Initial Review

CCME Canada Wide Standards for Petroleum Hydrocarbons

Prepared for

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Prepared by

Science Advisory Board for Contaminated Sites

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Executive Summary

At the request of the Ministry of Water, Land and Air Protection, the Science Advisory Board for Contaminated Sites has conducted an initial review of the Canadian Council of Ministers of the Environment, Canada Wide Standards for Petroleum Hydrocarbons in soil. The purpose of the review was to provide advice related to the scientific credibility of these Canada Wide Standards and whether adoption by the ministry of these standards would constitute a better scientific basis relative to current petroleum hydrocarbon soil standards contained in the Province's Contaminated Sites Regulation.

The Science Advisory Board (SAB) notes that the CCME Canada Wide Standards for Petroleum Hydrocarbons in soil were developed using risk based principles. The SAB notes that the current generic petroleum hydrocarbon standards of the Contaminated Sites Regulation are largely based on professional judgement.

From a methodological viewpoint, the protocols and procedures used by CCME to establish the Canada Wide Standards are similar to risk based protocols originally developed by the Contaminated Sites Standards Task group and subsequently adopted by the ministry to derive matrix standards for use under the Contaminated Sites Regulation. However, the CCME CWS-PHC protocol benefits from recent advances in science and hence incorporates a number of new protocol elements, which are not considered within the existing ministry protocol. However, the SAB notes that differences related to the underlying policy decisions and defined exposure scenarios (acceptable cancer risk for example) exist between CCME and the Province, and so the CWS in any event would require some revision before they would be consistent with the BC regulatory system. The SAB also notes that differences related to the underlying science policy decisions and defined exposure scenarios exist between CCME and the Province.

The initial investigation by the SAB into the approach used to derive the CCME CWS PHC standards suggests there are components of the CWS-PHC process that should be adopted by the Ministry. However the investigation also indicated that some components need further review to verify that the assumptions and tools used in the CWS-PHC represent the best available science. Until this review is completed, *it is recommended that the Province not adopt the CCME Canada Wide Standards for Petroleum Hydrocarbons in soil for regulatory purposes, at this time.*

The review must include:

a An assessment of the tools and methodologies used to develop CWS PHCs for protection of aquatic life and drinking water, specifically, an assessment of the groundwater transport model and an evaluation of the use of narcosis as a toxicological endpoint.
b An assessment of the tools and methodologies used to develop CWS PHCs for soil vapour intrusion of volatile chemicals.
c A re-evaluation of the methodology used to calculate soil standards for protection of terrestrial biota and plants.
d An evaluation of the use of soil depth to contamination within the regulatory process.

Further to the review of technical issues, the SAB recommends that the ministry move as expeditiously as possible to replace the existing professional judgement based generic soil standards for petroleum hydrocarbons found within Schedule 4 of the Contaminated Sites Regulation with risk based matrix soil standards developed using the ministry's current soil standard derivation protocol suitably modified to incorporate those new elements contained in the CCME approach which are deemed to have scientific merit.

Additionally, in the longer term, to ensure an appropriate and consistent level of environmental protection, the ministry should initiate a review and re-assessment of its current soil standards derivation protocol with the aim of updating the protocol to reflect current "best science" and facilitate the subsequent recalculation of existing matrix soil standards for all substances currently listed within Schedule 5 of the Contaminated Sites Regulation

1.0 Background

The CCME[1] Canada Wide Standards for Petroleum Hydrocarbons in soil (CWS-PHC) were derived using protocols, which are similar to, but different from, those used by the ministry in deriving matrix soil standards for the Contaminated Sites Regulation. In addition, the CCME CWS-PHC protocol benefits from recent advances in science and hence incorporates a number of new protocol elements, which are not considered within the existing ministry protocol.

The British Columbia Science Advisory Board for Contaminated Sites (SAB) has on behalf of the British Columbia Ministry of Water, Land and Air Protection ("the Ministry") completed an initial comparative review of the CCME Canada Wide Standards[2] for Petroleum Hydrocarbons in soil and the existing petroleum hydrocarbon soil standards[3] currently contained within the Province's Contaminated Sites Regulation (CSR). The major findings of that comparative review are detailed in this report.

[1] Canadian Council of Ministers of the Environment

[2] Note that the Canada Wide Standards are not "standards" in a true sense, in that they are not by any legislation legally enforceable.

[3] The SAB makes its findings in the context of the legal framework applicable to contaminated sites in B.C. as of October 2003- i.e., the use of legal standards for soil. It is noted the Minister's Advisory Panel on Contaminated Sites has recommended the use of "screening values" in place of standards. This concept is still under review by the Ministry.

