



Risk-Based Corrective Actions for Petroleum Hydrocarbon Impacted Sites

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Risk-based Corrective Actions For Petroleum Hydrocarbon Impacted Sites

PREFACE

This guideline revises the *Risk-based Corrective Actions for Petroleum Hydrocarbon Impacted Sites 2008*. The corrective action process essentially remains the same as in the 2008 guideline with some revisions to the Tier 1 risk management option. The revisions include removing all pathway elimination from the Tier 1 risk management option and referencing the most conservative criteria in Table 2.1. The specific revisions include:

- Section 2.5.1 *TIER 1 – Selection of Applicable Exposure Pathways* from the 2008 guideline was incorporated into Section 2.6 as 2.6.2 *Tier 2B – Pathway/Receptor Modification or Elimination* of the 2009 guideline to remove all pathway elimination from the Tier 1 risk management option.
- Table 2.1 was revised to reference the most conservative criteria. Specifically, the Toluene in coarse-grained soils criteria now references the protection of ground water for aquatic life (previously referenced protection of potable groundwater) and the ability to exclude the potable groundwater criteria for Fractions 1 and 2 have been removed.

The *Risk-Based Corrective Actions For Petroleum Hydrocarbon Impacted Sites 2009* provides a site management process specifically for soil and groundwater contamination originating from existing or former petroleum storage facilities and other petroleum impacted sites. The numerical criteria, risk management objectives and technical information presented in this document are a compilation of information from the following documents:

- *Canadian Council of Ministers of the Environment. Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil*⁽¹⁾.
- *Canadian Council of Ministers of the Environment. Canadian Soil Quality Guidelines for the protection of Environmental and Human Health: Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)*⁽²⁾.

This guideline is not a stand-alone document; all users of this document should become conversant in the theory and application of the above documents in order to be competent in application of this guideline.

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1.0 INTRODUCTION

Petroleum hydrocarbons (PHC) are used in nearly every facet of Canadian life. They provide energy to heat our homes and places of work, fuel our transportation systems and power manufacturing processes and tools, as well as providing a source for the numerous synthetic materials we take for granted in our lives. When they are used as intended, PHCs provide great benefits to society. However, when released to the soil environment as raw feed stocks or refined fuels or lubricants, problems can result. These include fire and explosion hazard, human and environmental toxicity, movement through soil to air or water, odour and impairment of soil processes such as water retention and nutrient cycling.

To provide a consistent approach to managing PHC impacts across Canada, The Canadian Council of Ministers of the Environment endorsed the *Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil* in 2001. The Canada-wide Standard was revised in January 2008 after an extensive review. Some of the key changes were: human soil ingestion and dermal contact pathways were combined; modifications to several fate and transport model parameters to reflect current science; ecological soil contact values were updated; and subsoil tables were removed from most of the Canada-Wide Standard reports and replaced with management limits.

Benzene, toluene, ethylbenzene and xylenes (BTEX) are excluded from the Canada-Wide Standard and are addressed as target compounds under the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* ⁽²⁾.

The responsibility for the remediation or management of contamination at a property fundamentally lies with the person(s) causing the contamination. This responsibility stems from The Environmental Management and Protection Act, 2002 ⁽³⁾. These guidelines are necessary since there is no legislative enactment, by statute or by regulation, prescribing acceptable levels of contamination for the purpose of decommissioning a petroleum-contaminated facility. As well, it is not practical to describe the specific remedial methodology in legislation for all possible contamination scenarios.

The Hazardous Substances and Waste Dangerous Goods Regulations ⁽⁴⁾ govern the decommissioning of petroleum storage facilities, including the removal of tanks, lines and associated equipment and the decontamination, reclamation or monitoring and management of all affected areas. Section 17 of the regulations state:

17(1) No person shall remove, abandon, dispose or permanently close all or part of any storage facility without the prior approval of the minister to decommission the storage facility and decontaminate and reclaim or manage and monitor every affected area.

17(2) At least 30 days prior to the removal, abandonment, disposal or permanent closure of a storage facility, the owner or operator of the storage facility shall submit a decommissioning application to the minister containing:

- (a) a description of how the decommissioning is to take place;*
- (b) a description of the plans for the disposal of any remaining equipment, hazardous substances, waste dangerous goods or contaminated materials; and,*
- (c) a detailed proposal to:*
 - (i) decontaminate and reclaim the affected area;*
 - (ii) to monitor and manage the affected area; or,*
 - (iii) that consists of a combination of decontaminating and reclaiming and monitoring and managing pursuant to sub clauses (i) and (ii).*

17(3) Before making a proposal pursuant to sub clause (2)(c)(ii), the owner or operator shall carry out a site assessment to determine the degree of contamination, the risks to the environment, and the risks to the health and safety of the public.

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17(4) *Within 12 months of the date of approval, an owner or operator of a storage facility, in accordance with the terms of the approval, shall decommission the facility, and:*

- (a) decontaminate and reclaim the affected area; or,*
- (b) initiate monitoring and management of the contamination and associated risks.*

17(5) *Notwithstanding any other provision in these regulations, no owner or operator of an underground storage tank shall abandon or permanently close the underground storage tank unless the underground storage tanks is:*

- (a) emptied;*
- (b) removed from the ground; and,*
- (c) rendered unfit for further use for the storage of hazardous substances or waste dangerous goods.*

17(6) *No person to whom an approval is issued pursuant to this section shall fail to comply with the terms of the approval.*

17(7) *No person shall decommission, remove, abandon dispose or permanently close an underground tank used for the storage of petroleum products other than by the means of the services of a qualified person or under the supervision of a person designated by the minister.*

17(8) *No person shall decommission, remove, abandon, dispose or permanently close an underground tank used for the storage of waste dangerous goods other than under the supervision of a person designated by the minister.*

The Ministry of Environment, in administering the applicable Act and Regulations, has developed and revised the *Risk-Based Corrective Actions for Petroleum Contaminated Sites* to adopt and reflect the revisions to the *Canada-Wide Standards for Petroleum Hydrocarbons in Soil*⁽¹⁾ and the *Canadian Soil Quality Guidelines for BTEX*⁽²⁾.

1.1 Concerns Regarding Petroleum Hydrocarbons Impacts in the Environment

PHCs in the environment are a concern for the following reasons:

- the reduced nature and volatility of PHCs pose a fire and explosion hazard;
- most PHC constituents present adverse effects through human and environmental toxicity;
- lighter hydrocarbons are mobile and migrate considerable distances from their point of release;
- larger and branched-chain hydrocarbons are persistent in the environment;
- PHCs may create aesthetic problems such as offensive odour, taste or appearance; and,
- under some conditions, PHCs can degrade soil quality by interfering with water retention and transmission and with nutrient supplies.

1.2 Objectives and Scope

The objective of these guidelines is to define requirements and methods to be employed for the uniform evaluation, decommissioning, remediation, reclamation and management of PHC-impacted sites in Saskatchewan. These guidelines establish a process whereby the parties managing a project can ensure risks to human and environmental health and safety are minimized. The guidelines are also intended to assist owners of petroleum storage facilities and persons undertaking management of sites in understanding the requirements of the ministry when a release of PHCs is known or suspected to have occurred.

These guidelines will be applied to sites with PHC impacts regardless of source.

1.3 Definitions

Aquifer means groundwater-bearing formations sufficiently permeable to transmit and yield water in usable quantities.

