# B.C. MINISTRY OF ENVIRONMENT, LANDS & PARKS

# CONTAMINATED SITES STANDARDS REVIEW WORKSHOP REPORT MARCH 20 - 22, 1996

**M. M. DILLON LIMITED**
**Consulting Engineers,**
**Planners, and**
**Environmental Scientists**

April, 1996
96-3396-01

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**Our File:** 96-3396-01

April 17, 1996

Don Fast
Executive Director
BC Environment
4th Floor
777 Broughton Street
Victoria, B.C.
V8V 1X4

**Contaminated Sites: Standards Review Workshop**

Dear Sirs:

We are pleased to present Dillon's report on the Contaminated Sites Standard Review Workshop, held on March 18 to March 20, 1996 inclusive. We enjoyed working with the Ministry, key stakeholder groups and the panel and found the workshop to be interesting and informative and constructive.

Dillon's report (copies attached) provides an overview of the workshop, and includes general observations from the facilitator, the panel's consensus recommendations, as well as the separate written comments received from six of the panel members.

We are currently arranging for the tapes of the workshop to be copied for the Ministry and each of the five key stakeholders. If we can be of any further assistance, please do not hesitate to contact me.

Yours truly,

M. M. DILLON LIMITED

D.J. Clark, M.Sc., P. Eng.
Regional Manager

Encl.

cc. Business Council of B.C.
Union of British Columbia Municipalities
Urban Development Institute
B.C. Ministry of Health
Westcoast Environmental Law
Dr. Alan Rubin
Dr. Anne Fairbrother
Dr. Dennis Konasewich
Dr. Francis Law
Dr. Jim Malick
Mr. Scott King
Mr. Robert Schutzman

M.M. DILLON LIMITED 130 - 10691 SHELLBRIDGE WAY
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## 1. INTRODUCTION

Draft 3 of the *Contaminated Sites Regulation* under the provincial *Waste Management Amendment Act, 1993* was released by the B.C. Ministry of Environment, Lands and Parks ("BCMOELP") on December 4, 1995. In February, 1996, in response to a suggestion from the Business Council of BC and concerns from various stakeholders about the proposed standards, BCMOELP agreed to hold a standards review workshop, with an independent expert panel appointed by stakeholders to review the standards. In March, 1996, five key stakeholder groups were invited to nominate one or two scientific experts for an expert panel. The key stakeholder groups were:

- Business Council of BC
- Union of British Columbia Municipalities
- Urban Development Institute
- B.C. Ministry of Health
- Westcoast Environmental Law

Mr. Dave Clark of M.M. Dillon Limited ("Dillon") was appointed by BCMOELP to be the facilitator for the workshop, to verify the expertise of the expert panel nominees, to confirm their willingness to provide independent comments at the workshop, and to produce a final workshop report.

Five members of the panel were nominated by the stakeholder groups:

Dr. Alan Rubin, Ph.D.
Health and Ecological Criteria Division
US Environmental Protection Agency
Washington, D.C.

Dr. Anne Fairbrother, Ph.D.
Ecological Planning and Toxicology Inc.
Corvalis, Oregon

Dr. Dennis Konasewich, Ph.D.
Envirochem Services
North Vancouver, B.C.

Dr. Francis Law, Ph.D.
Biological Sciences
Simon Fraser University,
Burnaby, B.C.

Dr. Jim Malick, Ph.D.
Norecol, Dames & Moore
Vancouver, B.C.

In addition to these members, an additional two members were appointed by Mr. Clark, with the approval of the key stakeholders, to provide further expertise from a hydrogeological perspective, as well as a proponent perspective. These two panel members were:

Mr. Scott King, M.Sc.
King Groundwater Science, Inc.
Pullman, Washington

Mr. Robert Schutzman, P.Eng.
Director, Environmental Affairs
IPSCO Inc.
Regina, Saskatchewan

The 3 day workshop was held from March 20 to March 22, 1996 inclusive at the Delta Pacific Resort and Conference Centre, and the Pacific Presentation Centre, in Richmond, British Columbia.

## 2. WORKSHOP OBJECTIVES

The stated objectives of the workshop were as follows:

- BCMOELP to receive a review of environmental quality standards proposed in the *Contaminated Sites Regulation* by an independent panel of scientific experts
- Key stakeholder groups with concerns about the proposed standards will have input into which experts are on the panel
- Stakeholders to have representatives to observe the review
- Review to be facilitated independently and recorded
- BCMOELP and key stakeholder groups to receive scientific recommendations and workshop report

## 3. WORKSHOP FORMAT

The format of the workshop was as follows:

- Workshop was facilitated by Dave Clark, Dillon
- Expert panel members heard presentations on the standards proposed in Draft 3 of the *Contaminated Sites Regulation* and changes under consideration since Draft 3 was released for comment

- Staff from BCMOELP and the B.C. Ministry of Health provided presentations summarizing the rationale and methods underlying derivation of the proposed standards.

- Panel members were invited to ask questions and comment throughout each section

- A wrapup session led by the facilitator highlighted the key findings

- The facilitator prepared a final workshop report summarizing key findings and recommendations.

A copy of the workshop agenda is attached as Appendix A. Prior to the workshop, the key stakeholders were invited to review the agenda and provide the facilitator with a succinct list of issues which the stakeholders believed should be addressed in each section. Several stakeholders responded to this request, and the information was compiled and copies distributed at the workshop to all participants. A copy of this information is attached as Appendix B. During the workshop session observers were encouraged to submit written questions or comments to the panel and BCMOELP staff. In addition, there was opportunity for all workshop participants to interact on an informal basis during coffee and lunch breaks. On the final day of the workshop observers had the opportunity to ask direct questions of either the panel or BCMOELP staff.

The panel caucused separately from the workshop at the end of day two and over lunch on day three to discuss the presentations and to develop consensus recommendations which were presented during the last day of the workshop. These consensus recommendations are included in section 4 below. In addition, panel members were invited to provide written comments and any supporting scientific references or data (where available) to Dillon by April 3, 1996.

The entire workshop was recorded on audio cassette, and copies were provided to the five key stakeholder groups.

## 4. OBSERVATIONS AND RECOMMENDATIONS

Several general observations were made by the facilitator over the course of the three day workshop:

- The expertise of each panel member complimented one other well and collectively they provided a comprehensive forum for BCMOELP staff to present the rationales behind the standards contained in Draft 3 of the *Contaminated Sites Regulation*. Several panel members have had experience with regulatory agencies through periods of developing standards and criteria and they were therefore able to share these experiences directly with BCMOELP staff. Other members have had extensive experience in various fields of scientific research which proved to be very helpful in assessing the appropriateness of available data and models which have been used in developing environmental standards and criteria within a number of jurisdictions.

- Throughout the workshop it was apparent that the development of the draft standards by BCMOELP could best be described as an integration of scientific knowledge with

environmental policy. Panel member Alan B. Rubin (US EPA) shared his observation with the workshop participants that this approach is quite analogous to the approach recently used by the US EPA in developing the 40 CFR Part 503 Rule for the Use or Disposal of Biosolids.

- Considerable time was spent by the panel discussing the availability of scientific data upon which to develop environmental standards. It is apparent that efforts are underway within many jurisdictions to gather additional field data which will, in future, assist regulators in refining existing environmental standards and criteria as they pertain to the protection of human health and specific ecosystem components. However available data, at best, can only guide regulators as they go about the challenge of establishing remediation standards in light of the complexity of issues such as toxicity thresholds, bioavailability, fate and transport of contaminants within our highly diverse environments.

- BCMOELP was encouraged by the panel to continue to participate in the collection of scientific data in order to confirm or refine BC's contaminated sites standards. This will be a long process, so in the interim, BCMOELP was encouraged to continue to apply "reality checks" to the proposed standards based on local and regional observations.