Detailed Findings of initial SAB review

2.1 RE: Classification of hydrocarbons

Background:
Petroleum hydrocarbon soil standards are derived by both agencies using a fractionation/surrogate toxicity approach. Both agencies fractionate the broad spectrum of petroleum hydrocarbons into sub-fractions based on carbon chain length. The CCME has established four petroleum hydrocarbon fractions F1 through F4. As shown in Table 2.1, the first three fractions used by CCME (F1 – F3) are essentially identical to the respective VPH (volatile petroleum hydrocarbons), LEPH (light extractable petroleum hydrocarbons) and HEPH (heavy extractable petroleum hydrocarbons) fractions as defined by the Ministry. The ministry currently lacks a F4 (i.e. EHEPH – Extremely Heavy Extractable Petroleum Hydrocarbon) fraction.

Table 2.1: Comparison of CCME and CSR petroleum hydrocarbon fractions

Hydrocarbon designation	Carbon chain length
CCME F1	C6-C10
CSR VPH	C6-C10
CCME F2	C10-C16
CSR LEPH	C10-C19
CCME F3	C16-C34
CSR HEPH	C19-C32
CCME F4	C34-C50
CSR	Hydrocarbons > C32 not considered

SAB considerations and recommendations:

The SAB notes that within the CWS-PHCs and the CSR standards for petroleum hydrocarbons, there is considerable similarity in regard to the surrogate substances (i.e., carbon chain lengths) to characterize the toxicity of the petroleum hydrocarbon fractions. The CCME surrogates are largely based on the United States TPHWG[4] approach. It is noted that compared to the ministry's surrogates, the TPHWG surrogates are of more recent development and have been extensively peer reviewed.

The SAB in consultation with the British Columbia Laboratory Quality Assurance Advisory Committee (BCLQAAC), was advised that for the purpose of harmonization, the "carbon ranges of the BC methods could be modified to be consistent with the CWS method, with the exception of the heavy hydrocarbon fraction (i.e. C10-16, and C16-34, but not C34-50)." It is the opinion of the SAB, that the modification will have minimal impacts on the CSR standards. As shown in Table 2.1, the CWS and CCME fractions are already very similar.

[4] Total Petroleum Hydrocarbon Criteria Working Group

Therefore, the SAB recommends VPH, LEPH and HEPH carbon ranges of the CSR be revised to have carbon ranges consistent with CSW F1, F2 and F3 fractions, respectively.

However the SAB is of the opinion that the Ministry's soil standards should not include the CWS-PHC F4 (EHEPH) fraction for regulatory purposes. The F4 fraction is likely to have limited utility in British Columbia, being relevant only to sites in the Province where large quantities of heavy hydrocarbons have been present (e.g. petroleum well sites, petroleum "heavy oil cracking" and refining and perhaps heavy crude oil storage sites). Furthermore, the mechanism of toxicity associated with the F4 (EHEPH) fraction (i.e. physical toxicity – osmotic effects) differs markedly from that of the three lighter fractions (i.e. chemical toxicity – acute intoxication/ carcinogenesis). While physical toxicity can be just as important as chemical toxicity, the SAB notes that the CWS PHC limits for the F4 fraction represent extremely high concentrations of EHEPH. At times the CWS-PHC limit for the F4 fraction exceeds concentrations, which would qualify the EHEPH, contaminated soil as special waste in British Columbia.

In consideration of this, *the SAB recommends that a F4 (EHEPH) standard not be included in the suite of petroleum matrix standards to be developed for the Contaminated Sites Regulation. Rather the SAB believes it would be appropriate to derive F4 (EHEPH) values for use as a guideline only, perhaps within a Director's Protocol, to assist in the characterization and remediation of the limited number of sites in the Province where EHEPH contamination may be an issue.*

2.2 Comparison of CWS and CSR standards

The SAB notes the extensive scientific documentation used in the development of the CCME CWS-PHC. Such documentation is not available for the generic soil standards for petroleum hydrocarbons contained in Schedule 4 of the B.C. CSR. It is noted that the generic soil standards of the CSR were developed largely on the basis of professional judgement.

Adoption of risk-based soil standards for petroleum hydrocarbons [either by use of the CWS-PHC approach or by the approach developed in 1995 by the B.C. Contaminated Sites Soil Task group (CSST)] to replace existing Schedule 4 standards would obviously improve the scientific basis of the standards. However new protocol elements such as the evaluation of soil vapour impacts on human health are introduced within the CWS-PHC and such elements should be more generally included within the Ministry's CSST protocols for the development of standards.

The SAB also notes that there are several significant fundamental differences in science policy, including levels of protection to be accorded and applicable defined exposure scenarios, between CWS-PHC and ministry soil standard derivation protocols.

