

**TREATMENT AND DISPOSAL
OF
PETROLEUM
CONTAMINATED
SOIL**

June 1996

Revised December 2010

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1.0 INTRODUCTION

This document on the treatment and disposal of petroleum contaminated soil (PCS), has been developed to assist environmental consultants, petroleum service contractors, waste disposal ground operators, and petroleum storage tank owners in the management of petroleum contaminated soil. Leaking petroleum storage tanks and petroleum contaminated sites can have serious environmental and public safety implications. Contaminated soil removed from petroleum storage tank sites requires proper treatment and/or disposal to ensure it does not pose a safety, public health, or environmental threat.

The following sections of this document discuss procedures that may be used to meet these objectives. Many people play a role in the management of petroleum contaminated soils, and by reading this document you will have a better understanding of how to properly dispose of and/or treat petroleum contaminated soil.

1.1 Scope

The scope of this document refers to soil contaminated with residual concentrations of refined petroleum products such as gasoline, diesel fuel, aviation fuel, fuel oil, waste oil, and related petroleum products stored in petroleum storage tanks. **This document does not supersede existing regulations or policies governing the classification, handling, disposal or treatment of petroleum contaminated soils and is intended to serve as an aid to parties involved in the design and operation of soil treatment facilities.**

This document outlines the requirements and operating procedures for the disposal/treatment of PCS at licensed soil treatment facilities, Manitoba Waste Disposal Grounds (WDG), and at single-use soil treatment sites approved by Manitoba Conservation.

The principle treatment method for PCS at these types of sites is by land farming. Under normal circumstances, the operating philosophy of the soil treatment facility should, to the maximum extent possible, control excessive emission of volatile organic compounds (VOC) to the atmosphere. In addition, losses of petroleum compounds by leaching should be controlled.

Alternative methods of soil remediation at approved PCS treatment sites, such as enhanced bioremediation, asphalt incorporation, soil washing, thermal treatment, etc. may be considered, where applicable.

2.0 GUIDELINES

Manitoba Conservation has developed objective guidelines with recommended clean-up criteria for the remediation of sites contaminated with petroleum hydrocarbon compounds. Manitoba's remediation guidelines recommend that the nature and extent of subsurface contamination be delineated prior to the implementation of remedial activities. This information will assist in determining the type(s) and range of concentrations of petroleum hydrocarbon compounds in the contaminated soil, and the amount of contaminated soil requiring treatment or disposal.

Other existing Manitoba Conservation Guidelines pertinent to PCS are as follows:

- Guideline 98-01 Guideline for Environmental Site Investigations June 1998. Revised May 2002
- Guideline 97-01 Guideline for the Designation of Contaminated Sites in Manitoba March 1997. Revised January 2004
- Information Bulletin 96-02E Contaminated Sites in Manitoba Submission of Remedial Action Plans. Revised January 2004
- Guideline for the Dismantling and Removal of Petroleum Storage Tank Systems in Manitoba February 2007
- Guideline 2002-02E Guideline: Criteria for Acceptance of Contaminated Soil at Licensed Waste Disposal Grounds. May 2002

Copies of these and other documents are available online.

3.0 CLASSIFICATION AND HANDLING OF PCS

It is important that petroleum storage tank owners, or contractors working for the tank owner, develop a Remedial Action Plan (RAP) prior to disposal of PCS. This RAP should cover the handling of the PCS from cradle to grave, and include procedures necessary for compliance with all provincial regulations and local policies. (see *Information Bulletin 96-02E*)

3.1 Classification

Prior to developing a procedure for handling PCS to be removed from a site, it is necessary to classify the soil based on the specific petroleum product type in question, and the degree of severity of hydrocarbon contamination. The subsequent handling, treatment and/or disposal of contaminated soil are dependent on the classification. Classification is based on results of analytical laboratory testing for petroleum hydrocarbon compounds and should be conducted prior to excavation of the soil.

Petroleum contaminant concentrations should be determined in reference to the Canadian Council of Ministers of the Environment (CCME) "Canadian Environmental Soil Quality Guidelines 1999 and Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil 2001, Table 1. Revised January 2008".