- BCMOELP was encouraged to maintain flexibility within the regulation to provide proponents with the opportunity to develop site specific standards based on defensible application of relevant scientific data and models. BCMOELP was commended for the provision of alternative approaches for the evaluation of contaminated sites. Unlike many jurisdictions, which only offer a single criteria for contamination in soil based on land use, the opportunity available to proponents, within Draft 3 of the Regulation, to generate site specific standards for the assessment of soil contamination was seen to be quite positive.

- Finally, BCMOELP was challenged by the panel to carefully consider the limitation of models which have been used to develop the matrix standards in Draft 3 of the Regulation. In particular, general concern was expressed regarding aspects of the hydrogeologic transport model and the odour model used by BCMOELP.

The panel provided both consensus and individual recommendations to the workshop. These joint and individual recommendations were provided by the panel on the last day of the workshop. The consensus recommendations are included in section 4.1 below. Written comments and recommendations were received from six panel members and are included in Appendix C to this report.

## 4.1 Consensus Panel Recommendations

The panel caucused separately from the workshop on two occasions and reached consensus on five recommendations. These recommendations were presented to the workshop by Dr. Rubin, on behalf of the panel. The consensus recommendations were as follows:

1. It is not scientifically defensible to have single number criteria or standards for all sites in British Columbia. The Panel encourages BCMOELP to emphasize and further refine site-specific criteria and prepare accompanying guidance documents on the generation and implementation of these site-specific criteria.

2. BCMOELP is encouraged to review its standards every 3-5 years and amend its standards accordingly to reflect the evolution of science and the generation of new data. BCMOELP staff are encouraged to meet with the Panel or a similar panel every two years to accomplish this review.

3. A site should not be labelled a "contaminated site" while it is still undergoing evaluation no matter what tier or part of the evaluation it is undergoing. Until the site is either finally declared to be contaminated or in compliance with the standards, the site's status should be declared "under evaluation" or similar neutral term.

4. The site-specific matrix and risk evaluation methods both should have the maximum flexibility built in. The proponents of a site should be able to use models other than those chosen by BCMOELP. A broader range of parameters for these models should be allowed.

5. Guidance documents that aid in the implementation of the risk evaluation tier should be prepared and distributed. These guidance documents would describe in greater detail how the risk evaluation method would be performed.

# appendices

## APPENDIX A

## Workshop Agenda

# AGENDA

## EXPERT PANEL WORKSHOP TO REVIEW STANDARDS IN THE CONTAMINATED SITES REGULATION (DRAFT 3)

**Location**: Delta Pacific Resort and Conference Centre
10251 St Edwards
Richmond, BC

**Dates**: Wednesday March 20 – Friday March 22, 1996

**Objectives**:

- BC Environment to receive a review of environmental quality standards proposed in the Contaminated Sites Regulation by an independent panel of scientific experts.
- Key stakeholder groups with concerns about the proposed standards will have input into which experts are on the panel
- Stakeholders to have representatives to observe the review
- Review to be facilitated independently and recorded
- BC Environment to receive scientific recommendations and workshop report

**Format**:

- Workshop to be facilitated by Dave Clark, M.M. Dillon Limited
- Expert panel members hear presentations on the standards proposed in draft 3 of the Contaminated Sites Regulation and changes under consideration since draft 3 was released for comment.
- Speakers from BC Environment and the Ministry of Health to provide presentations summarizing the rationale and methods underlying derivation of the proposed standards.
- The workshop will contain sections on major topics.
- Panel members will be invited to ask questions and comment throughout each section.
- Major standards issues identified by stakeholders in draft 3 of the regulation to be addressed in each appropriate section.
- A wrapup session led by the facilitator will highlight the key findings.
- The facilitator will prepare a final workshop report summarizing key findings and recommendations.

**9:00 AM TO 5:00 PM**
**WEDNESDAY MARCH 20, 1996**

**Facilitator: Dave Clark**

**Introductory Remarks and Overview**

Introduction – Don Fast, Executive Director, Environmental Protection Department, BC Environment, Victoria, BC

Introduction of Panel members, Goals and Objectives – David J. Clark, Regional Manager, M.M. Dillon Limited, Richmond, BC

**Overview**

Past, Present and Future British Columbia and Canadian Policy and Legislation

Coffee

Overview of Standards in Draft 3 of the Contaminated Sites Regulation

Provisions for analytical methods, analytical detection limits, and background levels of substances

Lunch provided

Overview of Contaminated Sites Soils Task Group (CSST) Work

**Proposed Soil Quality Matrix Standards for Protection of Human Health**

Inadvertent soil ingestion

Coffee

Real world adjustment of proposed human health protection standards for inadvertent soil ingestion

Adjourn for the day

**8:30 AM TO 5:00 PM**
**THURSDAY MARCH 21, 1996**

**Facilitator: Dave Clark**

**Proposed Soil Quality Matrix Standards for the Protection of the Environment**

Protection of soil invertebrates and plants from direct soil contact

Coffee

Protection of livestock from soil ingestion

Proposed soil quality standards for the protection of soil microbes

**Proposed Soil Quality Matrix Standards for the Protection of Groundwater**

Groundwater policy decisions, model and results

Lunch provided

Groundwater policy decisions, model and results (continued)

Coffee

Groundwater policy decisions, model and results (continued)

Adjourn for the day

**8:30 AM TO 4:00 PM**
**FRIDAY MARCH 22, 1996**

**Facilitator: Dave Clark**

**Proposed Soil Quality Matrix Standards for Odour Protection**

Odour protection policy decisions, model and results

**Soil Relocation**

Derivation and application of generic and matrix standards to soil relocation

Coffee

**Future Analytical Methods**

Bioavailability protocols

**Summary of Proposed Standards**

Summary of draft 3 regulation standards and proposed changes

Lunch provided

**Summary of Responses to Key Stakeholder Issues**

Review of key stakeholder issues and proposals to address those issues

**Conclusions and Final Comments**

Overview comments by Expert Panel Members

Coffee

Closing Facilitator comments

Workshop Adjournment

# appendices

## APPENDIX B

## Stakeholder Issues

**Business Council of British Columbia**
Suite 810
1050 West Pender Street
Vancouver, B.C. V6E 3S7
Telephone (604) 684-3384
Facsimile (604) 684-7957

1996 03 19

Mr. Dave Clark
Dillon Consulting Engineers
#130 - 10691 Shellbridge Way
Richmond, BC V6X 2W8

**Re: Contaminated Sites Workshop, March 20-22, 1996**

Dear Mr. Clark:

Further to your request of March 15, attached please find a list of some of the issues which we believe should be discussed at the workshop.

Thank you for the opportunity to provide this input.

Yours sincerely,

Jock Finlayson
Vice President - Policy & Analysis

\vjc
Attach.

**FAXED - 270-3644**
Original will not be mailed.

p:\corresp\clar0319.fax

1966 - 1996
**30**
*Years of Excellence*
*Business Council of British Columbia*

Bioavailability of metals and other contaminants is recognized as a fundamental factor in toxicity. Should bioavailability of contaminants be explicitly recognized in criteria for screening sites? How can this be achieved in the standards?

Overly Stringent Soil Standards:

Industry experts have argued that blanket use of CCME guidelines without recognition of the CCME's caveats and limitations, and without definition of species to be protected, represents a questionable use of the CCME guidelines and results in overly stringent soil standards.

Odor Protection Matrix:

Concerns have been raised about the derivation of these equations, particularly regarding the meaning of the "time," "area," and "VF" parameters. See attached excerpt from commentary prepared by the Canadian Petroleum Products Institute.

Undefined Groundwater Model:

The groundwater model used for derivation of matrix numerical soil standards is undefined. Whatever model the Ministry has used in developing the Draft Regulation, has not been forwarded for review by the outside expert community.

