e., it should provide sufficient information to acquaint the reader with the who, what, when, where, why, and how of site activities to date.)

1. Source information

    - Type of contaminants (gasoline, diesel, etc.);
    - Source of the release (tank, line, etc.); and
    - Amount of release (gallons, estimated or known)

2. Initial abatement/emergency response information

    - Tank Closure; and
    - Soil removal, quantity, and disposition.

3. Sampling/Investigation Results

    - Nature and extent of contamination;
    - Maximum contaminant concentrations; and
    - Applicable soil cleanup levels.

4. Proposed Remedy for Soil and Groundwater Contamination

    - Selected remedy;
    - Total estimated cost for remediation; and
    - Schedule for implementation.

C. Table of Contents

1. List each section with page numbers.
2. List of figures (all referenced by number and placed in a single section following contents text).
3. List of tables (all referenced by number and placed in a single section following contents text).
4. List of appendices.

D. Introduction

1. Purpose of RAP (e.g. remediation of soil, groundwater, surface water, vapors. etc).

    - State cause of contamination and source(s);
    - Discuss the cleanup levels that apply to the discharge or release and describe how the cleanup levels were determined;
    - State the contaminants that exceed the cleanup levels; and
    - Indicate whether free product is present and include thickness.

2. Brief summary of initial remedial actions to date

    - Provide information from the UST Closure Report, if applicable, dimensions of excavation, and quantity of soil excavated;
    - Include soil treatment/disposal (quantities and methods);
    - Indicate where the soil was disposed;
    - Include free product recovery information (quantities and methods);
    - Any other corrective actions taken; and
    - Specify additional quantities of soil, free product, etc. that need to be remediated.

3. Reference previous reports submitted (e.g., Limited Site Assessment Report, Comprehensive Site Assessment Report, etc.)

    - Cite titles, report dates, and dates that reports were submitted to the Ministry;
    - From the CSA report, attach the following:

- ✓ groundwater elevation maps;
- ✓ maps/cross sections indicating the lateral and vertical extent of contamination for soil, free product and dissolved groundwater contamination;
- ✓ tables containing groundwater elevations and other field measurements (dissolved oxygen, pH, temperature, specific conductivity, etc.); and
- ✓ tables containing all previous sampling results for soil and groundwater.

Do not attach a copy of any report as an appendix.

4. Reference any previous permits/certificates (e.g., certificate of approval, soil remediation permits, interim discharge permits, etc.)

- Cite permit number; and
- Cite permit approval and issue dates.

5. Receptor Information

Summarize information provided in the CSA on water supply wells, public water supplies, surface water, groundwater protection areas, subsurface structures, and land use.

From the CSA report, attach the following, updating information as necessary:

- ✓ maps and figures of receptor locations; and
- ✓ table listing the names and addresses of 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.

E. Proposed Remedial Action

1. Objectives

- State goals and expected accomplishments of the RAP (e.g., free product recovery, containment or retardation of plume migration, reduction of contaminant concentrations, protection of nearby water supplies, etc.); and
- Specify cleanup levels for soil and/or groundwater and provide the basis for their determination.

2. Evaluation of Remediation Alternatives

For each remedial option evaluated discuss:

- System process;
- Feasibility;
- Limitations;
- Options for discharge/disposal of groundwater following treatment including property access agreements, if applicable;
- Costs including capital expenses, yearly operation, and maintenance and monitoring costs;

- Possibility of connecting adjacent property owners to municipal water as an alternative to groundwater remediation and provide cost comparison; and
- Selected remedy and basis for selection.

3. Proposed Remediation

NOTE: Follow format below for soil and groundwater remediation. Address remediation of other media (e.g., surface water, vapor) in similar format, as necessary.

Soil - Using figures, maps, and tables as necessary, describe and provide specifications for the proposed remediation as appropriate including:

On-site treatment

- Estimated volume to be treated;
- Additional site data needed;
- Pilot tests to be performed (test results, if pilot test already completed);
- System design and process;
- Radius of influence of system and estimated rates of contaminant removal;
- Anticipated flow rates and pressures for soil vapor extraction;
- Anticipated effluent concentration after each unit of treatment;
- Evaluation of effectiveness of remediation method;
- Operation and maintenance plan (include schedule and discussion on measures to reduce operation and maintenance such as use of automated controls and remote telemetry);
- Monitoring and sampling plans (include proposed sampling locations, analytical methods, sampling frequency and reporting frequency);
- Limitations (including access issues, technological feasibility, etc.) and proposed measures for dealing with these limitations;
- Disposal of any waste (e.g., spent carbon) generated; and
- Permits needed (Attach copies of completed permit applications. Original permit applications should be submitted separately and should not be attached to the RAP).