Nonetheless the SAB does find similarities between some of the CWS-PHCs and CSR standards, as well as significant differences where the CSR standards are both numerically greater (less restrictive) and numerically less (more restrictive) than the CWS-PHCs. Table 2.2 provides a comparison of the similarities and differences

between the CWS-PHC and the petroleum hydrocarbons standards of the Contaminated Sites Regulation. The most conservative numbers derived for the CWS-PHCs are used for comparison.

Table 2.2: Comparison of CWS-PHCs and CSR petroleum hydrocarbon standards

	Land Use			
Fraction	**Agric.**	**Resid./Park**	**Commer.**	**Indust.**
Human Health				
CWS F1: C6-C10	180 (DW)	30 (vapour)	180 (DW)	180(DW)
CSR VPH	**200**	**200**	**200**	**200**
CWS F2: C10-C16	250 (DW)	150 (vapour)	250 (DW)	250 (DW)
CSR LEPH	**1000**	**1000**	**2000**	**2000**
CWS F3: C16-C34	18000 (ingest)	13000 (vapour)	> 30000 (ingest)	> 30000 (dermal)
CSR HEPH	**1000**	**1000**	**5000**	**5000**
CWS F4: C34+	25000 (ingest)	25000 (ingest.)	> 30000 (ingest.)	> 30000 (ingest.)
CSR	**No standard**	**No standard**	**No standard**	**No standard**
Ecological Health				
Fraction	**Agric.**	**Resid./Park**	**Commer.**	**Indust.**
CWS F1: C6-C10	130 (contact)	130 (contact)	230 (AW)	230 (AW)
CSR VPH	**200**	**200**	**200**	**200**
CWS F2: C10-C16	150 (AW)	150 (AW)	150 (AW)	150 (AW)
CSR LEPH	**1000**	**1000**	**2000**	**2000**
CWS F3: C16-C34	400 (contact)	400 (contact)	1700 (contact)	1700 (contact)
CSR HEPH	**1000**	**1000**	**5000**	**5000**
CWS F4: C34+	2800 (contact)	2800 (contact)	3300 (contact)	3300 (contact)
CSR	**No standard**	**No standard**	**No standard**	**No standard**

The review indicates:

a The ratios of the CSR VPH standards/CWS-PHC F1 guidelines (with one exception) are 0.9 to 1.5. It could be said that the CSR standards for VPHs are essentially the same with the exception of the standard for protection of human health on residential land.

b The CWS-PHCs are more restrictive for the F2 fractions than the CSR standards for the equivalent LEPH fractions for protection of both human

health and the environment. The ratios of the CSR LEPH standards/CSW-PHC F2 guidelines range from 4 to 13.

c The CSR standards for HEPH for protection of human health are significantly more restrictive than the CWS-PHCs for the equivalent fraction (F3), i.e., the CSR standards are approximately 6 to 18 times more restrictive. .

d The CWS-PHCs for the F3 fractions for protection of the environment are more restrictive (i.e., 2.5 to 3 fold) than the CSR HEPH standards for protection of the environment.

e There are no CSR standards for the heavy fractions equivalent to the CWS-PHC F4 limit for C34+.

The regulatory framework in British Columbia is such that soils are evaluated on the basis of legal standards versus guidelines or criteria as in other provinces in Canada. Before there is any consideration of modifying the B.C. standards to harmonize with the CWS-PHCs, it is therefore important to ascertain that the scientific basis for the CWS PHCs is well founded.

The initial investigation by the SAB into the approach used to derive the CCME CWS PHC standards suggests there is a need for review, on behalf of the Ministry, of some of the elements of the CWS-PHCs. Until this review is completed, *it is recommended that the Province not adopt the CCME Canada Wide Standards for Petroleum Hydrocarbons in soil for regulatory purposes.*

The initial SAB review identified that:

1. There are derivational elements of the CCME CWS PHC that require further review.
2. There are common derivational elements of CCME CWS PHC and current ministry matrix standards protocols.
3. There are elements of the CCME CWS-PHC that should be not considered for adoption into the Province's matrix standard derivation protocol.

2.2.1 Derivational elements of the CCME CWS PHC that require further review

As illustrated in Table 2.1, there are major differences between the CSR standards and the CWS-PHC. Those differences were noted by the SAB to be related to CWS-PHC protocols that address:

a Impacts of soil on groundwater quality, hence impacts on domestic drinking water and aquatic biota.

b Impacts on human health by soil vapour.

c Impacts on invertebrates and plants.