3.2 Characterization of the Soil Shipment

Detailed characterization of PCS, specifically contaminant types and concentrations, soil types and estimated volumes, must be conducted prior to any soil being shipped to a soil treatment/disposal facility. Procedures for characterization of the soil should follow those outlined in the Manitoba Conservation Guideline for the Dismantling and Removal of Petroleum Storage Tank Systems.

4.0 TRANSPORTATION OF PCS

PCS is not considered hazardous waste unless the soil is contaminated with Polychlorinated Biphenyls or meets the primary classification for classes 2 to 6 and 8 *under The Dangerous Goods Handling and Transportation Act* and regulation thereunder. PCS generators who wish to transport hazardous waste class PCS must ensure that they are registered with Manitoba Conservation and that the shipments are manifested and transported by a licensed carrier pursuant to MR 175/87.

Trucks containing the PCS should be equipped with tarpaulins to reduce wind blown particles and volatilization of petroleum constituents. During PCS transport, trucks must also effectively contain all residual liquids generated from the soil.

5.0 PERMITTING AND LICENSING PROCEDURES

The procedure for obtaining authorization to establish and operate a facility for the treatment of contaminated soils will depend on the type of facility being proposed. The various approval processes are described in this section. Regardless of the type of facility, it is anticipated that the design and operating parameters will generally follow the provisions in this guideline.

5.1 Municipal Waste Disposal Grounds

Soils which contain petroleum contamination at a concentration below CCME Canadian Environmental Quality Guidelines and the PHC CWS for Industrial land use can be received at a landfill and used directly as cover material without requiring further treatment. The landfill must be in compliance with Manitoba Regulation 150/91 under *The Environment Act* of Manitoba. Written authorization from the appropriate regional office of Manitoba Conservation and the landfill owner must be obtained for each originating site before this disposal option is used.

Where a designated soil treatment facility is to be developed as part of a waste disposal ground site, the authorization for the PCS facility will either be issued as a variance to the operating permit for the waste disposal ground pursuant to Manitoba Regulation 150/91 or as a license under *The Environment Act*. The application for the variance must contain adequate details to show that the proposed facility will meet the standards of this guideline. The application would be submitted to the Director of Environmental Operations of Manitoba Conservation. Where the volumes of soil treated exceed 4000 tonnes per year or 350 tonnes per month, the license application would be submitted to the Director of Approvals of Manitoba Conservation.

5.2 Commercial PCS Facilities

Proposals for soil treatment facilities which are not located at a municipal waste disposal ground, and which will be receiving soil from more than one originating site, will be processed through Manitoba Conservation's regular licensing system under *The Environment Act*. The application must be submitted to the Director of Approvals of Manitoba Conservation.

5.3 Single Use Sites

Where existing commercial facilities are not available in the vicinity of a remediation project, consideration will be given to authorizing the establishment of a single use site. If approved, the site would only be used once for soils originating from one location. Single use sites must be decommissioned once treatment of the soil is completed to a satisfactory level.

Requests for authority to establish a single use treatment site shall be submitted to the Director of Environmental Operations of Manitoba Conservation. Operation of the single use site shall not commence until written authorization has been received from the Director. Proponents of single use sites should ensure that any and all municipal approvals or notifications have been completed prior to initiating construction of a single use treatment site. No PCS classified as hazardous waste shall be received at a single use treatment site.

5.4 Minimum Application Information

Prior to developing a facility within the scope of this guideline, the proponent must provide Manitoba Conservation with enough information to allow the department to assess whether the facility should be permitted. Larger, more complex facilities, will require a greater degree of detail in the proposal. As a general guide for all levels of facilities*, the following minimum information should be included in all applications:

- Name and address of the owner and operator of the proposed facility.
- Name and address of the owner of the land where the facility will be sited.
- Site description to confirm that the site selection criteria outlined in Sec. 6.2 have been met.
- Physical description of the proposed facility addressing the items described in Sec. 6.2.
- Results of any baseline studies done to confirm the acceptability of the site.
- Description of the acceptance criteria to be used for receiving soil shipments.
- Description of monitoring, sampling and record-keeping procedures.
- Proposed uses for treated soil.
- Procedure to be used to decommission the site when the operation concludes.