Groundwater Transport of Inorganics:

A specific point has been made about a potential discrepancy in the modelling of groundwater transport of inorganics. See attached excerpt from commentary prepared by the Canadian Petroleum Products Institute.

Soil Ingestion Pathway:

See attached excerpt from commentary prepared by the Canadian Petroleum Products Institute.

## *PARTIAL LIST OF INDUSTRY ISSUES FOR SCIENTIFIC PANEL REVIEW OF CONTAMINATED SITES STANDARDS*

Summarized below are a number of issues pertaining to the standards (and related policy matters) that have been raised by industry stakeholders and experts in commenting on Draft 3 of the Regulation.

Balance of the Regulation:

The proposed standards appear to have much greater stringency on ecological grounds than on grounds of human health protection. To what extent is this scientifically warranted?

Separate Tracks of Regulation:

The standards and the Regulation itself seem likely to operate on separate tracks of ecological and human health protection. Situations may arise where health concerns can be remediated, yet land would still be classed as a "contaminated site" under the ecotoxicity standards where ecological values would not be impacted.

Should sites be exempted under one or the other track if the respective values (i.e., ecological or human health) are not likely to be affected? How could this be achieved in the standards? Alternatively, how can the two tracks of the standards be fully integrated?

Protocols:

Site specific standards and risk assessments are options to the matrix and simple numerical standards. Are there scientifically accepted protocols for these options? What is the experience in other jurisdictions? Should these protocols be integrated with the standards in the Regulation?

Bioavailability:

Anything can be toxic in the right form or quantity. Analytical protocols measuring bio-available forms of contaminants are necessary in order to correctly interpret CCME criteria and other draft soil standards used in the Regulation. Draft 3 of the Regulation references bioavailability, but does not specify protocols to deal with the fact that toxicity is a function of the bioavailable forms of a contaminant. It has been argued (by industry and GVRD staff) that all of this results in unrealistically low numerical standards.

Site-Specific Standards:

Little or no information has been provided by the Ministry on the process for deriving Site Specific Standards (cited by CPPI). This subject should be explored -- with appropriate information made available -- at the Workshop.

Alternative Approach to Defining Contamination:

The way the standards are now written, site contamination is more often than not defined by the standard to protect soil invertebrates rather than human health. Given that many of the standards to protect soil invertebrates are close to background levels, the standards will automatically capture many industrial sites in the province. The Ministry does not see this as a major problem, or as necessarily triggering site clean-up. They argue that land owners can do a site specific risk assessment to prove that the site contamination is not having an adverse environmental impact. However, not only would this be an extremely expensive undertaking, but it would also impart an unnecessary and undesirable "stigma" to most of the land in question.

An alternative approach would be to rewrite the Regulation so that properties are assumed not to be contaminated if the level of contamination is less than the human health standards. The ecotoxic standards would remain in the Regulation, but be used only in the event that a Ministry of Environment, Lands and Parks Regional Manager had a concern that the site was having some adverse impact on the environment. Only in these circumstances would the property owners be required to do a risk assessment to prove otherwise. This approach is consistent with the fundamental legal principle that, absent evidence, one is assumed to be "innocent." The approach now reflected in the Regulation, in contrast, assumes that most industrial land holdings are contaminated.

Availability of Key Reference Documents:

Industry stakeholders have voiced concerns over the lack of availability of certain documents relevant to the derivation of soil quality matrix standards for contaminated sites. CCME documents not provided to industry stakeholders include "Protocol for Derivation of Ecological Effects-Based and Human Health-Based...Sites"; and "Guidance Manual for Developing Site-Specific Soil Quality Remediation...Canada."

Odour Protection

We are concerned with the derivation of these equations, and particularly what the meaning of the "time", "area" and "VF" parameters are. These equations were designed to estimate the exposure from long term proximity to a remediated site of default size 45m x 45m. The VF, as defined by Golder, is inversely related to the flux of contaminant from the soil into the air, ie. gm/area/time. The average flux is inversely proportional to T*0.5. In other words, for soil that will not be further disturbed, the average flux in the first second after remediation is four times the average flux in the first four seconds after remediation, and so on. Over long exposure times, such as lifetime exposures of 70 years, the exact start time for "time" is not important. The "Area" is appropriate, since the lifetime exposure would cover the entire undisturbed area of the site over the "time".

However, this does not follow through in the odour exposure scenario modeled by the CSST. We believe the scenario documented is meant to represent something similar to the "residential gardener, who is digging and exposing fresh soil". By setting "time" equal to one second as CSST does, and using the Golder equations, the model predicts exposure during the first second after soil disturbance; this is reasonable, because in the case of a gardener, maximum exposure does occur in that first second. However, the "area" value in the model is incorrect. It is inconceivable that an entire 45m x 45m plot would all be freshly disturbed for the same one second exposure time. A more realistic scenario would be exposure to a 1m x 1m area of freshly disturbed soil; this would be roughly equivalent to the activity of a gardener using a rototiller, and would likely be a conservative estimate of exposure to freshly disturbed soil in its first second of emission.

B.C. Environment should review this model, and carefully consider these comments. It would appear that adjustments are necessary in the equations and default parameters.

Excerpt from Canadian Petroleum Products Institute submission to MELP
(February 22, 1996)

Excerpt from Canadian Petroleum Products Institute submission to MELP (February 22, 1996)

## Groundwater Transport of Inorganics

The CPPI group recognizes the pioneering efforts of the CSST and B.C. Environment in estimating the transport process of inorganic parameters. The protocol acknowledges that many factors are not accounted for, ie. redox conditions, chemical form of metal. However, the standards proposed in Draft 3 of the regulations could lead to some difficult situations.

For example, at one of our contaminated sites in the Vancouver area where the arsenic level in soil is greater than the level protective of groundwater flow to surface water used for aquatic life (10 mg/kg), the groundwater at the site readily meets the aquatic life criteria given in Schedule 6. The site may continue to be designated as a contaminated site based on soils criteria that are protective of groundwater, despite the real world data demonstrating that the groundwater has not been impacted.

This potential discrepancy may be due to problems in modelling the transport process. We recommend that B.C. Environment consider one of the following possible approaches to overcome this difficulty:

1. Incorporate a footnote in the appropriate matrix lines, indicating that the soil standards protective of groundwater are waived if the groundwater on the site meets the appropriate standard in Schedule 6;

2. Develop soil criteria based on the use of a dilution factor for groundwater entering the receiving surface water body, provided that surface water body meets the criteria within a certain distance from the entry point.

Excerpt from Canadian Petroleum Products Institute submission to MELP
(February 22, 1996)

## Soil Ingestion Pathway

The protocols purport that the most important exposure pathway is direct soil ingestion. The CPPI recommends that the CSST consider the realistic applications of this position. Soil ingestion is only the most important exposure pathway when contaminated soils are located at the surface of a site in an exposed area. The depth and accessibility to contamination should be accounted for when determining critical exposure pathways. More often than not, soil contaminants are found at least 1m below grade. As such, ingestion of soil by human receptors may not be applicable at many sites. The CPPI recommends that B.C. Environment reconsider the mandatory inclusion of the soil ingestion pathway in the matrix standards, and particularly in the development of Site Specific Standards and site specific risk assessments.

# Greater Vancouver Regional District

4330 Kingsway, Burnaby, British Columbia, Canada V5H 4G8

*Sewerage and Drainage Department*
*Project Engineering Division*
*Residuals Management Group*


## Fax Memo

| | | |
|---|---|---|
| **To:** | Name | Dave Clark |
| | Company | M.M. Dillon Limited |
| | Department | Contaminated Sites Workshop |
| | Phone | 278-7847 |
| | Fax | 270-3644 |
| **From:** | Name | Craig Peddie |
| | Phone | 604-432-6492 |
| | Fax | 604-451-6019 |

Date: March 19, 1996 Time: 10:24 AM

Total number of pages, including cover sheet:

**Message:** **UBCM/GVRD Stakeholder Issues & Agenda Items**

Further to your letter to stakeholders of March 15, 1996 we have compiled the following list of issues and topics we think should be discussed within the workshop agenda. As suggested, we have grouped our issues within the Agenda structure. However, stakeholder issues and suggestions raised during the consultation process to date should be raised and discussed in context during each segment of the program rather than being saved for the end of the last day.