Off-site treatment/disposal

- Estimated volume to be treated/disposed;
- Treatment/disposal method;
- Name and address of treatment/disposal facility;
- Analytical results for any pre-treatment/disposal samples; and
- Permits needed (Attach copies of completed permit applications. Original permit applications should be submitted separately and should not be attached to the RAP).

Post-Remediation Sampling/Monitoring

Describe the sampling that will be performed to document that soil has been cleaned up to applicable cleanup levels.

Groundwater - Using figures, maps and tables as necessary, describe and provide specifications for the proposed remediation as appropriate including:

- Estimated volume to be treated;
- Additional site data needed including proposed aquifer tests and sample collection for analysis of natural attenuation parameters, provide test results if already complete;
- Groundwater modeling (modeling results, if groundwater modeling already completed);
- Pilot tests to be performed (test results, if pilot test already completed);
- System design and process;
- Radius of influence of system and estimated rates of contaminant removal;
- Anticipated flow rates and pressures for groundwater recovery (i.e., both after stripper and after carbon), air sparging, and groundwater injection;
- Anticipated effluent concentration after each unit of treatment;
- Evaluation of effectiveness of remediation method;
- Operation and maintenance plan (include schedule and discussion on measures to reduce operation and maintenance such as use of automated controls and remote telemetry);
- Monitoring and sampling plans (include proposed sampling locations, analytical methods, sampling frequency, and reporting frequency);
- Options for discharging treated groundwater;
- Limitations (including access issues, technological feasibility, biofouling, etc.) and proposed measures for dealing with these limitations;
- Disposal of any waste (e.g., spent carbon) generated; and
- Permits needed (Attach copies of completed permit applications. Original permit applications should be submitted separately and should not be attached to the RAP).

NOTE: For a RAP proposing remediation by natural attenuation, a plan for monitoring the progress of the contaminant degradation process and estimated time to complete the cleanup must be incorporated into the remediation proposal above.

Post-Remediation Sampling/Monitoring

Describe the sampling or monitoring that will be performed to document and verify that groundwater has been cleaned up to applicable cleanup levels.

4. Cost Estimate

Provide a detailed cost estimate for performing the proposed remediation including costs for labor, pilot tests, aquifer tests, sampling and monitoring, equipment, operation and maintenance, permits, waste disposal, etc.

5. Schedule

Provide a detailed schedule for implementing the proposed remediation including but not limited to:

- Collection of additional data (aquifer tests, natural attenuation parameters, etc.);

- Performance of any pilot tests;
- Submittal of necessary permit applications;
- Excavation of soil;
- Treatment system installation and activation;
- Operation and maintenance;
- Monitoring;
- Estimated time frame to achieve cleanup goals (include basis for this determination); and
- Project completion.

F. Public Notice

NOTE: A responsible party who proposes to cleanup groundwater contamination to a standard other than the interim groundwater standard or to cleanup soil to a level other than the residential or soil-to-groundwater maximum soil contaminant concentration must provide public notice in accordance with Section 12.

Concurrent with the submittal of the RAP, the responsible party must provide notice to the following:

- the Chief Medical Officer;
- 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.

The notice must be made by registered mail. The notice must describe the nature of the remediation proposal and the reasons supporting it. Within 30 days of submitting the RAP, the responsible party must provide the Ministry 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 (see Section 12.0).

G. Figures

Provide figures and maps necessary to describe in detail the proposed remediation including, the area and volume of soil to be treated/excavated, the area and volume of groundwater to be remediated, and if applicable, the location of the treatment system and a detailed map of the system design and layout (include all major components of the system).

H. Tables

Provide tables as necessary to describe in detail the proposed remediation.

I. Appendices

- Attach all figures, tables and maps from CSA (update as necessary); and
- Provide the following, if applicable:

- ✓ Cost estimates for remediation alternatives evaluated including estimates and quotes obtained;
- ✓ Detailed design specifications of system components;
- ✓ Pump curves and performance charts;
- ✓ Design calculations;
- ✓ Pilot and aquifer test data/calculations (if already completed);
- ✓ Groundwater modeling results (if already completed); and
- ✓ Copies of completed permit applications.

A.7 Monitoring Reports

Periodic groundwater monitoring may be required in order to evaluate changes in groundwater contaminant concentration over time at specific locations. This information can be used to monitor plume migration, evaluate the effectiveness of a corrective action, account for the effects of fluctuating water table elevation versus contaminant concentrations, etc. Submitting periodic groundwater monitoring reports may be required by the Ministry of the Environment or may be required as part of an approved Remedial Action Plan (RAP), if applicable. There are essentially three types of monitoring reports.

