



Ministry of  
Environment

*PROTOCOL 15*  
**FOR CONTAMINATED SITES**

Soil Treatment Facility Design and Operation for  
Bioremediation of Hydrocarbon Contaminated Soil

Version 1.0

Prepared pursuant to Section 64 of the  
*Environmental Management Act*

Approved:

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Date

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## 1.0 Definitions

The following words, acronyms and expressions used in this protocol are defined in the ministry procedure “Definitions and Acronyms for Contaminated Sites”:

Act	hydrocarbon contaminated soil
berm	liner
Director	ministry
halogenated hydrocarbon	non-hazardous waste
hazardous waste	Regulation
	works

“**decommission**” for the purposes of this protocol, means the removal and appropriate disposal of all works related to the operation of a soil treatment facility including but not limited to liners, berms, covers, drain lines, aeration lines, buildings, and monitoring wells.

“**land farming**” for the purposes of this protocol, means a method of reducing the concentrations of hydrocarbon constituents in soil through biodegradation, characterized by spreading contaminated soil over a large surface area in the absence of engineered structures designed to contain the contamination.

“**soil treatment facility**” for the purposes of this protocol, means an engineered structure designed to contain hydrocarbon contaminated soil while reducing concentrations of hydrocarbon constituents through biodegradation. Examples of soil treatment facilities include biocells, biopiles and windrows but do not include land farms.

## 2.0 Introduction

This protocol is intended to ensure province-wide consistency in the design, operation and regulation of bioremediation soil treatment facilities by describing requirements for the containment and treatment of non-hazardous waste hydrocarbon contaminated soils as part of a remediation strategy. Application of the protocol extends to both commercial and non-commercial soil treatment facilities constructed after the effective date of the protocol.

Minimum standards for the design, operation and maintenance of a bioremediation soil treatment facility are provided under this protocol. The Director of Waste Management may impose additional requirements under section 54 (3) (d) of the Act, which he or she deems necessary to achieve remediation and to protect human health and the environment. Compliance with the requirements outlined below does not authorize the

discharge of waste to the environment or the movement or deposit of soil and Technical Guidance 14, "Operation of Soil Treatment Facilities for Bioremediation of Hydrocarbon Contaminated Soil" provides additional information on these topics [1].

Hazardous waste must not be accepted at a soil treatment facility unless such a facility is approved to manage hazardous waste pursuant to the Hazardous Waste Regulation under the Act.

### **3.0 Background**

Concentrations of hydrocarbon constituents in excavated soils can be effectively reduced through the process of biodegradation. Bioremediation technology is a controlled process which involves constructing cells, piles or rows of contaminated soils and stimulating microbial activity within the soils through aeration and/or the addition of nutrients and moisture.

Soil treatment facilities have been proven effective for treating soils contaminated with petroleum hydrocarbons and to a lesser extent, halogenated hydrocarbons. This protocol may be used for the bioremediation of contaminants other than hydrocarbons. Demonstration trials may be necessary to determine the effectiveness of bioremediation for other contaminants.

Bioremediation is not an effective treatment method for soils contaminated with metals, salts or other inorganic contaminants. High concentrations of these contaminants may be toxic to the microbial population and consequently inhibit the bioremediation process.

### **4.0 Size exemption**

A soil treatment facility containing less than or equal to 100 cubic metres of contaminated soil is exempt from the following sections of this protocol:

- siting requirements – Section 5; and
- groundwater monitoring and sampling requirements as described in Sections 11.2, 11.3 and 12.0.

### **5.0 Siting requirements**

A soil treatment facility must not be constructed on any land:

- where the slope is greater than 9% (note that the land surface may be graded to meet this requirement);

- where the seasonal high water table is less than 1 m below ground surface;
- where the boundaries of the facility would be within any area specified as a wildlife management area, wildlife area or sanctuary, ecological reserve or bird sanctuary under the *Wildlife Act*, *Ecological Reserve Act*, *Migratory Birds Convention Act (Canada)* or the *Canada Wildlife Act (Canada)*;
- in any area prone to flooding unless the facility has been specifically designed and engineered to withstand a flood.

## 6.0 Site access and security

Access to a soil treatment facility must be restricted to authorized personnel only, through fencing or other suitable means.

Appropriate notices must be clearly posted; for example, warning the public of the presence of contaminated soil and the physical hazards associated with the facility.

## 7.0 Basic design

Soil treatment facility designs must incorporate the components identified in Table 1.