Aromatic Compounds contain ring structures formed from closed loops of carbon chains (most containing six carbon atoms) where carbons in the ring have resonant double bonds. Aromatic compounds include compounds such as BTEX, as well as polyaromatic compounds such as naphthalene. Because of the double bonding between carbon atoms, the molecules are not saturated with hydrogen atoms.

BTEX: benzene, toluene, ethylbenzene and xylenes

Coarse-Grained Soil means soil having a median grain size of $>75 \mu\text{m}$, as defined by the American Society for Testing and Materials (ASTM Test Method C136 and C117).

Carcinogen means a substance or agent that causes the development or increases the incidence of cancer. A carcinogen can also act upon a population to change its total frequency of cancer in terms of numbers of tumors or distribution by site and age.

Contaminant Partitioning refers to the contaminant's chemical equilibrium condition, where the contaminant's chemical concentration is apportioned between two different phases according to the partition coefficient, which is the ratio of a chemical's concentration in one phase to its concentration in the other phase.

Contamination refers to a chemical that is present in soil or other material to which this guideline applies, at a concentration greater than background, or which is not naturally occurring in the soil or other material to which this guideline applies.

Delineate means identification of the lateral and vertical extent of contamination at the site and includes all four phases (vapour, dissolved, residual and free liquid) or other suitable endpoint, as agreed to in writing by the ministry.

Down Gradient is defined as any direction within 45 degrees either side of the direction of groundwater flow. In cases where the groundwater gradient is indeterminate, all surface water bodies within 500 m of the site will be considered.

Exposure Pathway means the route by which a receptor comes into contact with a contaminant.

Fine-Grained Soil means soil having a median grain size of $<75 \mu\text{m}$, as defined by the American Society for Testing and Materials (ASTM Test Method C136 and C117).

Groundwater means subsurface water beneath the water table in fully saturated geologic formations.

Hydraulic Conductivity refers to the proportionality factor between hydraulic gradient and flux in Darcy's Law. Hydraulic conductivity measures the inherent ability of a porous medium to conduct water.

Impact means impairment of or damage to human health, the environment, safety or property, including property value.

Ministry means the Saskatchewan Ministry of Environment.

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Petroleum Hydrocarbons (PHC) describes a mixture of organic compounds found in or derived from geological substances such as oil, bitumen and coal. For the purposes of this document, PHCs are subdivided into four fractions, according to specified ranges of equivalent carbon number (ECN). The four fractions are:

F1: ECN from C₆ to C₁₀ minus BTEX.

F2: ECN from C_{>10} to C₁₆.

F3: ECN from C_{>16} to C₃₄.

F4: ECN from C_{>34} to C₅₀.

Polycyclic aromatic hydrocarbons (PAH) are assessed and managed separately and should be subtracted from the aromatics in the F2 and F3 fractions as appropriate.

Proponent means the owner, operator or other responsible party proposing or undertaking remediation of a PHC-impacted site.

Receptor means the person or organism exposed to a chemical.

Remediation means the removal or reduction of contaminant concentrations to an acceptable land use endpoint based on risk-based generic numerical objectives.

Risk Assessment means characterization of the nature, magnitude and likelihood of adverse effects on human health or ecosystems from exposure to one or more contaminating substances through various routes of exposure (pathways).

Risk Management means eliminating or controlling one or more risk assessment components (contaminants, receptor and/or pathways) with the goal of achieving risk reduction on a contaminated property. Remediation is one possible risk management option.

Site Characterization includes, but is not limited, to identification and characterization of source, pathway and receptor.

Source means the source(s) of PHC.

Stakeholder, when used with risk assessment, means the property owner, adjacent property owners/residents, local health officials and municipal authorities, the ministry and any others who may be directly affected by the contamination and risk management plan.

Vadose Zone means the zone between land surface and the water table, within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore spaces also typically contain air or other gases. The capillary fringe is included in the vadose zone.

Additional definitions are provided in The Environmental Management and Protection Act, 2002 ⁽³⁾, The Hazardous Substances and Waste Dangerous Goods Regulations ⁽⁴⁾, and The Environmental Spill Control Regulations ⁽⁵⁾.

2.0 REPORTING, DECOMMISSIONING AND REMEDIATION

This section outlines the available options and steps to be taken by operators, owners and persons performing the required remediation and/or assessment.

The remediation process generally begins with the decision to take corrective actions. Issues such as groundwater contamination, potential off-site migration of PHCs, contamination of utility trenches, conduits and other underground structures, vapour migration, impairment of property and the results of environmental audits or assessments are all reasons for managing risks during the operation and decommissioning of a facility.

The proper decommissioning of a site includes a number of steps, including reporting to the ministry, remediation and reclamation, decommissioning and closure. A preliminary review and the completion of a site investigation are normally required to formulate a Corrective Action Plan. Once the Corrective Action Plan is completed, the proponent may apply to the ministry for decommissioning. The Hazardous Substances and Waste Dangerous Goods Regulations⁽⁴⁾ require that the application be submitted at least 30 days prior to decommissioning. Municipal approval, where necessary, should also be provided within the submission for the removal and decommissioning of storage tanks with regards to reducing fire risks and protecting publicly-owned utilities and infrastructures.

Once the decommissioning approvals have been granted, The Hazardous Substances and Waste Dangerous Goods Regulations⁽⁴⁾ require that the facility be decommissioned within 12 months. As part of the decommissioning process, a closure report and verification sampling are required. These steps are illustrated in Figure 2.1 and discussed in depth in the following sections.