Cleanup Level Verification Monitoring Report

The Soil Cleanup Level Verification Monitoring Report involves sampling monitor wells for a period of time to verify the groundwater cleanup levels determined are appropriate*. This type of monitoring should be conducted only at sites where groundwater cleanup levels are determined in the CSA using predictive analysis and groundwater remediation will not be needed based on these predictive analyses*. The Cleanup Level Verification is to be conducted only if instructed by the Ministry.

Pre-RAP Monitoring Report

Pre-RAP Monitoring is to be conducted only if instructed by the Ministry. This primarily involves sampling monitoring wells at the site prior to developing a RAP. Do not perform sampling more than four times, prior to implementing a RAP, unless otherwise instructed by the Ministry (ideally four quarters or less). Priority should be placed on completing the CSA and the RAP reports as soon as possible.

RAP Monitoring Report

The RAP Monitoring should be conducted after the RAP has been approved. This report should be used for monitoring the progress of cleanup of active remediation systems or remediation by natural attenuation. This type of report should also be submitted to verify that cleanup levels have been achieved. If a combination of active treatment and remediation by natural attenuation is being used to remediate contaminated groundwater, monitoring results should be included in one report of this type. See the table below for required report frequency.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1st Year	3	3	3	3
2nd Year and after	3	No report	3	No report

NOTE: If permits require more frequent system sampling, simply compile this data until the next monitoring report is due. Sample monitoring wells on the same schedule as the reporting schedule. The Ministry may modify the sampling and reporting schedule as necessary.

Minimum elements of a Monitoring Report:

A. Title Page

- Site name, location, Groundwater Incident number, and Facility I.D. number;
- Date of report;

- Land use category (residential or industrial/commercial) assigned by Department;
- Responsible party for the release or discharge including addresses and phone numbers;
- Current property owner including address and phone number;
- Consultant/contractor including address and phone number;
- Release information including the date discovered, estimated quantity of release, cause of release, source of release (piping/UST), and, if applicable, size and contents of UST system(s) from which release occurred;
- Latitude and longitude of the release (or grid reference number); and
- Signature of certifying Environmental Professional.

B. Discussion of Sampling Results

1. Summary of analytical results and free product thickness(s) (if applicable).
2. Description of current plume size and location (graphically indicate any significant changes in plume size or migration).
3. Include the following for active remediation monitoring reports:

    - Summary of remediation activities to date;
    - Remediation system status (list dates of up-time and down-time);
    - Treatment system monthly sampling and operational data;
    - Total gallons of water treated during the period;
    - Monthly operation and maintenance costs;
    - Mass of contaminant removed (lbs./day for the system);
    - Future remediation activities;
    - Gallons of recovered product; and
    - Discharge/non-discharge permit number, expiration date, updated permit monitoring requirements, and schedule.

4. Include the following in all monitoring reports:

    - Description of the proximity of the plume to the nearest potential receptor(s);
    - Groundwater flow direction;
    - Predictive rate of contaminant transport; and
    - Other field data obtained during monitoring (Groundwater elevations, Dissolved Oxygen, Temperature, pH, Redox Potential, Conductivity, and other electron acceptors as required).

C. Conclusions and Recommendations

1. For an Active Remediation Monitoring Report outline the progress of cleanup, evaluate the performance and efficiency of the remediation system, and suggest any necessary changes or modifications to the system.

2. For a Pre-RAP Monitoring Report, Cleanup Level Verification Monitoring Report, or a Natural Attenuation Monitoring Report outline attenuation progress and plume status (i.e., change in plume size, shape, etc.).
3. Include interpretations of submitted data.

D. Tables

NOTE: *Tables should list concentrations in µg/l (ppb) and indicate groundwater quality standards for listed analytes.*

- Table of sampling data for reported sampling event only;
- Table of historical sampling data from the site, including data from reported sampling event;
- Table of groundwater elevations obtained for reported sampling event;
- Table of historical groundwater elevations;
- Provide a free product recovery table which provides depth to free product and thickness for each well, and historical information (thickness of product in each well, total amount of product recovered);
- Table of field measurements (e.g., dissolved oxygen, pH, temperature, specific conductivity, etc.); and
- Table of monitoring well construction data including date constructed, total depth, date of abandonment (if applicable), elevations of top of casing, land surface, water level, screened intervals, etc.

NOTE: The measured point at top of casing must be permanently marked or noted in the field. The table of groundwater elevations should be part of the groundwater elevation map, if space allows.