**Table 1: Soil treatment facility design requirements**

Component	Minimum Requirements
Liner	<p>Soil treatment facilities must have a base liner with a permeability of less than or equal to <math>1 \times 10^{-6}</math> cm/sec.</p> <p>The following types of liners are considered acceptable:</p> <ul style="list-style-type: none"> <li>• soil with a minimum thickness of 1 m; or</li> <li>• synthetic material, for example polyethylene, with a minimum thickness of 0.5mm (20 mil) that is chemically resistant to the waste undergoing treatment and constructed in one piece or with sealed impermeable joints; or</li> <li>• composite liner, for example a combination of soil and synthetic material liners which meets or exceeds the permeability requirement indicated above.</li> </ul> <p>The area below a synthetic liner must be cleared of debris and sharp objects that could puncture the liner.</p> <p>Synthetic liners must be installed, maintained and replaced according to the manufacturer's specifications.</p> <p>All liners must be covered with a sacrificial indicator layer with a minimum thickness of 0.3 m, to ensure that the liner is not penetrated during turning or soil removal operations. Commonly used indicator layers include sand, gravel, and straw, or asphalt or plywood underlain by a thin granular layer.</p>

Component	Minimum Requirements
Berms	Soil treatment facilities must be surrounded by berms that <ul style="list-style-type: none"><li>• are a minimum height of 0.5 m; and</li><li>• are constructed to ensure complete containment of the entire volume of soil undergoing treatment.</li></ul> There must be no gap between the liner and the berm.
Cover	Soil treatment facilities must be covered, except while being worked, to minimize leachate generation, erosion, fugitive dust and air emissions.  The cover must extend over the berms to minimize leachate generated by precipitation and snow melt.
Leachate collection	The base of a soil treatment facility must be sloped or graded (1 to 5%) toward one or more collection sumps.
Aeration measures	Where the thickness of contaminated soil within a soil treatment facility is greater than 30 cm, periodic mechanical mixing or turning, or installation of ventilation piping is required.

## 8.0 Multiple waste streams

Subject to Protocol 3, “Blending, Mixing or Dilution as a Remediation Approach” [2], a soil treatment facility may be used to treat soil with different origins and different compositions or contaminant concentrations. These soils must be kept and treated in separate cells or stockpiles within the soil treatment facility. Each treatment cell or stockpile must be managed to provide the most efficient and environmentally sound remediation for the type of contaminant being treated.

## 9.0 Soil preparation

Soils which tend to clump together are difficult to aerate, difficult to mix uniformly with nutrients, and may retain water. Conversely, coarse-grained soil often will not retain sufficient water to support effective biodegradation. Soil amendments which will enhance remediation potential, including bulking materials such as sawdust or straw, may be added prior to or during treatment.

## 10.0 Operation and maintenance

### 10.1 Soil height

The maximum soil height allowed within a soil treatment facility is 3.0 m measured from the base of the facility to the peak of the soil pile.

## **10.2 Required activities**

During the operating season (typically April to October) the following activities must occur:

- Soil treatment facility works including liners, berms, cover, and leachate collection and treatment (if applicable) systems must be inspected at least twice per year and following significant storm events and be maintained in good working order.
- For soil treatment facilities where aeration is required, mechanical mixing or turning must be completed at least twice per year.
- Accumulations of liquid in leachate collection sumps must be reused within the facility to maintain moisture or be appropriately treated or disposed of in accordance with the requirements of the Act and its regulations.

Management of a soil treatment facility must be carried out so as to ensure optimal biodegradation of contaminants, to minimize volatilization and to ensure the integrity of the works.

## **10.3 Management of waste**

The discharge of waste to the environment is not authorized by this protocol. The Waste Discharge Regulation prescribes when an authorization is required for the discharge of wastes from a soil treatment facility.

## **11.0 Monitoring and sampling**

### **11.1 Sample collection and laboratory analysis**

Soil and groundwater sampling must be performed in accordance with applicable procedures described in the ministry's Technical Guidance 1, "Site Characterization and Confirmation Testing" [3] and the most recent edition of the British Columbia Field Sampling Manual [4] or by suitable alternative procedures authorized by the Director.

Soil vapour sampling must be performed in accordance with applicable procedures described in the ministry's Technical Guidance 4, "Vapour Investigation and Remediation" [5] or by suitable alternative procedures authorized by the Director.

Analyses must be carried out in accordance with procedures described in the most recent edition of the British Columbia Environmental Laboratory Manual [6], or by suitable alternative procedures authorized by the Director.