The application must be accompanied by relevant maps, drawings and lab results.

* **NOTE:** The Director may waive the requirement to submit portions of the information listed above for submissions for single use sites.

6.0 DESIGN AND OPERATIONS AT PCS TREATMENT/DISPOSAL SITES

The information provided in this section describes, in a general sense, the typical minimum requirements for the design and operation of PCS treatment sites. More detailed information based upon the site specific conditions at a potential PCS treatment sites can also be provided in technical proposals which form part of approval submissions (see Section 5.0).

6.1 Baseline Information and Inspections

Geological and Hydrogeological Baseline Information

Prior to operation of a treatment/disposal facility, subsurface baseline information should be obtained on geological and groundwater conditions, to serve as the basis for future comparisons.

If soil treatment facilities are within the limits of Class I and Class II Manitoba WDG's, data from the existing test holes and groundwater monitoring systems may be used to establish baseline geological and groundwater conditions. The design of a groundwater monitoring system and monitoring requirements should be consistent with, and should include appropriate analytical testing parameters for PCS.

Where appropriate, soil textural analyses (i.e. grain size distribution, soil classification) and in-situ, or laboratory soil permeability testing should be conducted. Soil sampling for such analyses should be conducted at representative depth intervals.

Soil and Groundwater Chemistry Baseline Information

Baseline soil information should also be obtained to establish chemical characteristics of soils beneath the proposed treatment/disposal area. Individual soil samples should be obtained at representative depth intervals, and groundwater samples recovered from all water-bearing zones. Each sample to be submitted for laboratory analyses should be tested for the following parameters:

- Soil Vapour Concentrations.
- Total Semi-Volatile and Total Volatile Hydrocarbons.
- Benzene, Toluene, Ethylbenzene, Xylenes.
- Metals (where appropriate).
- Other Parameters (where appropriate).

Subsurface Inspections and Monitoring

Routine inspections should be conducted to confirm that operation of the treatment facility has not adversely affected local groundwater quality. Such inspections should, as a minimum, be conducted on an annual basis. Groundwater monitoring parameters should follow the baseline parameters outlined in the previous subsection.

6.2 Design Considerations

Site Selection Criteria

The following criteria must be taken into account when considering a candidate site for a PCS treatment/disposal facility. Any variations from these criteria must first be approved by Manitoba Conservation:

- A site cannot be located in a groundwater pollution hazard area unless an impermeable base is being prepared or a synthetic liner is implemented.
- A 500 m separation distance must be maintained from residences, institutional or commercial buildings on other properties, or from any body of surface water.

- The proposed site location must be adequately separated from neighbouring occupancies to minimize the potential for objectionable odours beyond the property boundaries.
- The site must be in an area with the appropriate zoning for the intended land use.

Identification and Lay-Out

An area used for treatment of PCS should be identified as a "designated area" which is used exclusively for this purpose. Such areas/facilities should be clearly marked to prevent unauthorized access onto the treatment area and possible disturbance or compaction. Physical barriers are also recommended to restrict unauthorized access.

Permanent visible markers (posts, pegs, etc.) should be installed at regular intervals of 5 m to 10 m along 2 perpendicular edges of the treatment area to serve as a reference grid for routine inspections and monitoring.

Location

Treatment cells should be located in areas where the underlying native soils consist of relatively low permeability deposits. Where this is not practical, the subgrade soil should be suitably prepared in order to provide a low permeability barrier to minimize vertical migration of leached petroleum contaminant compounds.

Siting of treatment cells in local depressions or on sloping ground with gradients of 5% or greater should be avoided.

Treatment cells should normally be located in areas where the local groundwater table is at least 3.0 m below the prepared base so as to minimize the possibility of groundwater contamination, to avoid saturation of the treatment layer due to groundwater fluctuations or capillary action, and to minimize susceptibility of the prepared base to frost action.

