

**Canadian Council of Ministers of the Environment**

***CANADA-WIDE STANDARDS***  
*for*  
***PETROLEUM HYDROCARBONS (PHC) IN SOIL***

# ***CANADA-WIDE STANDARDS*** ***for*** ***PETROLEUM HYDROCARBONS (PHC) IN SOIL***

These Canada-Wide Standards (CWS) for petroleum hydrocarbons in soil are established pursuant to the 1998 Canada-wide Accord on Environmental Harmonization of the Canadian Council of Ministers of the Environment (CCME) and its Canada-wide Environmental Standards Sub-Agreement.

The PHC CWS is a remedial standard for contaminated soil and subsoil occurring in four land use categories. The standard is grounded in the science of risk assessment and can be applied at any of three “Tiers”: Tier 1 – generic numerical levels; Tier 2 – adjustments to Tier 1 levels based on site-specific information; Tier 3 – site-specific risk assessment. The same high level of environmental and human health protection is required at all three tiers.

Because the PHC CWS is tiered and risk-based there is necessarily some complexity in its development and application. Details regarding development and application of the standards are provided in a Technical Supplement.

The PHC CWS was developed with the input of four multistakeholder technical advisory groups and one dedicated working group involving the Canadian oil and gas industry, government and an academic chair. The PHC CWS represents a consensus view of the national Development Committee, developed with the assistance and input of the technical advisory groups.

## **RATIONALE**

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, power manufacturing processes and tools, as well as providing a source for the numerous synthetic materials we take for granted in our lives. Used as intended, PHC provide great benefits to society. However, when released to the soil environment as raw feedstocks or refined fuels or lubricants, a number of problems can result. These include fire/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.

About 60% of Canada’s contaminated sites involve petroleum hydrocarbon (PHC) contamination that, left unaddressed, impairs the quality and uses of both land and water. Presently, management of these sites across Canada varies considerably and generally lacks an adequate scientific basis – resulting in over- and under-management. Where over-management occurs, land sale transactions and real estate redevelopment are limited by remediation costs. Under-managed sites continue to pose risks to human and environmental health. The PHC Canada-wide Standard will provide a consistent approach to managing PHC-contaminated sites across the country.

## **DEFINITIONS**

Petroleum hydrocarbons (PHC) is a general term used to describe mixtures of organic compounds found in or derived from geological substances such as oil, bitumen and coal. For the purposes of this CWS, PHC are considered to be comprised of 4 fractions as defined in Part 1. PHC exclude – for the purposes of this standard – known carcinogens such as benzene and benzo(a)pyrene, which are addressed as target compounds. Because of the relatively long history of managing toluene, ethylbenzene and xylenes (“TEX”) as target compounds, these are also excluded from PHC.

## **CONTEXT**

Petroleum products released to the environment typically contain thousands of compounds, in varying proportions, composed predominantly of carbon and hydrogen, with minor amounts of nitrogen, sulphur and oxygen. The properties of PHC contamination in soils varies with the petroleum source, soil type, the composition, degree of processing (crude, blended or refined), and the extent of weathering caused by exposure to the environment.

The complexity of PHC, and the extreme variability of sources and site-specific circumstances, complicates assessment of the human and environmental health risks associated with PHC contamination in soil.

PHC contamination in soil is a concern for a number of reasons. First, the chemically reactive nature and volatility of PHC can pose a fire/explosion hazard, especially if vapours enter confined spaces. Second, most PHC constituents are toxic to some degree. Third, lighter hydrocarbons (i.e. those of lower molecular weights) are mobile and can become a problem at considerable distances from their point of release due to transport in ground, water or air. Fourth, larger and branched-chain hydrocarbons are persistent in the environment. Fifth, PHC may create aesthetic problems such as offensive odour, taste or appearance in environmental media. Finally, under some conditions, PHC can degrade soil quality by interfering with water retention and transmission, and with nutrient supplies.

Canadian regulatory agencies have responded to these concerns with assessment and remediation requirements where PHC contaminate soils and groundwater. A blend of generic guidelines and site-specific, risk-based approaches has emerged across Canada, but there is very little consistency across jurisdictions in the rationale for guidelines, numerical values provided, or application to land uses.

The CWS is founded on documented and scientifically defensible risk-based methodology, namely the *CCME Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* and the American Society for Testing & Materials (ASTM) *Risk-based Corrective Action (RBCA)* - and additions/improvements thereon, including the *Atlantic Partners in RBCA Implementation (PIRI)* (see Technical Supplement, section 1). Consequently, the derivation of the CWS involves explicitly listed receptors - both human and ecological, and the levels of protection accorded. It also involves defined exposure scenarios, and documented underlying assumptions, equations and policies (see Technical Supplement, sections 1 and 2).