E. Figures

All reports submitted to DENR should use graphical methods of data presentation to the greatest extent possible. Furthermore, the text of reports should provide a concise synthesis of this graphical information that clearly communicates the professional's own interpretations of the data.

If possible, a single base map should be used to prepare potentiometric maps, isocontour maps, etc. using a map. Maps and figures submitted to DENR should include conventional symbols, notations, labeling, legends, scales, and north arrows. The map should use a scale of 1 inch = 40 feet (or smaller scale for larger sites, if necessary) feet and conform to generally accepted practices of map presentation.

1. Base map (include bar scale and north arrow)

    - Drawn to scale;
    - Identify property boundaries and all site features;
    - Potential receptors (existing or new);
    - Labeled streets, roads, etc.; and
    - Labeled surface waters, creeks, etc.

2. Groundwater elevation map for reported sampling event

- Drawn to scale;
- Use data from groundwater monitoring wells;
- Indicate groundwater flow direction; and
- Plotted elevations (in feet) of groundwater, corrected for presence of free product, if applicable.

3. Attach historical groundwater elevation maps.
4. Include a topographic map indicating the location of the site, contaminant plume, and the location of all water supply wells, surface water bodies, groundwater protection areas, etc.(indicate 1500-foot boundary with circle).
5. Dissolved concentration map(s) and dissolved concentration cross sections (vertical isoconcentration plots), for individual contaminants exceeding standards, if sufficient data exists.

NOTE: *For all applicable plots, a groundwater standard contour must be shown in bold. Concentration units will be µg/l (ppb).*

6. Free product plume map measured in feet, if applicable.
7. Concentration versus water level (hydrograph - to reveal groundwater fluctuation through the “smear” zone).
8. Concentration versus time graph(s)

- Graph(s) showing contaminant concentrations versus time plotted for all wells sampled (for individual contaminants exceeding groundwater standards only); and
- Graph that outlines free product thickness (if applicable).

NOTE: *Concentration and time units will be µg/l (ppb) and months, respectively.*

9. Include the following for active remediation monitoring reports only:

- Graph showing total contaminant removal per monitoring well; and
- Graph showing total pounds recovered by means of groundwater recovery or Soil Vapor Extraction.

NOTE: *Calculations should be based on average pounds per hour. Graph(s) should show a total VOC for each sampling event to current date.*

F. Survey of potential receptors (current information)

This section is required only for incident sites where receptors have been impacted or where receptors are threatened; for these sites include only the items listed below which apply:

- Status of all water supply wells within 1500 feet of the contaminant plume. Include historical and current sampling data; and/or
- Status of surface water bodies, groundwater protection areas, utility lines, vaults, basements, etc.

G. Appendix

1. Copies of laboratory analytical reports (laboratory name and certification number, well numbers, sampling date, analysis date, analytical methods, and detection limits should be indicated on reports).
2. Chain-of-custody forms for all samples (all transfers);
3. Copies of field data sheets; and
4. Calculations (if applicable)

A.8 Site Closure Report

The Site Closure Report documents that contaminated soil and groundwater have been remediated to applicable cleanup levels. The Site Closure Report also incorporates a request for the Department to issue a notice of no further action. For discharges and releases where groundwater does not require remediation, the responsible party should complete only those reporting requirements below related to soil cleanup.

NOTE: *The Ministry of the Environment may request additional information in support of the Site Closure Report to aid in their review and reserve the right to deny the Site Closure Report if any of the elements specified below have not been included or have not been sufficiently addressed. The Site Closure Report will remain unapproved until it is submitted in a complete form.*

Minimum elements of the Site Closure Report:

A. Title Page

- Site name, location, Groundwater Incident number, and Facility I.D. number;
- Date of report;
- Land use category (residential or industrial/commercial) assigned by Department;
- Responsible party for the release or discharge including addresses and phone numbers;
- Current property owner including address and phone number;
- Consultant/contractor including address and phone number;
- Release information including the date discovered, estimated quantity of release, cause of release, source of release (piping/UST), and, if applicable, size and contents of UST system(s) from which release occurred;
- Latitude and longitude of the release (or grid reference number); and
- Signature of certifying Environmental Professional.

B. Executive Summary

The Executive Summary should provide a brief overview of the pertinent site information (i.e., it should provide sufficient information to acquaint the reader with the who, what, when, where, why, and how of site activities to date.)

1. Source information

    - Type of contaminants (gasoline, diesel, etc.);
    - Source of the release (tank, line, etc.); and
    - Amount of release (gallons, estimated or known).

2. Nature and extent of release

    - Maximum contaminant concentrations;
    - Horizontal and vertical extent of soil and groundwater contamination; and

- Applicable cleanup levels.