2.1 Preliminary Review and Site Assessment

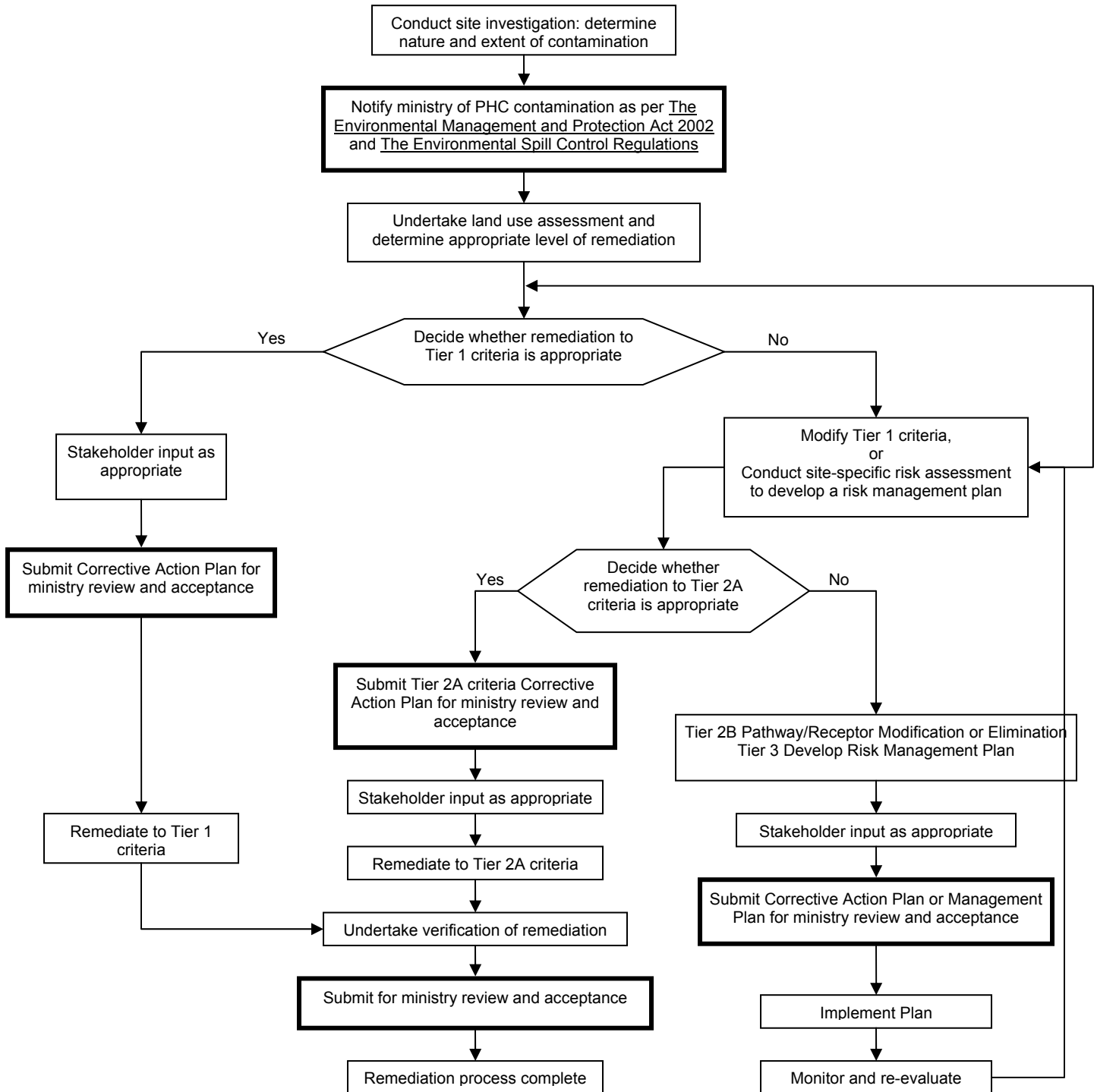
Decommissioning begins with a preliminary information review and site assessment that will provide the information necessary for the development of a Corrective Action Plan and assist in the proper planning, identification and cleanup of petroleum contamination. In the case of petroleum storage facilities, the assessment will determine the extent of contamination (if any) by identifying the location(s) and degree of petroleum contamination both on- and off-site. In most cases, site assessments are divided into phases. A Phase I environmental site assessment (ESA) is a preliminary investigation conducted to reveal any potential significant environmental concerns. A Phase II ESA is a detailed site investigation to confirm and quantify the contamination as indicated in Phase I. As well, there are standard documents that describe these phases, including:

- Canadian Standards Association
 - CAN/CSA-Z768-01 Phase I Environmental Site Assessment⁽⁶⁾; and,
 - CAN/CSA-Z769-00 Phase II Environmental Site Assessment⁽⁷⁾.
- Canadian Council of Ministers of the Environment (CCME)
 - PN1101 & PN1103 Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites - Volume I: Main Report & Volume II: Analytical Method Summaries^(8, 9), and,
 - PN1144 Subsurface Assessment Handbook for Contaminated Sites⁽¹⁰⁾.

The objective of the site assessment is to delineate contamination in order to select the appropriate decommissioning and remediation approach. The site assessment may be quite simple or complex, depending on the level of contamination. Subsurface assessments should include soil vapour concentration data. Where, in the opinion of the ministry, additional assessment is necessary, the proponent shall be required to undertake additional investigations.

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Figure 2.1 Flow Chart Illustrating the Steps Required to Decommission a PHC Impacted Site



NOTE: The flowchart is intended as a guideline only and does not replace any regulatory or legislative requirements.

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2.2 Risk Management Options

Following the completion of an appropriate site investigation, there are three main decommissioning risk management options that may be proposed to the ministry to address impacts at a site:

- Tier 1: Remediation to Generic Criteria Based on Land Use;
- Tier 2A: Adjustments to Tier 1 Levels Based on Site-Specific Parameters;
- Tier 2B: Pathway/Receptor Modification or Elimination; and,
- Tier 3: Site-specific Risk Assessment and/or Risk Management.

The risk management options are consistent with *Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soils*⁽¹⁾. Ministry approval of the Corrective Action Plan is required before implementing any of the options. The options are explained in greater detail in the following sections.

Benzene is classified as a carcinogen and Health Canada^(11, 12) provides guidance with respect to incremental cancer risk. Incremental cancer risk is deemed to be “essentially negligible” when the estimated incremental lifetime cancer risk is in the 1 in 1,000,000 ($\leq 1 \times 10^{-6}$) and 1 in 100,000 ($\leq 1 \times 10^{-5}$) range. In the application of the CCME Environmental Soil Quality Guideline for benzene in Saskatchewan, an incremental cancer risk of 1×10^{-5} has been applied. If a proponent conducts a Tier 3 assessment, the same incremental cancer risk should be applied.

2.3 Determination of Soil Type

Generic guidelines are available for two soil types, coarse-grained and fine-grained. Sufficient textural information should be obtained to permit classification of soils as coarse or fine. The absence of sufficient textural information should result in the default application of the more conservative values. Selection of the appropriate set of guidelines is based on the soil type that controls contaminant migration at the site, based on professional judgment. For example, a continuous layer of coarse-grained soil will often govern groundwater flow in the saturated zone, even though its thickness may be small in comparison to the total thickness of saturated fine-grained soil. In cases where it is not clear which soil type should be applied, the more conservative guidelines should be used.

2.4 Land Use

The *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soils*⁽¹⁾ has been developed for four generic land uses that have been adopted within these guidelines - agricultural, residential/parkland, commercial and industrial. A generic land use scenario is envisioned for each category based on the normal activities on these lands.

The four land uses as defined by CCME⁽¹⁴⁾ are:

- **Agricultural:** where the primary land use is growing crops or tending livestock. This includes agricultural lands that provide habitat for resident and transitory wildlife and native flora. The portion of a farm that houses people is considered residential/parkland.
- **Residential/Parkland:** where the primary activity is residential or recreational activity. The ecologically-based approach assumes parkland is used as a buffer between areas of residency, but this does not include wild lands such as national or provincial parks.
- **Commercial:** where the primary activity is commercial and there is free access to all members of the public, including children. The use would include, for example, shopping malls and commercial day-care centres. It does not include operations where food is grown.

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- **Industrial:** where the primary activity involves the production, manufacture or construction of goods. Public access is restricted and children are not permitted continuous access or occupancy.

Application of Other Land Uses

The four generic land uses can be extended to other land uses based on equivalent exposure scenarios. For example, pathways for wild lands would include ecological soil contact, ecological soil ingestion, nutrient cycling and potentially the protection of groundwater pathways. These pathways are also operative at agricultural sites; therefore Tier 1 agricultural levels can be applied at wild lands sites. Similarly, institutional land use would normally conform to a residential exposure scenario. While some institutional land uses (*i.e.*, schools) more closely resemble a commercial exposure scenario (exposure five days per week, ten hours per day), others, such as hospitals and senior citizen's homes, are essentially residential land uses.

The proponent should contact the applicable municipality to obtain information on allowable land uses. The ministry requires evidence of the most sensitive land use allowed under the relevant zoning to support the selected land use.

This classification approach provides the flexibility in assessment and management of different variations within a generic land use and extension of the standard to other land use categories. If the information does not fit into any of the four generic land uses, nor any hybrid thereof, it should be addressed at the Tier 3 level.

Modifying the Land Use

Where the site is located adjacent to a property where more stringent remediation criteria apply, the remediation criteria for the adjacent property must be applied within the site to a distance of 30 m from the adjacent property line. The intent of this modification is to prohibit development restrictions being unduly placed on the adjacent land. In some instances this may result in more than one remediation criteria being applied to a site.