2.2.1.1 Impacts of soil on groundwater quality

RE: Groundwater transport model

The CCME CWS PHC utilized the ministry's groundwater transport model in deriving the above-mentioned standards. The SAB would like to inform the Ministry of its concerns related to the scientific credibility of the groundwater transport model. (It is noted that similar concerns have been expressed within the 2003 Final Report of

the Minister's Advisory Panel on Contaminated Sites). It is the understanding of the SAB that that the Province's groundwater transport model was developed in a relatively short period of time circa 1996 and has never been updated. *The SAB thus recommends that the current BC groundwater transport model be critically reviewed and possibly revised to reflect recent scientific advances.* The SAB believes that updating of the current BC groundwater transport model is a necessary and absolute pre-requisite to the development of proper matrix standards for protection of aquatic life and drinking water quality.

The SAB also notes that in contrast to the ministry CSST protocol, the CCME did not use a common groundwater transport model to calculate their soil to drinking water protective and aquatic life protective Canada wide standards. As per the above paragraph, the CCME CWS PHC for protection of drinking water should be recalculated following the review and revision (if necessary) of the Ministry's groundwater transport model.

RE: Toxic endpoints – Aquatic life

The groundwater transport model described above is used to calculate the maximum concentration of a contaminant in soil that would ensure protection of groundwater and hence aquatic life in the subsequent receiving environment.

To ensure aquatic life protection, CCME uses petroleum hydrocarbon narcosis as the toxic endpoint to develop toxicity reference values upon which to back-calculate soil protective standards. The SAB recognizes the wealth of recent scientific literature relating to the narcosis toxic endpoint. However it is noted within the CCME technical documents that the approach has resulted in the prediction of toxicity at concentrations of hydrocarbons that are much lower than documented results of laboratory toxicity studies. At this time the SAB must reserve judgement on the scientific validity of using the narcosis endpoint to derive soil to aquatic life protective standards until the issue has been adequately investigated.

2.2.1.2 Impacts on human health by soil vapour

RE: Soil vapour model

The CCME CWS-PHC incorporates a soil vapour pathway exposure scenario, which includes a mathematical model for soil vapour intrusion. The SAB agrees with CCME that petroleum hydrocarbon soil vapour represents a significant and potentially hazardous condition to human health at coarse-grained soil sites and supports the inclusion of this pathway of exposure. However, the SAB recognizes that the CCME soil vapour protective approach results in exceedingly stringent soil standards and hence the SAB wishes to further evaluate the scientific basis of the CCME model. The SAB is aware of recent publications that indicate the model used by the CCME is more appropriate when the modelled input data concentration is a soil-vapour measurement, rather than a soil or groundwater measurement. As well the limitations of vapour intrusion modelling have to be recognized. For example, the use of modelling is questionable when preferential pathways are present.

RE: Level of acceptable risk

The SAB also notes that the level of acceptable human health risk used by CCME and the ministry vary (e.g. in the case of carcinogenic substances, by an order of magnitude). This difference in acceptable risk between the two agencies requires recalculation of the CCME CWS PHC for use within the Province's regulatory context.

If the CCME vapour intrusion model is found to represent the "best science" the SAB is aware that even after adjusting soil vapour standards to reconcile differences in acceptable risk, the resulting soil vapour protective standards are likely to remain extremely stringent in comparison to the ministry's existing generic petroleum hydrocarbon standards. The SAB also notes however, that relatively simple and straightforward presumptive remedies can be provided to deal with exceedances of these stringent soil vapour standards (e.g. inclusion of passive soil venting into new building design at redeveloped sites or retrofitting of enhanced indoor air exchange rates for existing buildings at historical sites).

2.2.1.3 Impacts on soil invertebrates and plants

Both CCME and the Ministry calculate standards to protect soil invertebrates and plants. However, the SAB review indicates that the methods used to calculate these standards markedly differ between CCME and the Ministry. CCME combines non-lethal (i.e. reproductive effects, growth and biomass yield) and lethal toxicological effects data into a single database when calculating their eco soil contact (i.e. soil invertebrate and plant) standards. The Ministry, on the advice of the CSST segregates non-lethal and lethal effects data, to allow calculation of separate non-lethal and lethal soil protective values. Then depending on land use, the soil invertebrate and plant matrix standard are established (e.g. for Agricultural, Residential and Urban Park land uses, the standard is the more stringent of the non-lethal and lethal values; for commercial and industrial land uses it is established as the less stringent of the non-lethal and lethal values). The SAB finds the current Ministry approach to be preferable to that of CCME. Segregating toxic endpoint data on the basis of lethality allows the soil invertebrate and plant matrix standards to more accurately reflect the relative importance and relevance of protecting soil invertebrates and plants for the various land uses. The Ministry's approach also ensures that neither a preponderance of non-lethal nor lethal data for a particular substance can erroneously skew the derived standard so that it is needlessly over or under protective.