Moreover, a vast array of analytical chemistry options exists for quantifying hydrocarbons in soil. Various methods have been developed to measure most or part of the hydrocarbons present in a sample based on different sampling, storage, extraction, purification, quantification, and data treatment approaches. Lack of measurement standardization has led to high variability in results and confusion for users of the data. The PHC CWS includes an analytical reference method to promote consistency in PHC-in-soil measurement practices and to ensure comparability of data nationally (see Technical Supplement, section 4).

The CWS Tier-1 levels have been selected despite gaps and uncertainties in some of the information used to support them. Nevertheless, the information available is sufficient to conclude that implementing the CWS will protect the environment and is technically and economically feasible. In this regard, jurisdictions will have considerable flexibility in the detailed design of jurisdictional plans and an opportunity to reduce information gaps and uncertainties.

## **PART 1:**

### **NUMERICAL TARGETS and TIMEFRAMES**

The PHC CWS is a remedial standard. The standard does not specify timelines that jurisdictions must follow in remediating PHC contaminated sites. Rather, it specifies consistent methods and outcomes for assessment and management of such sites. The CWS requires jurisdictions to commit to timelines for implementation of this consistent assessment and management approach, however.

The PHC CWS is based on the assessment and consistent management of risks posed to human, plants, animals and environmental processes under four common uses of land – agricultural, residential/parkland, commercial, and industrial. The standard is laid out in three tiers, which incorporate different amounts of site-specific information. Environmental and human health protection goals do not change between the tiers. Additional site-specific information available at Tiers 2 and 3 is used to manage risks through more precise knowledge of actual or potential exposure.

The environmental and human health protection goals of the PHC CWS are stated in the Tier 1 levels. A summary of Tier 1 levels is provided in Table 1. Additional Tier 1 levels are provided in the Technical Supplement along with Tier 2 and Tier 3 guidance. To develop these levels, the Development Committee identified -- in consultation with stakeholders -- for each land use: (1) the receptors and resources to be protected, (2) the pathways by which each could be exposed, and (3) the tolerable exposure along all applicable receptor/exposure pathway combinations. These tolerable exposures acknowledge that people may experience PHC exposures unrelated to contaminated soil and adjustments for known or expected exposures are made. Under Tier 1 and many Tier-2 approaches, exposures are managed below the tolerable level through reduction of PHC concentrations in the soil. Some Tier-2 and Tier-3 approaches achieve the same result by reducing exposures through engineered and/or institutional controls. The former approach is preferred; however, the latter is needed in some cases as indicated by socio-economic considerations. Irrespective of the approach chosen, the same high level of environmental and human health protection is required at each Tier.

Tier-1 levels are used when the proponent accepts the base assumptions and parameters in the Tier-1 exposure scenario. Tier-2 levels may be generated and used when site conditions exist that significantly modify the exposure and risk scenarios. Tier-3 levels are based on site-specific assessment and management of risks.

The PHC CWS implementation differs from other CWS. The trigger for remedial action is usually the need to act on a site-by-site basis to accommodate a new or intensified land use, and thus avoid human and ecological exposure to PHC during the modified land use. In such cases, the timeframe for achieving target cleanup levels at a particular site will depend largely upon the timeframe associated with the proposed land use for the site. The CWS will also find application in the cleanup and restoration phases of responses to pollution emergencies involving petroleum products and crude oils.

One of the guiding principles of the *CCME Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* is that impairment of relatively clean soil up to guideline levels is not advocated. Consistent with the principle, the PHC CWS target levels are not intended to be used as 'pollute-up-to levels' for uncontaminated land.

### Tier 1: Numerical Levels for Different Land Uses

Tier-1 numerical levels are summarized in Table 1, where:

- "Fraction" refers to the equivalent normal straight-chain hydrocarbon (nC) boiling point ranges (Fraction #1: nC6 to nC10; Fraction #2: >nC10 to nC16; Fraction #3: >nC16 to nC34; and, Fraction #4: nC35+).
- "Coarse" means coarse-textured soil having a median grain size of >75 µm as defined by the American Society for Testing and Materials.

- "Fine" means fine-textured soil having a median grain size of  $\leq 75 \mu\text{m}$  as defined by the American Society for Testing and Materials. .
- Levels without parentheses do not include consideration of the soil-to-groundwater contamination pathway.
- Levels within parentheses do include protection of groundwater.