Refer to Section 2.5.1 for the selection of applicable exposure pathways. Where more than one criteria may apply to the site, the proponent should select the most conservative criteria for each of the parameters. For example, a site with a commercial land use designation that is also less than 500 m down gradient of a surface water body should use the most conservative criteria for both commercial land use and freshwater/aquatic life for each parameter.

2.5 TIER 1 - Remediation to Generic Criteria Based on Land Use

The Tier 1 criteria provided in Tables 2.1 and 2.2 were developed by Health Canada and CCME. Details regarding the technical and scientific basis for the development of the numerical Tier 1 values are provided in:

- *Canada-Wide Standards for Petroleum Hydrocarbons in Soils: Scientific Rationale*⁽¹³⁾ for PHC;
- *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*⁽²⁾ presents the scientific rationale for BTEX;

The site assessment needs to verify the site conditions to determine if Tier I remediation criteria can be applied and which Tier I criterion is applicable.

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TABLE 2.1 Tier 1 - Risk-based Criteria for Petroleum Hydrocarbons in Soil (mg/kg)

Land Use	Benzene	Toluene	Ethylbenzene	Xylenes	Petroleum Hydrocarbon Fractions			
					Fraction 1	Fraction 2	Fraction 3	Fraction 4
Coarse-Grained Soils								
Agricultural	0.030	0.10	0.082	11	30	150	300	2,800
Residential	0.030	0.10	0.082	11	30	150	300	2,800
Commercial	0.030	0.10	0.082	11	240	260	1,700	3,300
Industrial	0.030	0.10	0.082	11	240	260	1,700	3,300
Fine-Grained Soils								
Agricultural	0.0068	0.08	0.018	2.4	170	150	1,300	5,600
Residential	0.0068	0.08	0.018	2.4	170	150	1,300	5,600
Commercial	0.0068	0.08	0.018	2.4	170	230	2,500	6,600
Industrial	0.0068	0.08	0.018	2.4	170	230	2,500	6,600

Note: additional exposure pathway risk-based criteria are available in Tables A2.4 and A2.5

TABLE 2.2 Tier 1 - Risk-Based Criteria for Petroleum Hydrocarbons in Groundwater (mg/L)

Exposure Pathway	Benzene	Toluene	Ethylbenzene	Xylenes
Potable Groundwater (applies to coarse- and fine-grained soils)	0.005	0.024	0.0024	0.3
Freshwater/Aquatic Life (applies to coarse-grained soils only - 10 m – 500 m from surface water)	0.370	0.002	0.090	NC

NC – not calculated

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When conducting the site assessment for a Tier 1 approach, the proponent may wish to conduct a more comprehensive and detailed assessment providing additional information in the event that they eventually select a Tier 2 or Tier 3 option. While there are advantages associated with a phased approach to site assessment, there may be economies in combining data collection activities into a single investigation.

2.5.1 TIER 1 - Applicability

The development of the Tier 1 guidelines employed a number of conservative assumptions that should make them applicable to the majority of PHC-impacted sites in Saskatchewan. At sites where these assumptions are not applicable, Tier 1 guidelines cannot be used and a Tier 2 or Tier 3 approach must be used. It is the responsibility of the proponent to identify and respond to any site or receptor factors that unduly accentuate exposure or risk beyond that envisioned in Tier 1 exposure scenarios and, when necessary, move to Tier 2 or Tier 3. Examples of where Tier 1 guidelines would not apply include:

- PHC contamination is closer than 30 cm to the foundation of an occupied building;
- PHC contamination is closer than 10 m to a surface waterbody;
- soils are predominantly sands and gravels, with a bulk hydraulic conductivity greater than 10^{-3} cm/s;
- the land use does not fall into any of the generic land use scenarios;
- water is used for irrigation or food processing;
- PHC contamination is in fractured bedrock; and
- any condition where, in the opinion of the ministry, Tier 1 is not applicable.

2.6 TIER 2 - Remediation Based on Site-specific Sensitivity

2.6.1 TIER 2A - Adjustment of Tier 1 Based on Site-specific Parameters

In some cases, the proponent may not consider that remediation to the Tier 1 criteria is either feasible or appropriate. In these cases, the proponent may modify Tier 1 remediation criteria for the specific site conditions, land use and exposure scenarios involved to develop objectives that are equivalent to the Tier 1 criteria.

It should be pointed out that the decision to undertake a Tier 2A assessment implies a commitment to increase the accuracy of the exposure and risk estimates in light of the available site-specific data. Therefore, the values of all linked parameters in Table 2.3 that are influential with respect to the governing pathway should be determined and implemented, even if the effect of one or more of the parameters, adjusted independently, would be to increase the potential level of exposure. This is particularly so with parameters such as total soil porosity and moisture content, which may have opposing influences but are correlated to a degree in practice.

Table 2.3 summarizes groups of parameters (e.g., hydrological or hydrogeological) that should be measured and adjusted together, along with the exposure pathways to which each group applies. Additional guidance on the application of Tier 2 assessments is provided in PN1398 *Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: User Guidance*⁽¹⁵⁾.

In cases where limited suites of adjustable parameters are presented, the ministry may require additional parameters. Derivation and justification is dependant on site-specific conditions and shall be presented for ministry approval.

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2.6.2 TIER 2B - Pathway/Receptor Modification or Elimination

The *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soils* ⁽¹⁾ considered the following exposure pathways:

- *Human Health*
 - Soil Ingestion
 - Soil Dermal Contact
 - Inhalation of Indoor Air
 - Protection of Potable Groundwater *

- *Ecological*
 - Plant/Invertebrate Soil Contact
 - Soil Ingestion by Livestock/Wildlife
 - Protection of Groundwater for Aquatic Life *
 - Protection of Groundwater for Livestock and Wildlife Watering *

The pathways without an asterisk (*) are always considered if applicable to the land use. The groundwater pathways with an asterisk may be excluded in the following circumstances:

- **Potable Groundwater:** The potable groundwater pathway may be excluded if either:
 - the site is not underlain by an aquifer that is used or has the potential for use for potable groundwater water supplies or
 - the contaminated soil and groundwater are not hydraulically connected to an underlying aquifer that is used or has the potential for use for potable groundwater supplies. A 5 m thickness of massive unfractured saturated fine-grained material, with a bulk hydraulic conductivity less than 10^{-5} cm/s or equivalent, as approved by the ministry, is considered sufficient to ensure isolation between groundwater aquifers.

As a guide, water-bearing units with a hydraulic conductivity of less than 10^{-4} cm/s are unlikely to be considered an aquifer for domestic water supplies. There are, however, situations where low hydraulic conductivity units may be the only groundwater resource available, so local water well records must be checked during the site assessment stage.

- **Freshwater/Aquatic Life:** The protection of groundwater for freshwater aquatic life and wildlife watering pathways may be excluded in cases where there is no surface water body (e.g. creek, lake, slough) within 500 m down gradient of the site. In cases where the groundwater gradient is indeterminate, all surface water bodies within 500 m of the site will be considered.

Other Tier 2 modifications are outlined in PN1398 *Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: User Guidance* ⁽¹⁵⁾ including elimination of exposure pathways and receptors and remediation objectives for subsoils. Where pathways or receptors are modified or eliminated, controls are necessary to preserve the assumptions used in the establishment of the Tier 2B objectives.