3. Remediation Activities

    - Soil treatment/ disposal (quantities and methods);
    - Groundwater remediation methods;
    - Effectiveness of remediation;
    - Post-remediation sampling/monitoring; and
    - Cost to perform remediation.

4. Conclusions and Petition for Site Closure

C. Table of Contents

1. List each section with the page numbers.
2. List of figures (all referenced by number and placed in a single section following contents text).
3. List of tables (all referenced by number and placed in a single section following contents text).
4. List of appendices.

D. Site Remediation

Using figures, maps, and tables as necessary, describe the remediation performed as appropriate including:

Soil

On-site treatment

- Volume to be treated;
- Additional site data collected;
- Pilot test results;
- System design and process;
- Design calculations;
- Radius of influence of system and rates of contaminant removal;
- Evaluation of effectiveness of remediation method;
- Operation and maintenance;
- Monitoring and sampling (include sampling locations, analytical methods, sampling frequency, and sampling results);
- Disposal of any waste (e.g., spent carbon) generated; and
- Permits obtained, permit numbers, and dates permits issued/approved.

Off-site treatment/disposal

- Volume treated/disposed;
- Treatment/disposal method;
- Name and address of treatment/disposal facility;
- Name and address of excavation contractor;
- Name and address of transporter;
- Analytical results for any pre-treatment/disposal samples; and
- Permits obtained, permit numbers, and dates permits issued/approved.

Post-Remediation Sampling

Describe sampling performed to document that soil was cleaned up to applicable cleanup levels including sample identifications, sample locations, sampling depths, sample collection methods, sample analyses and analytical results. Information should correspond to the map and table requested below.

Groundwater

- Additional site data collected including aquifer test results and results for samples collected for analysis of natural attenuation parameters;
- Groundwater modeling results;
- Pilot test results;
- System design and process;
- Radius of influence of system and rates of contaminant removal;
- Flow rates and pressures for groundwater recovery (i.e., both after stripper and after carbon), air sparging, and groundwater injection;
- Anticipated effluent concentration after each unit of treatment;
- Evaluation of effectiveness of remediation method;
- Operation and maintenance;
- Monitoring and sampling (reference reports submitted, attach results for the last four consecutive monitoring/sampling events);
- Disposal of waste (e.g., spent carbon, discharged groundwater) generated; and
- Permits obtained, permit numbers, and dates permits issued/approved.

Post-Remediation Sampling/Monitoring

Describe the sampling or monitoring that was performed to document and verify that groundwater has been cleaned up to applicable cleanup levels. Reference all monitoring reports submitted and attach the results for the last four consecutive monitoring/sampling events.

E. Actual Costs for Remediation

Provide a detailed breakdown of actual costs for performing the site remediation including costs for labor, pilot tests, aquifer tests, sampling and monitoring, capital expenses, operation and maintenance, permits, waste disposal, etc. Attach bids and quotes received.

F. Conclusions and Petition for Site Closure

NOTE: Once DENR verifies that site cleanup has been completed, the Ministry issue a notice specifying that no further action is required.

If the discharge or release has not been remediated to the standards or interim standards 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 Section 12.

Within 30 days of receiving a no further action notice, the responsible party must provide a copy of the notice to:

- the local Chief Medical Officer;
- the chief administrative officer of each municipality (e.g. Corporation of Hamilton or St. George) 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.

The notice must be made by registered mail. Within 60 days of receiving the no further action notice, the responsible party must provide the Ministry 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. (See Section 12.0)

G. Figures and Tables

Figures and tables should be used to the extent possible to document remediation activities and to verify that cleanup goals were achieved. The number and type of figures and tables will depend on the remediation alternative selected. At a minimum, the responsible party should present site maps showing the area and volume of soil that was treated/excavated and the area and volume of groundwater remediated. I f active treatment (e.g., soil vapor extraction, air sparging, pump and treat) was used, provide a map of the location of the treatment system and a detailed map of the system layout and design (include all major components of the system).

In a table, list the names and addresses of 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. *As specified above, the responsible party will need to provide notice to these persons, of the receipt of a no further action notice*.

H. Appendices

Provide appendices as necessary to document remediation activities including the following, if applicable:

- Remediation bids and quotes obtained;

- Detailed design and specifications of system components;
- Performance charts;
- Design calculations;
- Pilot test results;
- Aquifer test results;
- Groundwater modeling results;
- Monitoring reports for last four consecutive sampling events performed to verify that cleanup goals were achieved;
- Disposal manifests; and
- Copies of completed permit applications.

Appendix B – Whole RBCA Process Flow Diagram