If you do not receive all pages, please call as soon as possible to: (604) 432-6490.

**Day 1 - March 20th**

**Introduction & Workshop Overview**

**Overview: - Past, Present & Future BC & Canadian Policy & Legislation**

Discuss how the CCME doctrine of "no-net-degradation" is manifest within the BC CS regulation, and what are the key driving policy's underlying the structure and approach of Draft #3.

Contrast this approach with that of Washington State and the USEPA. In particular, what screening or trigger criteria and mechanisms determine which sites are assessed?

**- Draft #3 Standards**

The workshop presently appears to concentrate almost exclusively on the Matrix numerical soil standards. We believe there should be some discussion of the Generic numerical standards for soil and water. Specifically, where did these standards come from and what are they based on? How are these standards used within the regulation and what are the implications? Are the Generic numerical standards appropriate and practical for BC?

The Water numerical criteria should be reviewed briefly as well. The discussion should focus on the practicality of these criteria as the threshold for designating a contaminated site.

**- Analytical Methods, Detection Limits, Background Levels**

Our concerns with respect to analytical methods (total metals, unfiltered samples), practical detection limits, and accounting for background variability have been communicated previously. There should be adequate time allowed for discussion of these important issues.

**- Overview of CSST Work**

This discussion should focus on the key simplifying assumptions and policy decisions made by the CSST group. Why for example were ambient water quality guidelines used as the endpoint for groundwater protection when effects levels were used for other soil criteria? Why was "Real World" experience applied to health criteria but not to ecological criteria?

**Matrix Standards for Protection of Human Health**

We suspect that the health effects toxicology endpoints are principally based on metal salt studies as was found to be the case for the ecological criteria. As such, we believe the issue of bioavailability and metal speciation are equally important with respect to the application of the human health criteria. We would like to see some discussion around this point.

What were the findings of the "Real world" adjustment for inadvertent soil ingestion and what was adjusted?

We have concerns with respect to some of the very low standards for drinking water protection generated by the Matrix protocol. We can't quibble with using the drinking water standards as the endpoint, so we suspect the soil partitioning model and default assumptions need to be thoroughly reviewed.

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**Day 2 - March 21**

**Soil Matrix Criteria - Soil Invertebrates and plants**

We believe it is essential for the expert panel to be able to review all of the assumptions and data input into the matrix criteria calculations. The previous workshop dealt only with the formulas, which are for the most part well established. This workshop should deal more with how these formulas were applied and whether compounding conservatism results from the inputs selected.

We believe that bioavailability and metal speciation is a key issue with respect to the matrix criteria. We submit that the matrix criteria are only valid with respect to the "available" forms of metals within the soil.

**Soil Matrix Criteria - Livestock Protection**

We believe the selection of the most sensitive livestock receptor has been overly conservative in some instances, notably for Copper (sheep). Again, all input data and assumptions should be reviewed by the panel.

**Soil Matrix Criteria - Soil Microbe Protection**

Similarly review all data inputs and assumptions.

**Soil Matrix Criteria - Standards for Groundwater Protection**

We are concerned that compounding conservative assumptions and model inadequacies underlie the very stringent groundwater protection standards. Key concerns are:

- The use of the Ambient Water Quality objectives as the endpoint for the aquatic life protection criteria. These criteria incorporate various safety factors which are not readily apparent or understood. This contrasts other soil matrix criteria which used toxicological effects levels as the endpoints.
- No dilution was allowed for groundwater discharge into aquatic environments, while point discharges are as a matter of Ministry policy assumed to have a 20:1 dilution to meet Ambient Water Quality standards. We regard this zero dilution assumption as unduly stringent.
- The experts agreed in September that there were no adequate models available for metals in soils. The model adopted by the Ministry in the interim has not been peer reviewed and we suspect that there may be inadequacies in the model or in the manner it was applied. We suspect an overly conservative selection of soil partitioning coefficients may be driving the criteria.
- We would like the panel to review all of the data inputs and assumptions for the groundwater criteria in addition to reviewing the groundwater protection model. For example, what were the endpoint receptor species for the livestock watering protection?

**Day 3 - March 22nd**

**Soil Matrix Standards - Odour Protection**

Actual detection of odour may be an appropriate trigger for site assessment, while the use of presumed odour threshold concentrations may not. This is the same issue as the bioavalability discussion. Odour threshold concentrations in the absence of odour are meaningless.

**Soil Relocation Standards**

The trigger levels for soil relocation agreements are just too low, below background in many instances. This problem may fix itself once other issues with respect to the derivation of the Matrix criteria and the Generic criteria are dealt with.

We have proposed the Ministry consider adding a "Background Correction" to the soil generic and matrix criteria. This could alleviate some concerns with respect to these criteria, both with regard to site assessments and soil relocation.

**Bioavailable Protocols**

This is one of our core issues and we believe this is fundamental to making this contaminated sites regulation work in the long term given its present policy approach. Discussion should consider the appropriateness of setting standards in the absence of protocols necessary to administer the regulation.

Discussion should focus on how a bioavailable analytical protocol should apply to the human health standard.

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# FAX TRANSMISSION COVER SHEET

**FROM:** Sophie Megalos
Director, Municipal Affairs

Urban Development Institute
Third Floor, 717 West Pender St.
Vancouver, BC V6C 1G9

Phone: (604) 669-9585
Fax: (604) 689-8691

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To: D. J. Clark
Company: Dillon
Date: March 19, 1996

Fax: 270-3644
# of Pages: 2

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The following is forwarded for your information.

SM.

March 18, 1996

TO: Sophie Megalos, UDI —> forwarded to D.J. Clark.

FROM: Jim Malick

SUBJECT: WORKSHOP FEEDBACK FOR DAVE CLARK

Name Correction: Dr. Jim Malick, Ph.D.

The initial document received from Mr. Clark indicated in the "Agenda" section that three scenarios or case studies might be presented or reviewed in relation to the standards for contaminated sites as described in Draft 3 of the regulation. The three cases might be considered worst case type scenarios as it would appear that they may have the most leachable or readily transported substances present. It would be very useful to have, in addition, some more typical sites considered containing such materials as blasting grit, coal cinders, or other materials that are not leachable.

# appendices

## APPENDIX C

## Individual Panel Responses

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460



MAR 27 1996

OFFICE OF
WATER

David J. Clark
Regional Manager
M.M. Dillon Limited
130-10691 Shellbridge Way
Richmond, British Columbia V6X 2W8
Canada

Dear David:

Thank you and your staff for facilitating the Expert Panel Review of British Columbia's Contaminated Sites Risk Assessment Protocol and Criteria Development in Vancouver March 20-22. The Panel appreciates the frank exchange between the Panel and the staff of the British Columbia Ministry of the Environment(BCME) on this subject. We on the panel look forward to the response of the Ministry staff on the Panel's recommendations that you will be receiving in the next two weeks.

Consensus Panel Comments:

-It is not scientifically defensible to have single number criteria or standards for all sites in British Columbia(BC). The Panel encourages BCME to emphasize and further refine site-specific criteria and prepare accompanying guidance documents on the generation and implementation of these site-specific criteria.

-BCME is encouraged to review its standards every 3-5 years and amend its standards accordingly to reflect the evolution of science and the generation of new data. BCME staff is encouraged to meet with this or a similar panel every two years to accomplish the above.