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TABLE 2.3 Tier 2A - Adjustable Parameters by Pathway

Governing Pathway	Parameter Grouping	Measured Parameters
Protection of potable groundwater, protection of groundwater for aquatic life	Hydrogeological (saturated zone)	Soil bulk density Organic carbon fraction Hydraulic conductivity & hydraulic gradient ^a
	Hydrogeological (unsaturated zone)	Soil bulk density & moisture content ^{ab} Organic carbon fraction ^c Depth to groundwater ^b
	Source dimensions	Length (parallel to groundwater flow) Width (normal to groundwater flow) ^d Contaminant thickness ^b Distance between contamination and water table ^b
	Hydrogeological	Precipitation, evapotranspiration, and runoff ^a Days with surface temperature <0° C ^b
	Chemical	PHC composition
Vapour inhalation	Hydrogeological	Soil bulk density ^e & moisture content ^a Organic carbon fraction ^c Unsaturated zone soil vapour permeability
	Source dimensions	Depth or distance to contamination
	Chemical	PHC composition
Ecological soil contact		No user-adjustable parameters
Soil ingestion	Chemical	PHC composition

Notes:

a - parameters are linked and must be considered together.

b - only required if contaminated soil is not in direct contact with groundwater.

c - measured in the zone of contaminant partitioning.

d - only required for lateral groundwater transport.

e - soil bulk density is required in both the zone of contaminant partitioning and in the unsaturated zone (to calculate vadose zone soil porosity).

Source: *Canada Wide Standards for Petroleum Hydrocarbons (PHC) in Soil: User Guidance* ⁽¹⁵⁾

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Elimination of Exposure Pathways and Receptors

The site-specific adjustment of Tier 1 criteria based on the absence of exposure pathways and/or receptors may be permitted under Tier 2B. The guiding principle in this regard is whether the relevant site-specific conditions are fixed or stable and can be predicted or controlled in a generic way. In many cases, site management or administrative controls are required to support screening of exposure pathways or receptors within a given generic land use.

“Appendix I – Criteria for Tier 2B Evaluation” provides criteria for each exposure pathway for fine and coarse-grained soils that are to be used as part of Tier 2B evaluations. For information on how to apply these criteria, please refer to PN1398 *Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: User Guidance*⁽¹⁵⁾. An example of pathway/receptor elimination that may be allowed is the exclusion of soil organisms and related pathways from consideration on commercial or industrial land where the site is completely paved or capped and where no productive use of the soil system is anticipated or required. Although capping may not eliminate the presence of soil organisms, the need for a functioning soil ecosystem is diminished. Should landscaped areas exist or be planned, ecological soil contact would remain an active pathway.

Other pathways may be excluded in combination with the implementation of management measures or controls, provided that the use of such controls at Tier 2B is supported in the particular jurisdiction. Zoning jurisdictions may also elect to define generic land uses involving the presence or absence of any relevant receptors and pathways, if appropriate in the context of geographic location, local land use and development trends.

It is the responsibility of the proponent to identify and obtain the necessary land use restrictions when pathway elimination is proposed.

Remediation Objectives for Subsoils

In the 2008 Canada-wide Standard revision, the subsoil tables were removed from most of the Canada-wide Standard reports because of differences in implementation between jurisdictions and concerns regarding the approach taken. In their place, management limits were developed that have explicitly stated considerations that were previously incorporated into the subsoil ecological guidelines. Subsoil tables are still included in the technical supplement⁽¹⁶⁾ to maintain consistency with the 2001 Canada-wide Standard.

Management Limits

In addition to the chronic toxicity of PHC to human and ecological receptors, various effects of PHC contamination are also considered. These effects include:

- free phase formation;
- exposure of workers in trenches to PHC vapours;
- fire and explosive hazards;
- effects on buried infrastructure; and
- aesthetic considerations.

These potential effects, combined with technological factors, were used to derive management limits for PHC fractions, which are considered to apply at all soil depths and are not adjustable at Tier 2. For further information on management limits, refer to the technical supplement⁽¹⁶⁾.

2.7 TIER 3 - Site-specific Risk Assessment and/or Risk Management

A Tier 3 evaluation involves the completion of a site-specific risk assessment and the development of a Risk Management Plan. Detailed guidance on human health and ecological risk assessment is beyond the scope of this document. The technical activities of Tier 3 must be conducted by professionals competent in the field of human health and ecological risk assessment, which includes the disciplines of

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impacted site characterization, toxicology, contaminant fate and transport modeling, exposure assessment and risk management.

Based on the results of a site-specific risk assessment, the proponent would be expected to develop a Risk Management Plan that provides an equivalent level of health and environmental protection as the generic numerical remediation criteria. The Risk Management Plan should outline the controls that will be necessary to preserve the assumptions used in the establishment of the Tier 3 objectives. These controls may include engineered systems, designed to limit exposure via one or more exposure pathways through physical means such as barriers, and/or controls designed to limit exposure through land and water use restrictions.

Under certain circumstances it may be possible, and advantageous, to implement risk management measures without any associated remediation. Examples of such situations include operating facilities where natural attenuation is being relied upon in the long term and sites where remediation can be accomplished only at the time of site closure or redevelopment. In these cases, monitoring would be required to ensure that conditions do not become worse with time and that the risk management measures are effective. In cases, particularly those in which active remediation is not contemplated, the non-toxicity-based considerations, including explosion hazard, aesthetic and avoidance of free product, must be observed and addressed.

2.8 Regulatory Requirements Independent of Risk

Certain minimum conditions and actions are required on an impacted site to achieve compliance with the ministry's regulatory management goals and to address risk and stakeholder concerns. The following primary conditions and actions are necessary and independent of the level of risk at any impacted site. They are based upon mitigating current and potential future adverse effect and upon other requirements set out in The Environmental Management and Protection Act, 2002 ⁽³⁾.

2.8.1 Source Control

Gross sources of contamination can aggravate or otherwise worsen environmental quality by contributing to an increase in the extent and degree of contamination in the environment over time. Contaminant discharges are considered releases that must be remediated, removed or otherwise managed to the greatest extent practical if they are contributing adverse effect or impacts. Sources are defined as, but not limited to:

- a whole contaminant substance or product in a distinct phase that releases or disperses significant contamination into air, water or soil;
- non-aqueous phase liquid in soil exceeding the soil's residual holding capacity (free phase); or
- a mobile environmental medium containing significant amounts of contamination.

Source control is generally considered complete when monitoring data demonstrates that contaminant migration has either stabilized or decreased in all environmental media and that the degree of contamination at any point is unlikely to worsen over time.

2.8.2 On-site Contamination

Contamination identified on a proponent's property in excess of the land use criteria provided in Table 2.1 should be reported to the ministry as defined by The Environmental Management and Protection Act, 2002 ⁽³⁾. The Environmental Spill Control Regulations ⁽⁵⁾ require all subsurface discharges of hydrocarbon to be reported to the ministry.

2.8.3 Off-site Contamination and Impairment of Property

If contamination has migrated or may migrate off the proponent's property, the proponent is required to notify all affected parties and the ministry and to take action to prevent, manage and mitigate any adverse effect or impacts. The objective of a Risk Management Plan is to achieve a solution acceptable to all parties. In cases where neither the ministry nor the proponent has care and control of an affected

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property, a site-specific Risk Management Plan decision must involve input from the affected stakeholders. In the event that the affected stakeholder(s) will not participate in the Risk Management Plan process, the ministry will apply Tier 1 criteria to address adverse effect issues on the affected off-site property.