Therefore the SAB recommends that the database used for derivation of the CWS-PHCs be re-evaluated in accordance to the CSST approach in calculating soil invertebrate and plant protective matrix standards.

2.2.1.4 Soil type and depth

The CCME CWS PHC provides standards for two soil types (fine-grained and coarse soils) and two depths to contamination (surficial: < 1.5m and subsurface: > 1.5 m soils). The SAB notes that both the issue of soil type and depth to contamination have been previously addressed by the CSST. Promulgating standards for two different

types of soil (fine and coarse) has merit in situations where sites are isotropic in regards to soil morphology. For example, Canadian prairie soils are largely isotropic in regards to soil type as a result of being geologically formed from antediluvian ocean sediments. However, in British Columbia most sites present complex anisotropic soil morphology. The issue of soil type primarily influences the transport of contamination between media (i.e. soil vapour infiltration and contaminant transport to groundwater). Typically cross media contamination is facilitated by coarse as opposed to fine-grained soil. For this reason, CSST in developing the ministry's matrix soil standards derivation protocol established coarse soil type as the default assumption at all sites. The SAB therefore recommends that only coarse soil matrix standards for petroleum hydrocarbons be developed for use in Schedule 5 of the regulation and that the issue of fine-grained soil be dealt with under the ministry's site-specific risk assessment approach.

On the issue of soil depth to contamination, further review is required by the SAB. The SAB notes the Contaminated Sites Regulation already provides for a release from more stringent agricultural, residential and urban park standards under the "3m rule" wherein sites need only be cleaned to comply with industrial soil quality standards, irrespective of land use, below 3m depth. The SAB also notes that risk assessments in the Province generally assume ecological and human dermal exposure is potentially limited to the top 1 metre of soil. As well it is noted the "Guidance and Checklist for Tier 1 Ecological Risk Assessment of Contaminated Sites in British Columbia" only requires soil sampling to a depth of 0.15 metres, except for sandy soils where sampling to 0.5-0.7 metres is required.

The need to incorporate the surface and subsurface soil depth CCME CWS PHC standards for petroleum hydrocarbons under the existing Provincial regulatory regime obviously requires review. As well there is an obvious need for consistency within Provincial guidelines for depth sampling of soil.

2.2.2 Common derivational elements of CCME CWS PHC and current ministry matrix standards protocols

2.2.2.1 Human health- soil ingestion

Both agencies' (i.e., CCME and the Ministry) approaches include calculation of human health soil ingestion standards, using essentially identical procedures. The main difference between the two agencies' procedures relates to the manner in which estimates of contributions to exposure from non-contaminated site sources influence the calculation of the standard. CCME's approach includes a mandatory calculation of estimated daily intake of contaminants, which includes non-contaminated site sources of exposure to the contaminant in question. Often only approximate estimates of such non-contaminated site exposures are available which can lead to uncertainty in the estimate, which is reflected by an increased conservatism inherent in the calculated standard. The ministry's approach recognizes this and therefore includes consideration of non-contaminated site contributions to contaminant exposure on a discretionary basis. Where non-contaminated site exposures can be estimated with a high degree of scientific rigor, the ministry's approach would incorporate this data in the calculation of the human health soil ingestion standard. In the case of the CCME

CWS PHC, the SAB is confident that the CCME's estimates of non-contaminated site exposures to petroleum hydrocarbons meet the requisite degree of rigor.

Consequently, *the SAB recommends adoption of the CCME CWS PHC human health soil ingestion standards for use in ministry matrix standards.*

2.2.2.2 Soil standards to protect groundwater for aquatic life and livestock watering

In regard to deriving soil standards to protect livestock watering, both the ministry and CCME utilize essentially the same procedures to calculate these types of standards. *The SAB recommends that the Ministry adopt the CCME CWS PHC soil standards to protect livestock watering for use in petroleum hydrocarbon matrices developed for use in the regulation.*

2.2.2.3 Produce, meat and milk check

The CCME protocol allows for the derivation of "check values" to ensure that vegetable produce, meat and milk obtained from remediated agricultural contaminated sites will be fit for human consumption. Due to the large number of non-empirically verified assumptions inherent in the models used to calculate these check values, neither CCME nor the CSST recommend that these check values be used for regulatory purposes. The SAB concurs with this advice and also recommends this potential pathway of exposure not be included in any petroleum hydrocarbon matrix standards developed for ministry use. Rather the SAB suggests this pathway of exposure be reserved for use under the site-specific risk assessment approach.