-A site should not be labelled a "contaminated site" while it is still undergoing evaluation no matter what tier or part of the evaluation it is undergoing. Until the site is either finally declared to be contaminated or in compliance with the standards, the site's status should be declared "under evaluation".

-The site-specific matrix and risk evaluation methods both should have the maximum flexibility built in. The proponents of a site should be able to use models other than those chosen by BCME. A broader range of parameters for these models should be allowed.

-Guidance documents that aid in the implementation of the risk evaluation tier should be prepared and distributed. These guidance documents would describe in greater detail how the risk evaluation method would be performed.

Alan B. Rubin's Comments

-I have no opinion on the degree of conservatism that the overall risk assessment methodology has. The BCME approach appears to follow USEPA's approach in the 40 CFR Part 503 Rule for the Use or Disposal of Biosolids in that both rules combine science policy and scientific risk assessment.

-Use only field data in deriving criteria. This will most effectively account for bioavailability. If the use of field data is not always feasible, develop bioavailability protocols to generate criteria.

-Do not force criteria development. If sufficient data does not exist, then leave the space in the matrix blank.

-In BCME's reality check for the site-specific criterion for cadmium based on soil ingestion by a child, BCME modified the original value of 35 mg./kg. to 3 mg./kg. based on a chart of measuring urine cadmium in a Belgian population exposed to cadmium via consumption of vegetables in their diet. Yet upfront, BCME stated that they did not consider a vegetable dietary food pathway to offer significant exposure to people and, therefore, did not perform a risk assessment on this pathway. If BCME now believes from this Belgian study that this foodchain pathway is a significant source of cadmium exposure, they should formally model that pathway with peer review of the modeling and the data used in the models before they reduce the cadmium value from 35 to 3 mg./kg.

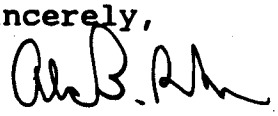
-In BCME's reality check for the impact of contaminants on soil microbes, empirically evaluate legumous crops like alfalfa to see if field metal in soil levels actually suppress rhizobia activity and see how these observations compare to laboratory data being utilized for this portion of the risk assessment.

-Perform sensitivity analyses for all pathways of exposure but especially for the groundwater pathway. From this analysis, list the most sensitive parameters in any of the models. Doing this will aid in a more efficient performance of site-specific risk assessment. However, all parameters must be site-specific when this tier is performed. BCME is urged to label all of its default values as either upper end or mid-range to improve the transparency of the risk assessment and to better judge the degree of conservativeness of the methods.

-Document the pathway of recharge of surface water from groundwater. Have BCME cite actual field verified sites where groundwater discharges into surface waters have created negative impacts.

-BCME should plan to have sufficient inside staff and outside resources to efficiently evaluate all submissions that they will receive under site-specific matrix criteria and the risk evaluation options. All sites should be evaluated as quickly as possible once the site's proponent has submitted all of the QA/QC'd information to BCME.

Sincerely,



Alan B. Rubin, PH.D.
Biosolids Team

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(503) 752-3707 FAX (503) 753-9010

25 March, 1996

David J. Clark
Dillon
130 - 10691 Shellbridge Way
Richmond, B.C.
Candada V6X 2WB

ep and t DCN: 96-O-300

Dear Dave:

Enclosed are my written comments regarding the matrix soil standards proposed by British Columbia Ministry of the Environment. I made all these comments verbally at last week's meeting, but attempted to include some additional references that I thought might be helpful to the BCME.

The document is on the enclosed diskette in WordPerfect 5.2 for Windows. Please let me know if you have electronic difficulties and I will attempt to provide a more compatible file.

Thank you for the invitation to participate on this science review panel. I learned a lot and hope I contributed constructively to the dialogue. BCME has begun a process that I hope they are committed to continuing. The data as they now stand have enough weaknesses in them that BCME must seriously review the standards on a regular basis in order to incorporate new information and adjust the standards accordingly.

Please do not hesitate to call at anytime if you have further need of the services that I and my colleagues at ep and t can provide. Best wishes in your endeavors.

Sincerely,

Anne Fairbrother

Anne Fairbrother, DVM, PhD
Senior Wildlife Toxicologist

## 1. Background

Prior to the passage of Bill 26, BCME managed contaminated sites under Section 20.1(1) of the *Waste Management Act.* This set forth numerical criteria as benchmarks for assessing the extent of the risks and the adequacy of any proposed remedial measures. Criteria are defined as *numerical limits or narrative statements indentified as guidance for the protection, maintenance, and improvement of specific uses of soil and water.* The regulations in support of Bill 26 would define numerical standards which are *legally enforceable numerical limits or narrative statements...which have been adopted or adapted from criteria.* In otherwords, BCME currently uses numerical soil criteria as a guide in their decision-making process. Following the implementation of Bill 26, these numbers would become legally enforceable. Therefore, BCME is attempting to adjust the generic soil criteria (adapted from CCME guidance documents) to be more specific for British Columbia. More importantly, BCME is hoping to make the process more transparent by dividing the numerical criteria into pathway specific components (human health, soil tilth, groundwater, and livestock protection). This would enable proponents to select standards that are directly applicable to their site and reduce the potential for needing to achieve excessive clean-up to levels that were generated from hypothetical events that would not occur in that area. For example, areas with no potential for contaminants to leach into groundwater would be exempt from meeting soil standards set for the groundwater pathway. Proponents also would be given the option of adjusting the standards using site-specific parameters.

My comments are framed within the context of the question that we were asked to address. Specifically, whether the matrix soil standards proposed in the Draft 3 regulation are scientifically defensible. While I will make a few comments on each of the pathways, the majority of my comments will focus on the ecological endpoints.

# CSST Procedures for the Derivation of Soil Quality Matrix Standards for Contaminated Sites

## Technical Review Panel Individual Comments

**25 March, 1996**

***Prepared by:***

Anne Fairbrother, DVM, PhD

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## 2. General Comments

One stated goal of the Bill 26 Guidelines is to provide a transparent process so it is open and clear how numbers were generated. There are several areas where the desired level of transparency has not been achieved. Section A3.2 [Limitations of CSST Methodology] of the *Overview of CSST Procedures for the Derivation of Soil Quality Matrix Standards for Contaminated Sites* may need to be expanded to cover these points. Alternatively, they can be included in the pathway-specific sections.

*Background* – a statement needs to be made that matrix standards will be adjusted so that they are not below background concentrations. The panel discussed what should be considered background (90th, 95th, or greater percentiles from the soil and groundwater background studies now being conducted). The soil background study is looking at two horizons (0-10 cm and 50-60 cm). It is not clear which depth or which percentile will be considered when setting background values. Whatever is chosen, the policy decisions about how the number was derived should be clearly stated.

*Bioavailability* – this is an extremely important issue as bioavailability may be significantly less than one for many exposure pathways. Therefore, some general statement should be made in the beginning of the technical support document, with explicit discussions of default values in the sections for each specific pathway.

*Province-wide versus Regional numbers* – acknowledgment is made in section A3.2 that there are many types of contaminated sites containing complex mixtures of chemicals. While there is extensive precedence for considering single chemical effects in standard-setting, it is more difficult to justify scientifically setting a single soil standard for the entire province of British Columbia. Soil type plays such an important role in determining bioavailablity and toxicity of many of the contaminants, that it is highly likely that a single number will be over-protective of many (if not most) environments. Therefore, it must be clearly stated that a policy decision was made to use conservative estimates in order to set a single standard. The ability to adjust these numbers on a site-specific basis is limited primarily to the groundwater pathway. There is no mechanism for adjustment to the plant/invertebrate or human health pathway. The

livestock pathway can be slightly adjusted through the use of site-specific plant uptake factors. I urge BCME to commit to a program of developing a table of standards for each of the major soil types in the province (beginning with Fraser River sand), in order to increase the environmental realism of the resulting standards.