2.9 Corrective Action Plan

A Corrective Action Plan should provide all information required for the ministry to assess the application for the proposed remediation activities planned for the impacted site. In brief, it should provide general information, facility and site information, assessment criteria/objectives with respect to the governing pathways and the remediation/management plan. When the Corrective Action Plan is complete with all pertinent information, it must be included within the submitted application. Ministry approval of the application/Corrective Action Plan must be obtained prior to initiating any remediation work. An example outline for a Corrective Action Plan is presented in Appendix II.

The plan will be reviewed by the ministry to determine its acceptability and, in some cases, in consultation with the owner and local officials. When the plan is not acceptable, the ministry will identify deficiencies and ask that the plan be upgraded. When the plan is acceptable, the ministry will approve the proposal in writing and the project can begin.

2.9.1 Risk Management Plans

The Risk Management Plan will apply to Tier 2B and 3 only and shall include criteria for measuring success and a schedule for reporting monitoring results and assessing progress. The measures to be implemented require review and acceptance by the ministry. A checklist to be used in the development of Risk Management Plans is provided in Appendix III.

Once implemented, the risk management measures would have to be maintained indefinitely, unless further remediation is carried out and/or generic criteria are met and verified by additional assessment. Ministry approval in writing is required to amend a Risk Management Plan.

Since the risk management option potentially leaves in place contaminant concentrations greater than generic risk-based remediation criteria, or may impose long term management obligations on an affected party, the ministry may require all stakeholders' input to the Risk Management Plan. For example, if the contaminant concentration exceeds applicable criteria on a property not controlled by the proponent, then the proponent must obtain acceptance from the affected stakeholder(s) prior to submitting the plan to the ministry. Furthermore, if the site-specific risk assessment and Risk Management Plan is based upon restrictions on allowable land use or site accessibility within relevant zoning category, the affected stakeholder(s) must be willing and able to accept the required land use restrictions. In the absence of agreement by a directly affected stakeholder, the ministry requires compliance with generic criteria.

2.10 Submission of an Application

Notification of decommissioning shall be through the completion and submission of an application for approval to decommission a petroleum storage facility 30 days prior to the decommissioning. In the case of a remediation based on future land use, completion of this application 30 days in advance will allow the ministry time to review and comment on the acceptability. If the proponent intends to use a Tier 2 or Tier 3 approach, more details will be required in the proposal. Additional information can be obtained by contacting the Environmental Protection Branch of the ministry or through the ministry's website at: www.environment.gov.sk.ca.

2.11 Approval of the Submitted Application from the Ministry

The ministry reviews the application. When the plan is not acceptable, the ministry will request additional information or refuse the application. When the plan is acceptable, the ministry will grant approval in writing.

2.12 Notification of Local Authorities

Some municipalities have established bylaws with specific requirements for removal and decommissioning of storage tanks to reduce fire risks and protect publicly-owned utilities and infrastructures. Anyone planning to carry out any decommissioning, site assessment or risk management activities shall contact the appropriate municipal authorities, such as municipal engineering or fire departments, for specific local requirements. Documentation including municipal authority names and contact information shall be provided to the ministry.

2.13 Decommissioning

Generally, the decommissioning will involve the removal of tanks and any equipment (the source of contamination) and remediation of soil and water contamination, if present. Tank and associated equipment removal should be carried out in accordance with *PN 1326 Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products*⁽¹⁷⁾ as amended from time to time. Soil and water contamination should be remediated using appropriate technology, subject to ministry approval.

2.13.1 Disposal of Contaminated Liquids

Any liquids removed from tanks or containers that cannot be used for the original purpose are considered to be waste dangerous goods and must be handled, stored and/or disposed of according to The Saskatchewan Dangerous Goods Transportation Act⁽¹⁸⁾ and Regulations⁽¹⁹⁾ and The Hazardous Substances and Waste Dangerous Goods Regulations⁽⁴⁾. This includes contaminated wash water and any contaminated liquids resulting from spills. Wastewater discharge from oil/water separators may be subject to prior approval by municipal authorities for discharge to the sanitary sewer systems.

2.13.2 Storage and Disposal of Tanks

The Hazardous Substances and Waste Dangerous Goods Regulations⁽⁴⁾ require that all decommissioned underground tanks be rendered unfit for further use for the storage of hazardous substances or waste dangerous goods. The ministry may consider approval for re-use in special circumstances or if the tank is re-certified by the manufacturer. Rendering the tank unfit can be accomplished by puncturing the tank in several places or by cutting holes in the ends. Ultimately, underground tanks should be cleaned, cut up and used as scrap metal. Documentation as to the rendering of the tank unfit for further use and its ultimate disposal location shall be supplied to the ministry as part of the Closure Report.

2.13.3 Mitigation of Petroleum Contamination

There are many methods for mitigating contaminated soil, groundwater and surface water at a facility. Contaminated soil, for example, may be excavated and treated at an approved site/facility through land spreading, low temperature thermal desorption or by incineration of the soil. Excavation and land spreading at an approved site is the most commonly used contaminated soil treatment method.

Technologies that treat contaminated soil or groundwater without excavation (*in situ* treatment) are practical in certain situations. *In situ* methods must meet or exceed the risk management criteria and plans submitted to the ministry need to describe how the *in situ* technologies will be applied.

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Some *in situ* technologies are:

- *In Situ* Vapour Extraction;
- *In Situ* Aeration; and
- Liquid Recovery/Groundwater Treatment

2.13.4 Soil Treatment

If the chosen treatment method is soil venting (land spreading and tilling), the proponent should use an approved municipal or commercial treatment facility. For municipal facilities, the ministry must give prior approval for final disposal of treated soils, if they are not to be used for cover at the municipal waste disposal grounds. Municipal soil treatment should be conducted as per the ministry's *Guidelines for Treatment and Disposal of Petroleum Contaminated Soils at Municipal Waste Disposal Grounds* ⁽²⁰⁾. Commercial treatment facilities require monitoring, sampling and other requirements as outlined within their permits to operate.

2.14 Verification Sampling and Closure Report

To complete a decommissioning and/or remediation project, a sampling program must verify that the risk remaining is acceptable. An example outline of a Closure Report is presented in Appendix II. Soil samples should include samples from the tank bed, excavation walls and pump island area. The number of samples required will vary for each situation. In general, the more samples taken, the more likely conditions at the site are characterized accurately and the more likely the site will present an acceptable amount of risk. Samples should be taken from excavated areas below obviously contaminated areas (e.g., areas where high combustible vapour readings were taken, below tanks or below the pump island) and on the sidewalls of the excavation. The proponent shall provide soil vapour concentration data. Where, in the opinion of the ministry, additional vapour phase investigation is needed, the proponent shall undertake additional investigation.

The ministry evaluates if remediation criteria have been met and risk addressed through the Closure Report submission. The submission therefore needs to include the work schedule, names of companies or individuals who performed the work, the fate of any equipment removed from ground (tanks, pipes, etc.), description of treatment method(s), fate of contamination, future land use, verification sampling results and any ongoing monitoring (on- and off-site).

2.15 Ministry Approval

The Closure Report should be submitted to the ministry as soon as possible after completion. The ministry will comment on whether the guidelines and regulatory requirements have been met. A final declaration as to the complete cleanup of the site will not be issued, as these guidelines are based on risk management techniques. The ministry will, however, comment on whether an acceptable amount of risk remains, subject to the accuracy of the information supplied.

If criteria are met, Tier 1 and Tier 2A projects will be acknowledged by the ministry. Tier 2B and 3 projects will be acknowledged, providing risk is adequately addressed.