### **11.2 Baseline information**

Before construction or operation of a soil treatment facility, subsurface baseline information must be obtained on soil and groundwater quality beneath and surrounding the proposed treatment area, to serve as the basis for future comparisons. A groundwater monitoring network must be established under the direction of a qualified professional. The network must include a sufficient number of wells installed at appropriate depths to yield groundwater samples that represent the groundwater that could be affected by leakage from the soil treatment facility.

### **11.3 Operational monitoring**

To confirm the performance of the biodegradation process, representative soil samples must be collected from within the soil treatment facility before soil removal or facility decommissioning activities occur. Soil samples must be analysed for pH and contaminant of concern concentrations in order to determine the appropriate end use or disposal options for the treated soil.

A groundwater monitoring program must be completed annually. Groundwater must be monitored for appropriate indicator parameters associated with the contaminants of concern.

An ambient air monitoring program must be completed during each turning event. Air samples must be collected from multiple locations around the perimeter of the property and analysed for contaminants of concern associated with the soil undergoing treatment. The ambient air monitoring program must be established under the direction of a qualified professional and include locations which represent both upwind and downwind of the soil treatment facility. If concentrations of contaminants of concern exceed the applicable Schedule 11 vapour standards for the affected neighbouring property (ies) during a turning event, measures must be taken during subsequent turning events to capture and treat air emissions from the soil treatment facility. A permit may be required for the discharge of treated air emissions.

### **12.0 Decommissioning and closure**

Following successful remediation of soil to the applicable environmental quality standards, the treated soil must be reused or disposed of appropriately. When the soil treatment facility is no longer in use it must be decommissioned and the land surface must be contoured to its original grade and revegetated where appropriate for erosion control.

Following decommissioning, closure samples must be collected from the soil beneath and surrounding the former soil treatment facility and from the groundwater

monitoring well network. Soil, soil vapour and groundwater samples must be submitted for laboratory analysis of contaminants of concern to establish whether the land has been contaminated during soil treatment. Remediation of contamination caused by the operation of the facility is required as part of the closure process.

### **13.0 Record keeping and reporting**

#### **13.1 Record keeping requirements**

Operators of a soil treatment facility must maintain the following records for inspection by ministry staff if requested:

- Results of any demonstration trials (for contaminants other than hydrocarbons in the contaminated soil) conducted to determine the biodegradation potential of the contaminant type;
- Complete design drawings and engineering specifications for the soil treatment facility accompanied by a statement signed by a qualified professional licensed to practice in British Columbia indicating that the design fully complies and was built in accordance with this protocol;
- An inventory of the soil undergoing treatment including its origin, volume, contaminant types and concentrations;
- Documentation of operational activities including aeration activities, leachate management and records related to the addition of nutrients and bulking materials;
- Results of all monitoring activities and soil, groundwater and vapour analyses;
- Documentation of findings of any inspections performed and records of maintenance or repairs completed;
- Copies of any required authorizations for wastes discharged (for example: leachate or air emissions) or reuse, disposal or relocation of treated soil; and
- All records and correspondence related to inspections previously completed by ministry staff.

#### **13.2 Reporting requirements**

Spills must be reported in accordance with the Act's Spill Reporting Regulation. Appropriate corrective action must be taken to contain and control any release of leachate from a soil treatment facility and measures must be taken to prevent occurrence of similar events in the future.

Under section 54 of the Act and section 57 of the Regulation, any person undertaking independent remediation must notify the Director within three days after the commencement of any remediation activity and within 90 days of completing

remediation. The Director may impose additional requirements under section 54 (3) (d) of the Act.

#### **14.0 References**

1. B.C. Ministry of Environment. (2011). Technical Guidance ?? on Contaminated Sites: Operation of Soil Treatment Facilities for Bioremediation of Hydrocarbon Contaminated Soil. Victoria, B.C. Month 2011.
2. B.C. Ministry of Environment. (1999). Protocol 3: Blending, Mixing or Dilution as a Remediation Approach. Victoria, B.C. July 1999.
3. B.C. Ministry of Environment. (2005). Technical Guidance 1 on Contaminated Sites: Site Characterization and Confirmation Testing. Victoria, B.C. August 2005.
4. B.C. Ministry of Environment. (2003). British Columbia Field Sampling Manual – For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment and Biological Samples. Victoria, B.C. January 2003.
5. B.C. Ministry of Environment. (2010). Technical Guidance 4 on Contaminated Sites: Vapour Investigation and Remediation. Victoria, B.C. September 2010.
6. B.C. Ministry of Environment. (2007). British Columbia Environmental Laboratory Manual - For the Analysis of Water, Wastewater, Sediment and Biological Materials". Victoria, B.C. April 2007.