**Table 1. Summary of Tier 1 Levels (mg/kg) for surface soil.\***

Land Use	Soil Texture	Fraction 1	Fraction 2	Fraction 3	Fraction 4
Agricultural	Coarse-grained soil	130	450 (150 <sup>a</sup> )	400	2800
	Fine-grained soil	260 (180 <sup>b</sup> )	900 (250 <sup>b</sup> )	800	5600
Residential/ Parkland	Coarse-grained soil	30 <sup>c</sup>	150 <sup>c</sup>	400	2800
	Fine-grained soil	260 (180 <sup>b</sup> )	900 (250 <sup>b</sup> )	800	5600
Commercial	Coarse-grained soil	310 (230 <sup>a</sup> )	760 (150 <sup>a</sup> )	1700	3300
	Fine-grained soil	660 (180 <sup>b</sup> )	1500 (250 <sup>b</sup> )	2500	6600
Industrial	Coarse-grained soil	310 (230 <sup>a</sup> )	760 (150 <sup>a</sup> )	1700	3300
	Fine-grained soil	660 (180 <sup>b</sup> )	1500 (250 <sup>b</sup> )	2500	6600

\* Additional Tier 1 levels are presented in Technical Supplement.

a= Where applicable, for protection against contaminated groundwater discharge to an adjacent surface water body.

b= Where applicable, for protection of potable groundwater.

c= assumes contamination near residence with slab-on-grade construction.

### Tier 2: Site-specific Adjustments to Tier-1 Levels

Tier-2 levels may be generated and used when site-specific information indicates that site conditions exist that modify human or ecological exposure to PHC contamination and, thereby, alter risks significantly, relative to the generic conditions used to derive Tier-1 levels.

Thus, Tier-2 levels are derived on a site-by-site basis using site-specific parameters where necessary; the potentially adjustable parameters and corresponding calculation protocols are summarized and referenced in the Technical Supplement (section 2).

### Tier 3: Site-specific Risk Assessment and Management

The process of developing site-specific cleanup levels and related management options requires the appropriate use of both general and site-specific information. Background information and guiding principles have been established to direct and focus this process, and are documented in the *Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada* (CCME 1996). The use of these guiding principles in developing Tier 3 standards is outlined in the Technical Supplement.

Additional guidance in this connection is also available in *A Framework for Ecological Risk Assessment: General Guidance* (CCME, 1995) and *Risk Assessment Guidance for Superfund Vol I* (USEPA 1989). Other appropriate guidance may also be available from the appropriate jurisdictional authority.

## **PART 2:**

### **IMPLEMENTATION**

Because environmental issues related to PHC release to soil are principally limited to intra-jurisdictional effects, Clause 6.1 of the CWS Sub-agreement applies for this CWS. This means that specific measures undertaken by each government to meet this CWS will be at the discretion of each jurisdiction.

Jurisdictions agree to review current programs and tools and, as required, develop and activate jurisdictional implementation plans to integrate the CWS or ensure equal or better protection.

### **REVIEW**

The CWS will be reviewed as follows:

By the end of year 2003, review of additional scientific, technical and economic analysis to reduce information gaps and uncertainties and allow revision of the PHC CWS in the year 2005 as appropriate.

### **REPORTING on PROGRESS**

Progress towards meeting the above provisions will be reported as follows:

- (a) to the respective publics of each jurisdiction on a regular basis, the timing and scope of reporting to be determined by each jurisdiction; and,
- (b) to Ministers, with comprehensive reports at five-year intervals beginning in year 2003.

### **ADMINISTRATION**

Jurisdictions will review and renew Part 2 and the Annexes five years from coming into effect.

Any party may withdraw from these Canada-wide Standards upon three month's notice.

These Canada-wide Standards come into effect for each jurisdiction on the date of signature by the jurisdiction.

## Canada-wide Standards for Petroleum Hydrocarbons (PHC) in Soil

Signed by:

British Columbia	Honourable Ian Waddell
Alberta	Honourable Lorne Taylor
Saskatchewan	Honourable Buckley Belanger
Manitoba	Honourable Oscar Lathlin
Ontario	Honourable Elizabeth Witmer
Environment Canada	Honourable David Anderson
New Brunswick	Honourable Kim Jardine
Nova Scotia	Honourable David Morse
Prince Edward Island	Honourable Chester Gillan
Newfoundland and Labrador	Honourable Ralph Wiseman Honourable Tom Lush
Yukon	Honourable Dale Eftoda
Northwest Territories	Honourable Joseph Handley
Nunavut	Honourable Olayuk Akesuk

Note: Québec has not endorsed the Canada-wide Accord on Environmental Harmonization or the Canada-wide Environmental Standards Sub-agreement.