2.2.2.4 Offsite migration check

The CCME protocol also allows for calculation of "off-site migration" check values for remediated industrial sites to ensure that contaminated soil (as entrained dust) is not transported in sufficient quantity to represent a possible human health inhalation risk on neighbouring properties. Again CCME acknowledges the considerable scientific uncertainty associated with calculating check values for this potential pathway of exposure and does not recommend the use of the check values for regulatory purposes. The SAB concurs with this advice and recommends off site dust migration not be included in any petroleum hydrocarbon matrix standards developed for use under the Contaminated Sites Regulation. As in the case of the produce, meat and milk check, the SAB believes that the issue of off-site dust migration should more appropriately be left to the aegis of risk assessment.

2.2.2.5 Livestock ingesting soil and fodder and major microbial functional impairment standards

Ministry and CCME protocols differ in regard to the derivation of livestock ingesting soil and fodder protective standards. Most of this difference can be attributed to differences in assumptions related to default characteristics of the modelled hypothetical livestock receptor for which the standards are calculated. The SAB has not yet reached a conclusion as to whether ministry or CCME assumptions have greater scientific merit.

Under the ministry's existing protocol, the CCME's major microbial functional impairment standard is simply adopted for contaminated sites regulatory purposes.

In the case of petroleum hydrocarbons the issue to adopt or not adopt CCME livestock soil ingestion and major microbial functional impairment soil standards is moot however, as CCME has yet to promulgate such standards.

2.2.3 Elements of the CCME CWS-PHC that should not be considered for adoption into the Province's matrix standard derivation protocol

2.2.3.1 Analytical methods

The SAB notes the conclusion and advice of the British Columbia Laboratory Quality Assurance Advisory Committee (see Appendix 2) in recommending that the Province **not** adopt CCME CWS PHC chemical analytical methods. The SAB notes that the majority of the difficulties identified with the CCME analytical methods seem to be associated with analyses for the F4 (EHEPH) fraction. This fraction is apparently also responsible for much of the increased analytical costs of the CCME methods, as the elution temperatures required to volatilize this fraction for gas chromatographic assay are so high that GC separatory column life is markedly reduced. The CCME attempted to address this problem by making silica gel extraction a mandatory component of the assay. However, silica gel clean up has the potential to remove, albeit to a variable extent, both petroleum and non-petroleum hydrocarbons, potentially resulting in a methodologically induced bias, i.e. underestimation of true petroleum hydrocarbon concentration. The SAB notes that the recent Director's analytical method for silica gel extraction recognizes this limitation and specifies that use of this technique is justified at petroleum contaminated sites only in the case where there is evidence of significant co-contamination with non-petroleum hydrocarbons.

> In view of the advice received from the British Columbia Laboratory Quality Assurance Advisory Committee related to the relative scientific merit and precision of the CCME and ministry chemical analytical methods for petroleum hydrocarbons, *the ministry is advised to retain its existing analytical methods and* ***not*** *adopt those of CCME, except to adjust the carbon ranges of the BC methods, as discussed in section 2.1.*

2.2.3.2 Dermal Contact

Trans-dermal exposure is a legitimate pathway of exposure for those organic substances which are both highly lipid soluble and of sufficiently small molecular weight that they can effectively transit cell membranes of epithelial tissues. The SAB would not expect this potential route of exposure to be critical in the case of petroleum hydrocarbons. Petroleum hydrocarbons exhibit great lipid solubility; however they also tend to be high molecular weight compounds. This is likely the explanation for the exceedingly large (i.e. concentrations in excess of soil solubility limits) seen for the CCME CWS PHC dermal contact soil standards. In consequence, the SAB is of the opinion that the dermal contact standards serve no practical utility in

regard to significantly enhancing human health protection and can be effectively ignored for the purposes of developing petroleum hydrocarbon matrix soil standards.

3 Conclusions and recommendations

The SAB has completed an initial comparative review of the CCME Canada Wide Standards for Petroleum Hydrocarbons in soil and the existing petroleum hydrocarbon soil standards currently contained within the Province's Contaminated Sites Regulation. The SAB has concluded that prior to consideration of adoption of the CWS-PHCs by the Ministry; several derivational elements of the CWS-PHCs should be reviewed.

The SAB recommends:

1. The Province should not adopt out-right the CCME Canada Wide Standards for Petroleum Hydrocarbons in soil, including associated analytical methods, for regulatory purposes, at this time.

2. The carbon ranges of the BC methods should be modified to be consistent with the CWS-PHC fractions (with the exception of the heavy hydrocarbon fraction, i.e. C6-C10, C10-16, and C16-34, but not C34-50).