3.0 REFERENCES

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APPENDIX I
CRITERIA FOR TIER 2B EVALUATION

TABLE 2.4 Tier 2B - Risk-Based Criteria - Coarse-Grained Soils (mg/kg)

Land Use	Exposure Pathway	Benzene [*]	Toluene [*]	Ethylbenzene [*]	Xylenes [*]	Petroleum Hydrocarbons Fractions ^{**}			
						F1	F2	F3	F4
Agricultural	Soil Ingestion	110	22,000	10,000	150,000	12,000	6,800	15,000	21,000
	Dermal Contact	250	220,000	58,000	NA	12,000	6,800	15,000	21,000
	Vapour Inhalation (basement)	0.15	200	88	22	40	190	NA	NA
	Vapour Inhalation (slab-on-grade)	0.095	120	55	14	30	150	NA	NA
	Ecological Soil Contact	31	75	55	95	210	150	300	2,800
	Protection of Ground Water (Livestock)	1.7	1,800	13,000	20,000	5,300	14,000	NA	NA
	Protection of Ground Water (Potable)	0.030	0.37	0.082	11	240	320	NA	NA
	Protection of Ground Water (Aquatic Life)	1.0	0.10	50	37	970	380	NA	NA
Management Limit ^a					700	1,000	2,500	10,000	
Residential	Soil Ingestion	110	22,000	10,000	150,000	12,000	6,800	15,000	21,000
	Dermal Contact	250	220,000	58,000	NA	12,000	6,800	15,000	21,000
	Vapour Inhalation (basement)	0.15	200	88	22	40	190	NA	NA
	Vapour Inhalation (slab-on-grade)	0.095	120	55	14	30	150	NA	NA
	Ecological Soil Contact	31	75	55	95	210	150	300	2,800
	Protection of Ground Water (Potable)	0.030	0.37	0.082	11	240	320	NA	NA
	Protection of Ground Water (Aquatic Life)	1.0	0.10	50	37	970	380	NA	NA
	Management Limit ^a					700	1,000	2,500	10,000
Commercial	Soil Ingestion	110	82,000	36,000	560,000	19,000	10,000	23,000	RES
	Dermal Contact	250	790,000	210,000	NA	19,000	10,000	23,000	RES
	Vapour Inhalation	0.30	1,400	630	160	320	1,700	NA	NA
	Ecological Soil Contact	180	250	300	350	320	260	1,700	3,300
	Protection of Ground Water (Potable)	0.030	0.37	0.082	11	240	320	NA	NA
	Protection of Ground Water (Aquatic Life)	1.0	0.10	50	37	970	380	NC	NC
	Management Limit ^a					700	1,000	3,500	10,000
Industrial	Soil Ingestion	110	NA	620,000	NA	RES	RES	RES	RES
	Dermal Contact	250	NA	560,000	NA	RES	RES	RES	RES
	Vapour Inhalation	0.30	1,400	630	160	320	1,700	NA	NA
	Ecological Soil Contact	180	250	300	350	320	260	1,700	3,300
	Protection of Ground Water (Potable)	0.030	0.37	0.082	11	240	320	NA	NA
	Protection of Ground Water (Aquatic Life)	1.0	0.10	50	37	970	380	NC	NC
	Off-site Migration	NC	NC	NC	NC	NA	NA	4,300	RES
	Management Limit ^a					700	1,000	3,500	10,000

a - includes additional considerations such as free phase formation, explosive hazards, and buried infrastructure effects;

* - BTEX criteria from Canadian Environmental Soil Quality Guidelines 2007⁽²⁾;

** - PHC criteria from Canada-wide Standards for Petroleum Hydrocarbons (PHC) in Soil 2008⁽¹⁾;

NA - not applicable. Calculated value exceeds 1,000,000 mg/kg;

NC - not calculated;

RES - residual PHC formation. Calculated value exceeds 30,000 mg/kg and solubility limit for PHC fraction.

TABLE 2.5 Tier 2B - Risk-Based Criteria - Fine-Grained Soils (mg/kg)

Land Use	Exposure Pathway	Benzene [*]	Toluene [*]	Ethylbenzene [*]	Xylenes [*]	Petroleum Hydrocarbons Fractions ^{**}			
						F1	F2	F3	F4
Agricultural	Soil Ingestion	110	22,000	10,000	150,000	12,000	6,800	15,000	21,000
	Dermal Contact	250	220,000	58,000	NA	12,000	6,800	15,000	21,000
	Vapour Inhalation (basement)	2.1	2,600	1,300	320	710	3,600	NA	NA
	Vapour Inhalation (slab-on-grade)	2.1	2,700	1,300	320	610	3,100	NA	NA
	Ecological Soil Contact	60	110	120	65	210	150	1,300	5,600
	Protection of Ground Water (Livestock)	NC	NC	NC	NC	4,200	10,000	NA	NA
	Protection of Ground Water (Potable)	0.0068	0.08	0.018	2.4	170	230	NA	NA
	Protection of Ground Water (Aquatic Life)	NC	NC	NC	NC	RES	RES	NA	NA
	Management Limit ^a					800	1,000	3,500	10,000
Residential	Soil Ingestion	110	22,000	10,000	150,000	12,000	6,800	15,000	21,000
	Dermal Contact	250	220,000	58,000	NA	12,000	6,800	15,000	21,000
	Vapour Inhalation (basement)	2.1	2,600	1,300	320	710	3,600	NA	NA
	Vapour Inhalation (slab-on-grade)	2.1	2,700	1,300	320	610	3,100	NA	NA
	Ecological Soil Contact	60	110	120	65	210	150	1,300	5,600
	Protection of Ground Water (Potable)	0.0068	0.08	0.018	2.4	170	230	NA	NA
	Protection of Ground Water (Aquatic Life)	NC	NC	NC	NC	RES	RES	NA	NA
	Management Limit ^a					800	1,000	3,500	10,000
	Commercial	Soil Ingestion	110	82,000	36,000	560,000	19,000	10,000	23,000
Dermal Contact		250	790,000	210,000	NA	19,000	10,000	23,000	RES
Vapour Inhalation		2.8	13,000	6,500	1,600	4,600	23,000	NA	NA
Ecological Soil Contact		310	330	430	230	320	260	2,500	6,600
Protection of Ground Water (Potable)		0.0068	0.08	0.018	2.4	170	230	NA	NA
Protection of Ground Water (Aquatic Life)		NC	NC	NC	NC	RES	RES	NA	NA
Management Limit ^a						800	1,000	5,000	10,000
Industrial		Soil Ingestion	110	NA	620,000	NA	RES	RES	RES
	Dermal Contact	250	NA	560,000	NA	RES	RES	RES	RES
	Vapour Inhalation	2.8	13,000	6,500	1,600	4,600	23,000	NA	NA
	Ecological Soil Contact	310	330	430	230	320	260	2,500	6,600
	Protection of Ground Water (Potable)	0.0068	0.08	0.018	2.4	170	230	NA	NA
	Protection of Ground Water (Aquatic Life)	NC	NC	NC	NC	RES	RES	NA	NA
	Off-site Migration	NC	NC	NC	NC	NA	NA	19,000	RES
	Management Limit ^a					800	1,000	5,000	10,000

a - includes additional considerations such as free phase formation, explosive hazards, and buried infrastructure effects;

* - BTEX criteria from Canadian Environmental Soil Quality Guidelines 2007⁽²⁾;

** - PHC criteria from Canada-wide Standards for Petroleum Hydrocarbons (PHC) in Soil 2008⁽¹⁾;

NA - not applicable. Calculated value exceeds 1,000,000 mg/kg;

NC - not calculated;

RES - residual PHC formation. Calculated value exceeds 30,000 mg/kg and solubility limit for PHC fraction.