*Environmental Protection Goals* -- The CSST has made a series of policy decisions on what level of ecosystem protection they are trying to achieve. These are in the written document *CSST Policy Decision Summary* (24 January, 1996).. These policy decisions are very important for determining acceptable levels of contamination, particularly for industrial and commercial sites. Human health endpoints have been well-defined through many years of discussion and debate within the regulatory, scientific, and industry communities. Cancer, birth defects, impaired fertility, and neurobehavioral effects are all unacceptable consequences of exposure to pollutants. The level of acceptable risk has been defined as 1 in 100,000 for nonthreshold substances and exposure below the effects threshold for other substances. However, risk endpoints and level are not clearly established for environmental pathways and it is likely that they will differ with use, location, and societal values. Therefore, it is extremely important that BCME clearly define their environmental goals and direct all subsequent review and remediation towards these goals.

CSST policy states that industrial sites should be able to support the unsupplemented growth of grass. Commercial zones should also be able to grow grass and some ornamental plants. Residential/parkland areas should support the growth of ornamental and native flora. No mention is made of vegetable crops. Nor is there any discussion of wildlife (birds and mammals). While this may not be necessary for residential areas, parklands (even urban parks) generally are considered as suitable habitat for many wildlife species. Similarly, agricultural areas are expected to allow growth of crops and raising of livestock, but do not mention the possibility of native flora and fauna resident in the area. BCME should clarify their intent in this area and include this information in Table 1 of Section B2.1.1 in the *Overview* procedures document. Protection of plants and soil invertebrates will not necessarily provide protection of wildlife (either fossorial animals such as gophers or above-ground birds and mammals). Page 8 of the technical support document suggests that "it is assumed that the level of

protection provided for soil dependent species will also be generally adequate for the protection of livestock and wildlife". I suggest that BCME delete this statement as it is not true.

## 3. Specific Pathways

The following sections will provide specific comments regarding the scientific defensibility of the approach for setting soil standards for the protection of human health, plants/invertebrates, livestock, and groundwater.

### 3.1 Human Health

In the equations used to derive the $PSQS_{HH}$, the absorption factor for gut was set at 1.0. As this is a policy decision and not a scientifically-derived number, some discussion should be given to state that this is BCME policy and whether a proponent can substitute a scientifically-derived number for a particular chemical when making site-specific adjustments. Similarly, the basis for selection of soil ingestion rates for child and adult should be given.

I shared concerns with other panel members about the use of the "real world adjustment" using exposure data (rather than effects data). The cadmium study, for example, measured urine cadmium levels, but there was no indication that these are correlated in a linear fashion to renal dysfunction. If they are, is the correlation 1:1 such that the same environmental concentration that results in a statistically significant increase in urine cadmium also results in a biologically real decrease in renal function? It may be that the short time period of the discussion session precluded the presentation of these details of the study. However, I firmly believe in a "reality check" of all the derived data and applaud BCME's efforts to do so.

### 3.2 Plants/soil invertebrates

The derivation of the soil standards protective of plants and soil invertebrates is less defensible scientifically than are the human health standards. Both the toxicity

threshold derivations and the exposure pathways (i.e., bioavailability) have significant shortcomings. They will be addressed separately and suggestions will then be made about how BCME could move to improve the process.

*Toxicity threshold derivations* -- BCME is to be commended for rejecting CCME's stringent criteria for data acceptability and electing instead to use more of the available data from the literature. However, having decided to do so, BCME is then faced with deciding how to use data that were not generated for the purpose of setting soil criteria and that represent the efforts of a variety of researchers using different soil systems, different effects endpoints, different forms of the same chemical, different exposure durations and conditions, and different plant or invertebrate species. BCME developed a method to group the endpoints as lethal or nonlethal and then plot all the studies on a single graph in order to artificially generate a dose-response curve. Several of the datasets do not produce straight line dose-response relationships and a policy decision was made following a previous scientific review to force a linear fit. This results in ignoring several data points and it is not clear what criteria are used to include or exclude certain data points (the "Empirical Exception Rule" stated on page 10 of the guidance document is not adequately described). The data set for cadmium nonlethal endpoints as a good example of a nonlinear relationship. Personally, I do not like this procedure as it gives more validity to the dose-response relationship than is warranted and it is not always transparent about how the curves are generated.

The Ambient Water Quality Criteria use data from a variety of species for determining threshold values, with the goal of protecting 95% of the species 95% of the time. Generally, the lowest value is selected, but not always. Another procedure for using data from a diverse set of studies in criteria setting is available from the U.S. effort to develop Apparent Effects Thresholds for sediment quality criteria. I recommend BCME review these approaches and consider whether either could be adapted to the soil environment to provide more scientifically defensible standards. The relevant references are:

PTI. 1988. Briefing report to the EPA Science Advisory Board: The apparent effects threshold approach. PTI Environmental Services, Bellevue, Washington.

Science Advisory Board. 1989. Report of the sediment criteria subcommittee: Evaluation of the apparent effects threshold (AET) approach for assessing sediment quality. U.S. EPA. Science Advisory Board, SA&EETFG89027. 18pp.

Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman, and W.A. Brungs. 1985. Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses. U.S. EPA, Washington, DC. NTIS No. PB85-227049. 98 pp.

*Bioavailability* – BCME is aware of the concerns about measuring total chemicals in soils versus bioavailable material. Metals, in particular, vary greatly in their bioavailablity depending upon soil conditions, but organic compounds also are not 100% bioavailable. Soil pH, clay, cation exchange capacity, redox potential, and organic content are among the factors that affect uptake of materials by plants and soil invertebrates. Since most of the laboratory studies that were used to develop the toxicity effects thresholds were conducted in artificial matrices using salts that generally have a high degree of bioavailability, the resulting soil standards will be overprotective when compared to total materials in the soil. I have found this to be the case in most (if not all) of the field risk assessments of which I am aware. BCME must clearly state in the support document that the selection of a single, province-wide bioavailability factor is a policy decision that will result in a conservative protection level consistent with their mandate. I suggest that a bioavailability term be included in the derivation of the soil standards. Furthermore, I recommend that BCME discuss lowering the plant/invertebrate bioavailability factor to 0.8, based on a policy decision that 1.0 is not realistic and may be too conservative.

*Site-specific adjustment* – there is no provision in the way the plant/invertebrate standards are developed to make site-specific adjustments. Can the proponent chose to derive a site-specific toxicity threshold using data only from plants that should be expected on that site? For example, should industrial sites use data only on effects to grasses (if available) since vegetables, ornamentals, and native plants need not be sustained on this site? BCME has approached this by increasing the acceptable level of effect (from $LC_{20}$ to $LC_{50}$, etc.) in their threshold calculations, but they may wish to do some sensitivity analysis to see how many of their values are driven by plants other

than grass. In addition, BCME should give thought to how a site-specific bioassay would be used -- as a site-specific adjustment or as a risk assessment? The placement of a site in each of these tiers apparently has serious implications for financial commitment and labeling as "contaminated" or not.

*Chromium* -- chromium is the only metal that has a standard based on a particular species. Since most soil chemistry assays will not differentiate the +3 and +6 speciation ratios, I am not clear how this standard will be applied. It cannot be used to compare standards against total chromium concentrations as most of the chromium in soil is in the +3 state. Even groundwater generally is not entirely in the +6 state, existing for the most part as 30% +6 and 70% +3 (Shupack, 1991; WHO, 1988). Chromium +3 does not cross cell membranes, so plants and invertebrates are very insensitive to toxic effects, with toxicity thresholds close to 1,000 mg/kg soil.. Moreover, when earthworms take up chromium +6, they change it to the +3 state so it becomes unavailable to their predators (Arillo and Melodia, 1991). I recommend BCME revisit what they intend by setting standards for chromium +6.