Soils impacted with petroleum hydrocarbons with benzene, toluene, ethylbenzene and xylene (BETX), where any of these individual constituents exceed 100 ppm (high impacted soils), shall be managed separately from other contaminated soils in a dedicated cell for treatment at Municipal Waste Disposal Grounds and Commercial PCS Facilities. The location of this cell shall be provided to the appropriate Manitoba Conservation Regional office.

Site Preparation

Treatment cells should be surrounded by berms to prevent surface water runoff and run-on. The berms should be designed to permit equipment access and have a minimum height of 0.5 m. Temporary cross-berms or windrows may also be provided to avoid mixing and cross-contamination of different soil shipments.

The base of treatment cells should be lined to prevent downward migration of contaminants below the treatment layer. The liner may consist of synthetic material, compacted clay, or a combination of both. Synthetic liners should be resistant to deterioration by sunlight and by petroleum hydrocarbon compounds, and should be installed to avoid puncture or tearing from soil spreading and tilling operations. Unless determined otherwise based on site-specific conditions, clay liners should normally have a minimum compacted thicknesses of 500 mm.

The base of the treatment area should be graded to facilitate surface drainage. A gradient of 1% to 2% will normally be adequate for this purpose. The impermeable layer on the base of the cell should be covered with a sacrificial indicator layer of sand, gravel or straw to ensure that the base is not penetrated during tilling or soil removal operations.

Design of treatment cells should include provisions to contain internal storm runoff and seepage in order to prevent offsite losses, and inundation of the treatment layer. Sumps or internal drainage ditches installed for this purpose should be suitably lined. Internal and external surface drainage systems must be capable of accommodating runoff volumes resulting from a 24-hour, 10 year frequency storm.

Monitoring Wells

The installation of monitoring wells must be incorporated in the design of the treatment area. In general, monitoring wells should be designed in order to monitor any groundwater contamination within the regional aquifer and within any perched groundwater-bearing soil formations beneath the site. The total number, location, and completion design of the monitoring wells must be approved by Manitoba Conservation, prior to installation.

6.3 Operating Considerations

Inventory Control

Operation of soil treatment facilities should incorporate inventory control and management procedures that account for the status and progress of the various individual soil shipments being treated concurrently. Information for contaminated soil for each originating site should include, but not necessarily be limited to, the following:

- Origin of the contaminated soil.
- Number of soil shipments.
- Total volume of PCS.
- Contaminant type(s) and concentrations.
- Placement area.
- Destination for remediated soil.

Where high impacted soils are received (BTEX exceeding 100 ppm for any of these constituents), the following information shall also be provided to the appropriate Manitoba Conservation regional office within 5 working days:

- Results of analytical testing by an accredited laboratory
- Company name and address of the generator.
- Estimated quantity of soil.

Placement of Treatment Layer

PCS placed in the treatment area should be spread in an even layer in a manner that avoids compaction and inter-mixing of different soil shipments.

The final thickness of the treatment layer normally should not exceed 300 mm or the effective mixing depth of on-site equipment (discs, roto-tillers, etc.), whichever is less.

Boulders and other large debris should be removed from the treatment layer to avoid potential damage to the tilling/aeration equipment, and to provide for optimum soil tillage.

Alternatively, soil may be placed in windrows which should normally not exceed 1 m in height. The windrows will require periodic mixing in a similar fashion to a treatment layer as described in the following section.

Layer Amendments

The treatment layer should be thoroughly aerated (mixed/tilled) on a regular basis. In most cases, a tillage frequency of 1 to 2 weeks should provide optimum soil aeration while minimizing excessive VOC emissions. In cases where enhanced soil remediation operations are being conducted, soil tilling frequency can be modified to suit the requirements of the remediation methods employed.

Soil augmentation procedures such as addition of fertilizers, desiccants, and soil bulking agents, are to be conducted only as approved within the licence or permit for the facility.

Periodic irrigation of the treatment layer may be necessary to avoid desiccation or prevent excessive wind blown dust. However, saturation of the soil should be avoided. Water impounded in runoff/leachate sumps may and should be used for treatment layer irrigation.

The use of sewage effluent or sewage sludge as an amendment is not recommended as it can introduce other contaminants into the soil.