3. An F4 (EHEPH) standard should not be included in the suite of petroleum matrix standards for Schedule 5 of the Contaminated Sites Regulation Rather the SAB believes it would be appropriate to derive F4 (EHEPH) values for use as guideline only, perhaps within a Director's Protocol, to assist in the characterization and remediation of the limited number of sites in the Province where EHEPH contamination may be an issue.

4. The current BC groundwater transport model should be critically reviewed and possibly revised to reflect recent scientific advances. Simultaneously the SAB recommends an evaluation of the scientific validity of using the narcosis endpoint to derive aquatic life protective standards.

5. A third party review of the scientific basis of the CCME model for soil vapour should occur, given that the CCME soil vapour protective approach returns exceedingly stringent soil standards and given the recent findings in the literature.

6. The database used for derivation of the CWS-PHCs should be re-evaluated in accordance with the CSST approach in calculating soil invertebrate and plant protective matrix standards.

7. The CCME CWS PHC human health soil ingestion standards should be considered for use in Ministry's matrix standards.

8. The CCME CWS PHC soil standards to protect livestock watering should be adopted for use in development of the Ministry's matrix standards.

9. In view of the advice received from the British Columbia Laboratory Quality Assurance Advisory Committee related to the relative scientific merit and precision of the CCME and Ministry chemical analytical methods for petroleum hydrocarbons, the Ministry is advised to retain its existing analytical methods and **not** adopt those of CCME other than to normalize PHC fraction carbon chain lengths.

10. Following resolution of the above noted technical issues, the ministry should move as expeditiously as possible to replace the existing professional judgement based generic soil standards for petroleum hydrocarbons found within Schedule 4 of the CSR with the risk based matrix soil standard approach once suitably modified to incorporate those new elements contained in the CCME approach which are deemed to have scientific merit.

Finally, over the longer term, the ministry should initiate a review and re-assessment of its current soil standards derivation protocol with the aim of updating the protocol to reflect current “best science” and facilitate the subsequent recalculation of existing matrix soil standards for all substances currently listed within Schedule 5 of the Contaminated Sites Regulation.

Appendix 1.

Notes on CCME Canada Wide Standards for Petroleum Hydrocarbons in Soil

History of Development

1. Developed over 2 year period (1998-2001)
2. Developed by CCME CWS Development Committee (drawn from CCME SQGTG)
3. Developed with extensive multi-stakeholder involvement - technical advisory groups
    - AMTAG
    - ECOTAG
    - HHEFATAG - PIWG
    - SEATAG
4. Risk-based, scientifically defensible
5. Ratified by COM - May 1 2001
6. Clause 6.1 "standards" under CCME Harmonization Accord, Sub-agreement on Standards
7. CWS requires jurisdictions 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."
8. Timeframe for jurisdictional implementation not specified - reporting obligation to member jurisdiction's constituents
9. First Minister's report on implementation due end 2003, then every 5 years thereafter
10. Mandatory CCME review (science & socio-economics) by end 2003
11. First CCME revision of CWS - 2005
12. Mandatory renewal/re-ratification - May 2006

Form of Standard - *Similarities to CSST standards indicated in italics*

1. *Remedial numerical concentration environmental quality standards for use at contaminated sites*
2. *Incorporate three-tiered remedial approach (tier 1 numerical standards, tier 2 site specific objectives, tier 3 risk assessment).*
3. Single most stringent standards (i.e. not matrix)
4. Standards developed for 4 chemical PHC fractions
    - F1: C6 -C10 *(similar to CSR VPH: C5-C10)*
    - F2: C10-C16 *(similar to CSR LEPH: C10-C19)*
    - F3: C16-C34 *(similar to CSR HEPH: C19-C32)*
    - F4: C34+
5. Standards developed for 4 land uses *(Agriculture, Residential/Parkland, Commercial, Industrial)*
6. Standards developed for 2 soil types: fine and coarse (vs. CSR single soil type - sand)
7. Standards developed for 2 soil depths: surface and subsoil (vs. CSR single depth)

CWS PHCs Human Health standards

1. 4 Pathways considered (*Soil ingestion, groundwater for drinking water use,* dermal contact, vapour inhalation)
2. Uses CCME groundwater model to calculate GW for DW (not BCE GW for DW model)
3. Incorporates 2 health "checks": produce (vegetable garden) and offsite migration (dust)
4. *Standards surrogate RfD based (CCME: US TPHWG 1997 CSST:BCE/Golder 1995 PHC Working Doc)*

CWS PHCs Ecological Health standards

1. 5 pathways considered (*soil contact: invertebrate & plant, livestock soil ingestion, groundwater for aquatic life use, groundwater for livestock watering, nutrient cycling: microbial protection)*
2. *Uses BCE Groundwater model for aquatic life protective soil standards*