Arillo, A. and F. Melodia. 1991. Reduction of hexavalent chromium by the earthworm Eisenia foetida (Savigny). Ecotoxicology and Environmental Safety. 21:92-100.

Shupak, S.I. 1991. The chemistry of chromium and some resulting analytical problems. Environmental Health Perspectives. 92:7-11.

World Health Organization. 1988. Environmental Health Criteria 61: Chromium. WHO, Geneva, Switzerland.

*Reality check* -- as with the human health standards, the plant/invertebrate standards should be subjected to a reality check. Available field data should be reviewed to determine if there is any information relevant to the British Columbia soil environment that could be used to validate the generated standards. Nelson Beyer and his colleagues from the US Fish and Wildlife Service have published several papers on soil environment effects form the Palmerton zinc smelter in Pennsylvania. The Clark Fork River and the Anaconda mine in Montana have provided a risk assessment of plant and soil invertebrate effects, several papers being published in *Environmental Toxicology*

*and Chemistry* by Linder, Pascoe, and others. The Asarco smelter in Washington also has available data as do several other areas from eastern Europe. BCME may know of environmental impact assessment data from within the Province that also can be used as a real-world check.

## 3.3 Livestock

The livestock pathway for ingestion of soil and contaminated forage is very straightforward. Again, the assumption of 100% bioavailability of materials in ingested soil should be clearly stated. Exhibit 1 on page 11 of the technical support document has a bioavailability factor (AB) of 1, but it is not clear that this if for both soil and plant ingestion (in reality, they sometimes are different). It also should be stated (on page 12) that site-specific adjustments in the soil-to-plant transfer coefficients can be made, based on actual measurements in soil and forage material (both on a dry weight basis). Finally, it was not clearly stated in the support document that the final value is the lowest derived from calculated values for cattle, sheep, goats, pigs, and chickens.

In addition, I recommend that BCME compare the data from Puls (that is unpublished and has not been subjected to a peer review) with information from the National Research Council's book on *Mineral Tolerances of Domestic Animals* (1980; from National Academy of Sciences Press).

I commend the BCME for their realization that livestock are not surrogates for terrestrial wildlife species. Toxicity data exist for birds and mammals for some of the chemicals in the matrix standards. Therefore, if BCME wishes to set standards protective of terrestrial wildlife, they should use these data. However, BCME should be cautioned against using allometric scaling factors to extrapolate toxicity data (on a mg/kg-body weight) across species (as recommended by Sample and Suter) as erroneous results will be generated.

## 3.4 Soil Microbes

As there are limited data on effects of contaminants on soil microbial processes, BCME has not generated many matrix standards for this pathway. This is commendable. BCME also must consider that microbial communities frequently are adapted to extreme soil conditions and that laboratory studies generally do not predict field effects. Much more work needs to be done in this area before there is sufficient scientifically-defensible information for standard setting.

## 3.5 Groundwater / Odor

I am not qualified to comment in detail on these two pathways as I am not an environmental chemist nor a mathematical modeler. However, listening to the discussion during the presentations it is clear that the groundwater model is not sophisticated enough to generate defensible numbers for metals. BCME may wish to state that it is a policy decision to use the model for this purpose, but that they recognize that more sophisticated methods may produce more accurate estimates. Furthermore, the assumption of no dilution between source and receptor may be unrealistic for long pathways. Therefore, BCME should allow more sophisticated models to be used when developing site-specific estimates of groundwater exposure that would account for both the metals and dilution issues.

The presentation of the model used to develop odor estimates suggested that this is the least well-developed pathway. Mike McFarlane explained the difficulties he has been having in contacting the appropriate people to have a discussion of the validity of the proposed model. Since the model was developed to predict life time exposure (over 30 to 70 years), it may be entirely inappropriate to use it for a 1 to 300 second exposure as it likely cannot handle these initial conditions very accurately. I recommend that BCME not promulgate standards for odor until they have had sufficient time to properly validate this model or select a different model, if more appropriate.

## 4. Recommendations

I have the following additional recommendations for BCME to consider in order to increase the scientific defensibility of their matrix standards. These are meant to be in addition to, and complementary of, any recommendations made in the above sections.

1. BCME should develop matrix standards for plants/invertebrates for each major soil type within the Province as it is unrealistic to provide a single number for all areas.

2. BCME should commit to developing data for plant/invertebrate toxicity for the matrix chemicals as current data are not directly applicable to this exercise. This would consist of the following steps:

    - identification of major soil types in the province
    - bioassays with each soil type for each chemical for the following (at a minimum):
        - ryegrass
        - lettuce
        - an ornamental plant
        - earthworm (*Eisenia foetida*)

3. Bioassay data for development of petroleum hydrocarbon toxicity to plants/invertebrates should have highest priority, as no data are currently available for matrix standard development and there are many sites potentially contaminated with these chemicals.

4. BCME should commit to setting up a task force on development and validation of chemical extraction methods that would measure the bioavailable fraction of compounds in soil relative to plant and earthworm uptake. This is a long-term effort but will eventually result in more realistic exposure estimates for comparison with laboratory-derived data.

Reference:

Ure, A.M. 1995. Methods of analysis for heavy metals in soils. in: Alloway, B.J. (ed). *Heavy Metals in Soils*. Blackie Academic & Professional, London. pp. 58-102.

5. A simple yes/no question should be added to Schedule 1 (the questionnaire used to enter a site into the registry) to ask if grass, trees, or other plants are currently growing on-site. A photo should also be allowed to accompany the application. This would assist in the process if a site does not pass the plant/invertebrate matrix standard, yet it is obvious that it can support the intended level of environmental protection (e.g., growth of grass on an industrial site). It can be used as a qualitative site-specific adjustment to the matrix standards.

6. BCME should commit to a continuing process of updating the soil matrix standards on a regular basis (at least once every 5 years for each matrix standard). This will allow BCME to incorporate advances and changes in available data and measurement techniques and ensure the credibility of this exercise.

KING GROUNDWATER SCIENCE, INC.



4 April 1996

Ref: 9601

M. M. Dillon Limited
130 - 10691 Shellbridge Way
Richmond, B.C.
Canada V6X 2W8

Attention: David J. Clark, P. Eng.

RE: STANDARDS REVIEW WORKSHOP
FOLLOW-UP COMMENTS

Dear Dave :

I have prepared the comments below following the workshop held in Richmond on March 20-22, 1996. These comments formalize similar comments that I made during the workshop. Most of my comments are specific to the BCE Transport model used to calculate soil quality standards for the groundwater pathways.

1. From my point of view, setting soil quality standards that can be uniformly applied across British Columbia, or anywhere, is extremely difficult to balance the risks and benefits of doing so. The efforts of BC Environment are commendable in general, but I have some reservations about certain aspects. The matrix approach and identification of the pathways of concern is a good approach. There was talk of using the best science possible in this effort, but it was clear during the workshop that the setting of the draft standards using any of the risk or transport models cannot be done solely on technical reasoning or "science". The level of uncertainty can be very large, there is very limited data available in most cases and as a result a certain amount of policy and judgement is necessary.

2. *Stigmatization of a "contaminated" site.* This is a very practical issue that deals with perception. A site should not be designated as being contaminated until the site owner has had a chance to proceed through the system and has the opportunity to show which standards are appropriate to the site and negotiate with BCE. During the process a site could be designated as "under review" or "under assessment" or other neutral language.

3. *Use of transport models.* It is my opinion that use of computer codes is best applied to obtain insight and understanding of the importance of certain parameters or processes, and sensitivity. The accuracy of the results is highly dependent on the implicit assumptions, the value of input data and whether the simulated conditions actually reproduce reality. Use of the simplified analytic solutions in the development of soil quality standards which are incorporated into legislation and which may be interpreted by some (including regulatory personnel) as remediation criteria, goes beyond the purpose of the model code,

in my opinion.