Control/Discharge of Impounded Water

The soil treatment site must be capable of preventing run-on and run-off water from contacting contaminated soil. In addition, run-off water from the PCS treatment facility must be controlled on-site in order to prevent migration of contaminants. Surface water control will generally involve use of ditches, sumps, and culverts, along with a properly graded land surface.

Prior to any discharge or removal of impounded surface water from the PCS treatment facility, representative analytical testing of the water for petroleum hydrocarbon compounds must be conducted and the results reviewed by Manitoba Conservation.

Air Monitoring

Where high impacted soils are being managed, air monitoring shall be conducted to ensure the following concentration limits are not exceeded at the property boundaries:

<u>Air Contaminant</u>	<u>Period of Time Air Contaminant is Measured</u>	<u>Concentration Limit</u>
Total Hydrocarbons	24-hour average	32 mg/m ³
Benzene	24-hour average	150 µg/m ³
Toluene	24-hour average	2000 µg/m ³
Ethylbenzene	24-hour average	4000 µg/m ³
Xylenes	24-hour average	2300 µg/m ³

Air sampling shall be undertaken in adherence to accepted protocols and conducted during the period from April to November. The 24-hour average should commence during periods where volatilization will be at the maximum (i.e. soil placement and tilling). Air monitoring reports shall be provided to Manitoba Conservation within 30 days of the sampling event.

6.4 Confirmatory Testing of Treated Soil at PCS Treatment Site

Confirmatory laboratory testing should be conducted on representative samples from the treatment layer in order to demonstrate that the accepted clean-up criteria have been achieved prior to re-use of the soil, as defined in Section 7.0 of this document.

Testing Protocol

The timing and methodology for confirmatory soil testing may be based on preliminary field hydrocarbon vapour testing of soil samples.

Soil vapour concentration measurements can be used as an indicator of the relative level of volatile hydrocarbons remaining in the soil. Using this technique field screening technique, the more highly contaminated areas of the treatment layer ("hot spots") can be identified. Once soil vapour concentrations have been lowered to near background levels in these areas, soil samples may be obtained for confirmatory laboratory analyses to prove that the appropriate clean-up criteria have been achieved.

Soil vapour concentrations within the treatment layer should be carried out according to Appendix D of the Manitoba Conservation Guideline for the Dismantling and Removal of Petroleum Storage Tank Systems in Manitoba. Such measurements should be conducted on a regular grid pattern. A grid spacing of 5 m will ensure detection of "hot spots" equivalent to 10 m³ (one truck-load spread 300 mm thick) with an 80% confidence level.

Soil vapour surveys should not be conducted under saturated soil conditions.

NOTE: The use of soil vapour surveys as the basis for confirmatory soil testing may not be appropriate for some less volatile petroleum products such as diesel fuel and lube oils. In such cases, soil sampling and laboratory analyses would be required.

Confirmatory Soil Sampling

Confirmatory laboratory analyses are to be conducted at the end of the remediation period to determine if acceptance criteria have been achieved.

Individual soil samples are usually combined to form one or more "composite" sample for the purpose of laboratory analyses. As a general rule, soil sampling should be conducted for every 20 m³ of PCS in order to generate a single composite sample for confirmatory laboratory analyses. For example, for a total volume of 100 m³ of treated PCS, a single composite sample should contain soil obtained from five locations within the contaminated soil mass.

The recommended number of composite soil samples to be submitted for confirmatory laboratory analyses is dependent upon the volume of the treatment layer as follows:

Soil Volume (m³)	Number of Composite Soil Samples for Laboratory Testing
<100	1
100 - 500	3
500 - 1000	5
1000 - 2000	6
>2000	Representative Number

The above approach is biased towards the most contaminated portions of the treatment layer and, therefore, results may be conservative.

Depending on the variability of contaminant concentrations and soil conditions in the treatment layer, more or less analyses may be required.

Where field vapour screening methods have been used and are applicable, confirmatory laboratory analyses may be concentrated in the areas of pre-defined "hot spots" having the most elevated vapour concentrations.