APPENDIX II
CORRECTIVE ACTION PLAN AND CLOSURE REPORT OUTLINES

CORRECTIVE ACTION PLAN

The Corrective Action Plan should contain, but is not limited to, the following:

1. Objective
2. Contact Information:
 - facility owner and/or operator;
 - name of landowner;
 - facility name;
 - facility address;
 - phone numbers; and
 - Ministry of Environment Facility Code or Operating Approval Number.
3. Facility and Site Information:
 - facility and site history;
 - historic and current fuelling facilities;
 - current land use;
 - proposed future land use;
 - water well search;
 - previous assessments; and
 - location, type and construction materials of underground services.
4. Assessment Criteria:
 - identify sensitive receptors and pathways for soil and groundwater;
 - identify on-site sources; and
 - develop remedial objective.
5. Remediation/Management Plan (Excavation):
 - name(s) of qualified persons and companies performing the work;
 - drawing of facility showing proposed excavation limits;
 - outline of procedure to decommission any underground and/or aboveground tanks and management of any residual fluids;
 - excavation plan, taking into account applicable occupational health and safety acts and regulations;
 - procedures for handling emergencies occurring during decommissioning process;
 - fate of tanks and associated piping;
 - field screening and confirmatory soil and water sampling plan;
 - identify soil disposal facility and any post construction treatment requirements;
 - proposed work schedule; and
 - other remedial activities, if any.

CLOSURE REPORT

The Closure Report should contain, but is not limited to, the following:

1. Title of the remediation report
2. Contact Information;
 - facility owner and/or operator;
 - name of landowner;
 - facility name;
 - facility address;
 - phone numbers; and
 - Ministry of Environment Facility Code or Operating Approval Number (if applicable).
3. Facility and Site Information:
 - facility and site history;
 - current land use;
 - proposed future land use; and
 - remedial objectives.
4. Summary of Corrective Actions:
 - description of how and when site was remediated;
 - number of tanks and piping systems; and description of their conditions;
 - fate of tanks and associated equipment;
 - treatment/disposal of contaminated materials;
 - disposal locations for soils and liquids;
 - volume of contaminated soil/liquid removed; and
 - sampling schedule for land spread contaminated soil, where applicable.
5. Verification Sampling Methodology:
 - name of laboratory performing analysis, field screening procedures and laboratory analysis requested;
 - name of laboratory performing analysis; and
 - description of sampling methods and quality assurance/quality control procedures.
6. Results:
 - physical location of samples with diagram (results are to be included on the diagram with any excursions highlighted);
 - summary table of field screening and analytical results with comparisons to applicable criteria;
 - copy of laboratory analytical results; and
 - brief discussion on the compliance of objectives.
7. Comments Discussion and Recommendations:
 - discussion on compliance, with applicable criteria and any off-site impacts, where applicable;
 - plume closure and comment on all four phases;
 - off-site impact action plan, where applicable; and
 - recommendations or general comments about special circumstances regarding the project.
8. Summary

APPENDIX III

REVIEW CHECKLIST FOR RISK ASSESSMENT BASED APPROACH

Review Checklist for Risk Assessment Based Approach

Note:

Except where stated below, if any one or more of the following requirements are not satisfied (unless they are not applicable), the corrective action plan will not be accepted as proposed and further information will be required.

If any of the answers to items 4, 5, and 6 are “no”, risk management will normally not be considered by the Ministry of Environment to be an acceptable option.

A dash (-) in the N/A column indicates a Yes or No answer is required.

A.	Is the corrective action plan appropriate for the site conditions?	Y	N	N/A
1	Delineation is complete (soil, groundwater, and vapour).			-
2	There is liquid product (on-site or off-site).			-
3	There are heavily impacted soils present in the source area(s) that may limit the effectiveness of the risk management option.			-
4	If the answer to 2 or 3 is “yes”, are there technologies/options available to manage the impacts.			-
5	The identified impact is unlikely to cause adverse effect to third parties (including adjacent landowners, groundwater users and buried infrastructure). Supporting rationale must be provided. If adverse effect is likely, a remedial response is required under EMPA.			-
6	Water use restrictions will not be required in the short or long term.			-
7	There are no cost effective and/or practical remedial alternatives.			-
B.	Have necessary stakeholder commitments been obtained?	Y	N	N/A
8	Written approval from potentially affected third-parties has been provided.			
	- Private landowners			
	- Provincial Government			
	- Utility owners			
	- Others			
9	The owner has committed to maintaining the corrective action plan indefinitely or until compliance with governing risk management objectives has been demonstrated (i.e. beyond the timeframe estimated by the consultant, if necessary).			-
10	All land use restrictions and/or institutional controls have been clearly communicated to the affected stakeholders.			
C.	Is the proposed corrective action plan technically and financially adequate?	Y	N	N/A
11	The corrective action plan is adequate to: - Protect health and environment throughout the program. Supporting rationale must be provided in all cases.			-
	- Monitor vapour concentrations near buildings.			
	- Prevent worsening of off-site conditions.			
	- Monitor on-site and off-site conditions.			-
	- Manage contamination if disturbed by future activities (e.g. excavation).			-
	- Notify future affected parties of site conditions.			-

12	The plan includes adequate contingency measures to: - Respond to adverse changes in site conditions.			
	- Implement alternate risk management measures if contaminant concentrations are not decreasing with time or the plume is not stable.			-
	- Initiate renewed stakeholder consultations.			-
13	The scope and frequency of the monitoring program is adequate to assess the effectiveness of the corrective action plan and enable a proactive response to changes in environmental conditions.			-
14	The monitoring program is adequate to demonstrate the effectiveness of any institutional controls that were place to protect potential receptors.			
15	The future cost of risk management has been adequately estimated.			
16	A closure plan has been provided to demonstrate compliance with the governing risk management objectives.			-
17	The plan includes a clearly defined monitoring schedule with reporting, as needed, to the Ministry of Environment and any affected stakeholders.			-
D.	Additional requirements specific to monitored natural attenuation or other risk management methods that rely on natural attenuation processes.	Y	N	N/A
18	The plan includes source removal (considered to include liquid product and heavily impacted soil) in accessible areas.			-
19	Historical data has been provided to demonstrate that natural attenuation processes are occurring.			-
	1. Decreasing concentrations with time.			
	2. Measured changes in chemical data showing loss of contaminant mass.			
20	If historical data are not available, a suitable trial program has been proposed to determine if natural attenuation will be effective at the site. This program should include specific hydrogeological or geochemical indicator parameters of natural attenuation.			-
21	The plan will address hydrocarbon contamination in the vadose zone.			
22	The performance monitoring program is adequate to demonstrate that natural attenuation is occurring to expectations, including: 1. A stable contaminant plume (down gradient, laterally and vertically).			-
	2. Deceasing contaminant concentrations with time.			-
	3. No unacceptable impact to down gradient receptors.			-
23	Natural attenuation is occurring (or expected to occur) at a rate that will achieve the desired endpoints in a reasonable period of approximately 10-15 years.			-
24	An appropriate timeframe has been used to estimate costs and evaluate natural attenuation vis-à-vis the alternatives.			-
25	The corrective action plan is sufficiently well-developed technically.			-
26	The plan includes contingency measures for more aggressive risk management if the proposed natural attenuation program is found to be ineffective.			-