Quick Comparison to existing CSR PHC standards

	Land Use			
Fraction	**Agric.**	**Resid./Park**	**Commer.**	**Indust.**
Human Health				
F1: C6-C10	180 (DW)	30 (vapour)	180 (DW)	180(DW)
CSR VPH	**200**	**200**	**200**	**200**
F2: C10-C16	250 (DW)	150 (vapour)	250 (DW)	250 (DW)
CSR LEPH	**1000**	**1000**	**2000**	**2000**
F3: C16-C34	18000 (ingest)	13000 (vapour)	> 30000 (ingest)	> 30000 (dermal)
CSR HEPH	**1000**	**1000**	**5000**	**5000**
F4: C34+	25000 (ingest)	25000 (ingest.)	> 30000 (ingest.)	> 30000 (ingest.)
Ecological Health				
Fraction	**Agric.**	**Resid./Park**	**Commer.**	**Indust.**
F1: C6-C10	130 (contact)	130 (contact)	230 (AW)	230 (AW)
CSR VPH	**200**	**200**	**200**	**200**
F2: C10-C16	150 (AW)	150 (AW)	150 (AW)	150 (AW)
CSR LEPH	**1000**	**1000**	**2000**	**2000**
F3: C16-C34	400 (contact)	400 (contact)	1700 (contact)	1700 (contact)
CSR HEPH	**1000**	**1000**	**5000**	**5000**
F4: C34+	2800 (contact)	2800 (contact)	3300 (contact)	3300 (contact)

Appendix 2

Copy of BCLQAAC letter on CCME CWS-PHC analytical methods.

Glyn Fox,
Senior Risk Assessment Officer,
Ministry of Water, Land, and Air Protection,
Pollution Prevention and Remediation Branch,
Contaminated Sites Section,
PO Box 9342 Stn. Prov. Govt.
Victoria, BC, V8W 9M1

June 6, 2002

Dear Glyn Fox;

Re: Canada Wide Standards for Petroleum Hydrocarbons – Analytical Methods

The BCLQAAC Technical Subcommittee wishes to advise the BC Ministry of WLAP that in our opinion, the current British Columbia analytical methods for petroleum hydrocarbons (LEPH, HEPH, and VPH) should remain as the approved methods for use at contaminated sites under provincial jurisdiction in British Columbia.

We recognize and accept that the CCME Canada Wide Standard method for Petroleum Hydrocarbons (PHC's) will be required for management of contaminated sites under Federal or joint Federal/Provincial jurisdiction.

Although the CCME Canada Wide Standard method for PHC's is in many ways similar to the BC methods, it is our opinion that the BC methods are more feasible in terms of reliability and economic viability while capable of providing results comparable to CCME method.

Specifically, the relative response requirements of the CCME method are extremely difficult to achieve on a regular basis, causing an unacceptable frequency of Quality Control failures, instrument maintenance, and re-analyses. This was a recurring complaint of numerous laboratories involved in the May/June 2002 CAEAL CWS PHC round robin study. Because of these and other issues, we estimate the analytical costs per sample for the CWS method to be approximately double the cost of the BC methods.

Should the Ministry decide to adopt the CCME methods for BC Contaminated Sites Remediation work, the higher analysis costs would of course translate to higher costs of site remediation. An additional consideration is that BC's CSR guidelines contain criteria for petroleum hydrocarbons in waters. There are no CCME CWS methods for

PHC in waters, and the CCME has no plans to develop any such methods. Even if the CCME PHC methods were adopted for soils and sediments, the BC hydrocarbon methods would still be required to support the water criteria.

The BC Methods for PHC analysis already provide equal or better protection to the environment than the CCME method, with the exception that heavy hydrocarbons beyond nC32 are not analyzed. Further harmonization between the methods can be achieved if this is perceived as beneficial. Specifically;

- Carbon ranges of the BC methods could be modified to be consistent with the CWS method, with the exception of the heavy hydrocarbon fraction (i.e. C10-16, and C16-34, but not C34-50).

- Oil and grease analysis could be used to quantify heavy hydrocarbon concentrations when GC chromatograms indicate they are present at a site.

- Reporting levels (detection limits) could be modified if necessary, although this may also result in some increase to analytical cost.

To summarize, we recommend that the BC LEPH, HEPH, and VPH methods remain the required methodologies for Contaminated Site Remediation work in BC. Should the deficiencies of the CCME CWS method for PHC's be addressed to our satisfaction in the future, we may reconsider our position on this issue.

Sincerely,

Tom Zhu,

Chair,
BCLQAAC Technical Sub-Committee

cc: Steve Horvath, Laboratory Services