Sample Collection Procedures

Sample collection should be conducted by personnel who have been adequately trained in proper sampling procedures. Only pre-cleaned dedicated sampling equipment and containers should be used. Care must be taken to limit potential cross-contamination.

All sampling procedures should conform to accepted methods and protocols.

6.5 Record Keeping and Reporting

The PCS treatment facility operator/owner must maintain a current inventory of the volumes of soil and contaminant types and concentrations within the soil being treated as indicated in Section 6.3. As required under section 6.3, the information for the treatment and disposal of high impacted soils shall be provided to the appropriate Manitoba Conservation regional office within 5 working days. Submission of year-end reports to Manitoba Conservation will be required. In addition, this information should be readily available and produced at facility inspections conducted by Manitoba Conservation during the operation season.

7.0 REMOVAL AND RE-USE OF TREATED SOIL

The main objective of remediation of PCS is to reduce hydrocarbon concentrations to acceptable levels such that the soils are suitable for appropriate re-use.

PCS which has been treated to CCME Canadian Soil Quality Guidelines and PHC for Industrial land use, can be used directly as landfill cover material in a waste disposal ground upon approval by the WDG authority and the local regional office of Manitoba Conservation. Treated PCS that contains contaminants in excess of these concentrations of petroleum hydrocarbon compounds, cannot be used as cover soil directly, but would require additional active treatment within the WDG area as approved. Where PCS contains inorganic contaminants in excess of the CCME Canadian Soil Quality Guidelines for Industrial land use, approval must be obtained from the Director prior to landfill disposal or cover material use. No soil exceeding the applicable leachate criteria shall be placed in a waste disposal ground unless approved by the Director or in accordance with section 29(1) of *The Dangerous Goods Handling and Transportation Act*.

Unless otherwise approved by Manitoba Conservation, treated soil cannot be deposited on a site which does not contain pre-existing contamination at concentrations greater than or equal to the residual contaminant levels in the treated soil.

8.0 DECOMMISSIONING OF PCS TREATMENT FACILITY

Submissions for operation of a PCS treatment site must include a site decommissioning plan which describes the steps to be undertaken in restoration of the site following the completion of soil treatment operations. The plan should include investigation of subsurface conditions beneath the active soil treatment layer area. Investigations should follow the procedures outlined in Guideline 98 - 01. In addition, the plan should describe procedures for the removal of any infrastructure (i.e. buildings, berms, sealing monitoring wells), and re-grading of the land surface to original grade.

Submission and approval of a site decommissioning report to Manitoba Conservation will be required.

9.0 MANITOBA CONSERVATION REGIONAL OFFICES

Central Region

Winnipeg - 945-7100 Fax 948-2338
123 Main Street, Suite 160
Winnipeg MB R3C 1A5

Gimli - 642-6095 Fax 642-6108
75 – 7th Ave.
Gimli MB R0C 1B9

Winkler - 325-1750 Fax 325-1758
Main Plaza, 555 Main Street
Winkler MB R6W 1C4

Portage la Prairie - 239-3608 Fax 239-3215
25 Tupper Street North
Portage la Prairie MB R1N 3K1

Selkirk - 785-5030 Fax 785-5024
Lower Level, 446 Main St.
Selkirk MB R1A 1V7

Eastern Region

Lac du Bonnet – 345-1444 Fax 345-1440
Provincial Highway 502
P.O. Box 4000
Lac du Bonnet MB R0E 1A0

Steinbach - 346-6060 Fax 326-2472
Unit B, 284 Reimer Avenue
Steinbach MB R5G 0R5

Western Region

Brandon - 726-6064 Fax 726-6567
1129 Queens Ave.
Brandon MB R7A 1L9

Dauphin – 622-2030 Fax 638-8626
27 – 2nd Ave. SW
Dauphin MB R7N 3E5

Northwest Region

The Pas - 627-8499 Fax 623-1773
Provincial Building
P.O. Box 2550
The Pas MB R9A 1M4

Northeast Region

Thompson – 677-6703 Fax 677-6888
59 Elizabeth Dr. Provincial Bldg.
P.O. Box 32
Thompson MB R8N 1X4