Very similar analytical solutions have been used in the Risk Based Corrective Action (RBCA) approach in the USA for petroleum hydrocarbons (ASTM document ES-38-94, August, 1995). A significant point made in this document is that the results of using the code should be used as screening values and not for setting remediation criteria.

4. *Transport of metals in groundwater.* In my opinion, the application of the BC Transport model, as formulated, to predict the mobility of metals is not scientifically accurate. The complex processes that control subsurface fate and transport were identified in the documentation, but then rolled into a single coefficient that varied with pH. This seems to be an over-simplification of the situations intended to be modelled. The model was first developed to address migration of non-polar organic compounds, which behave differently and for which the model is more suited.

pH is important but is not the only variable that will affect the mobility of an inorganic species. The approach that was used does not specifically address the fundamental processes that affect the transport of metals in the subsurface, or the contaminant-specific and site-specific factors that are important. Use of the MINTEQA2 code to develop a coefficient as done be BCE requires a certain set of assumptions and only address a specific set of conditions, water chemistry and mineralogy. This portion of the modeling was not transparent to me. The modelling does not appear to take into account the speciation of the contaminant, presence of other mineral phases, ion exchange, competition, or changes in geochemical conditions that may occur during transport along a groundwater pathway.

As a result, there is no certainty that the soil quality standards for metals as proposed will be either protective or unprotective of groundwater quality based on the calculations made. Experience would suggest that in the large majority of contaminated sites, the mobility and migration of metals in groundwater is not a major concern unless there are unusual pH, redox, or other conditions occurring at a site. But in the matrix standards, it would appear that the groundwater pathway is often a controlling factor for soil quality for some metals. This seems inconsistent.

My interpretation of the approach used by BCE to develop the groundwater pathway soil standards for metals is that they have relied on a great deal of professional judgement in the application of the model to simplify a complex problem. I believe that the overall approach utilized for metals transport in groundwater does not have the scientific support that it should.

Due to the difficulty in setting a soil standard that is protective of groundwater for metals, these matrix values should be either designated as "guideline only", left as "NS" for the time being, or more effort be spent to provide support for the values specified.

Suggestions for alternative methods:

- use of geochemical transport codes such as MINTRANS (University of Waterloo) or PHREEQC (US Geological Survey) that couple geochemical processes with groundwater transport. These codes are recent developments and further refinements are being made, and it is fair to say that they are at the state-of-the-art, but they would be more appropriate than the current model approach.

- a detailed survey of background soil quality throughout the Province. Production of a document such as "Natural Background Soil Metals Concentrations in Washington State" prepared by Washington Dept of Ecology (publication 94-115, October 1994) would provide a better basis to determine natural levels, the variability that might be expected, and a comparison to actual soil and groundwater quality on a province-wide and regional basis.

- development of a protocol for a soil quality leachability screening test(s). This could be dangerous if misapplied for the same reasons noted above, however, a more representative test procedure than the SWEP or TCLP test procedures may be applicable.

- undertake a review of file information regarding metal contamination of groundwater in BC and associated site soil and geochemical conditions. Stakeholders may wish to contribute site information. Then the questions of whether metal contamination of groundwater is a real problem and the likely conditions when it will occur can be compared to our theoretical understanding of metal behaviour.

5. *Lack of Data* It appears to me that there is a general lack of data available to support some of the decisions made in the development of the standards. This applies to the human health and ecological effects levels, as well as the groundwater pathway modeling. A commitment by BCE to implement a program of data collection that can support the judgements made in standards development should be made. For example, surveys of background soil and groundwater quality throughout the Province would be very useful.

6. *Future revisions.* A commitment to review standards at future dates as more data and experience becomes available should be considered.

7. *More flexibility.* I have a particular concern with the requirement that site owners must utilize the BCE Transport code to assess their site's site-specific conditions. This is particularly important for the groundwater pathways. Of course, there is the opportunity to do a "risk assessment" but the implication is that the requirements at this stage would be far more than would be warranted ie. a perceived requirement that all pathways would need to be evaluated and not just the groundwater pathway, for instance.

   Other methods and codes are available that may be more suitable to a sites particular conditions, and proponents should not be constrained from using them. The site-specific nature of hydrogeology and geochemical behaviour of contaminants can not be

emphasized enough. There would still be an onus on the proponent to demonstrate the case and adequately support all work.

The BCE argument that many site-specific models would require additional resources and expertise for review is a weak one in view of the significant fees which are to be charged.

8. *Conflict with federal jurisdiction.* In areas where discharge from a site to a fishery exists, development of a risk based remediation standard may not entirely relieve the proponent of liability from Environment Canada, particularly in setting an acceptable ecological risk or effects level.

9. *External review.* It is not clear that the BCE Transport model has been formally peer-reviewed for it's intended purpose or compared to other codes or actual site data. If not, this should be done before implementation to ensure that the correct results are being derived.

The results of sensitivity analyses should be documented and released for comment and review.

10. The use of $K_d$ values to model the transport of various metals is incorrect as noted above, and the use of copper $K_d$ values as a surrogate for lead is also incorrect. The geochemistry of copper and lead are sufficiently different that similar fate and transport behaviour would not be expected.

11. The log $K_{oc}$ values for PCP used in the BCE Transport code range from 4.3 (pH=4.5) to 0.71 (pH=8.5). Work by Lee et al. (1990) suggests that sorption of both the ionized and neutral species are important and that log $K_{oc}$ stabilizes at a value of about 2.6 at a pH above 8. It appears that the BCE model does not incorporate the sorption of the neutral species. As a result, the $K_{oc}$ values used by BCE are lower than they should be, particularly in the critical 6 to 8 pH range (see Figure 1). The resulting $K_d$ values used in the model would therefore also be lower than they should, resulting in an underestimation of the degree of sorption onto the soil that may be occurring for a certain equilibrium water concentration. This means that the soil standards may be too low, or too conservative.

Reference: Lee, S. L., P. S. C. Rao, P. Nkedi-Kizza and J. J. Delfino, 1990. Influence of solvent and sorbent characteristics on distribution of pentachlorophenol in octanol-water and soil-water systems. Environ. Sci. Technol., v 24, no. 5, pp 654-661.

12. There is an order of magnitude jump in the $K_d$ used for cadmium between pH 8.0 and 8.1, which seems unusual.

13. There will be a need for full documentation and guidance to be provided to proponents, consultants and regulators as to how the new regulations and standards are to be implemented.

14. A recent editorial in Ground Water journal made the argument that any soil remediation standards should take into account the soil conditions *after* remediation. The point being that the remediation itself may result in significant alteration of a soils geochemical (or ecological) properties, such that the soil's ability to retain contaminants and prevent their migration into groundwater is reduced. The authors also propose a "recalibration process" to establish final soil cleanup levels.

    These authours also suggest that "Government agency use of generic concentrations can reduce or eliminate scientific and legal discourse on the appropriateness of a cleanup solution and limit useful public and responsible party involvement in remediation decisions. The best solution to speeding soil cleanups is to enhance the role of science while streamlining the remainder of the process that consumes so much time and so many resources".

    There may be aspects of this discussion that BCE may wish to consider, particularly for complex sites.

    Reference: Belluck, D. A. and S. L. Benjamin, 1994. Scientifically credible site-specific soil cleanup levels to protect ground water. Ground Water, v 36, pp 882-883.

15. Since there appear to be scientific and technical issues that are not fully resolved, formation of a technical advisory committee from the regulatory, academic, consulting and stakeholder communities would be useful. Similar groups have been formed in Washington state to address science issues (Science Advisory Committee) and implementation of policy (Policy Advisory Committee).

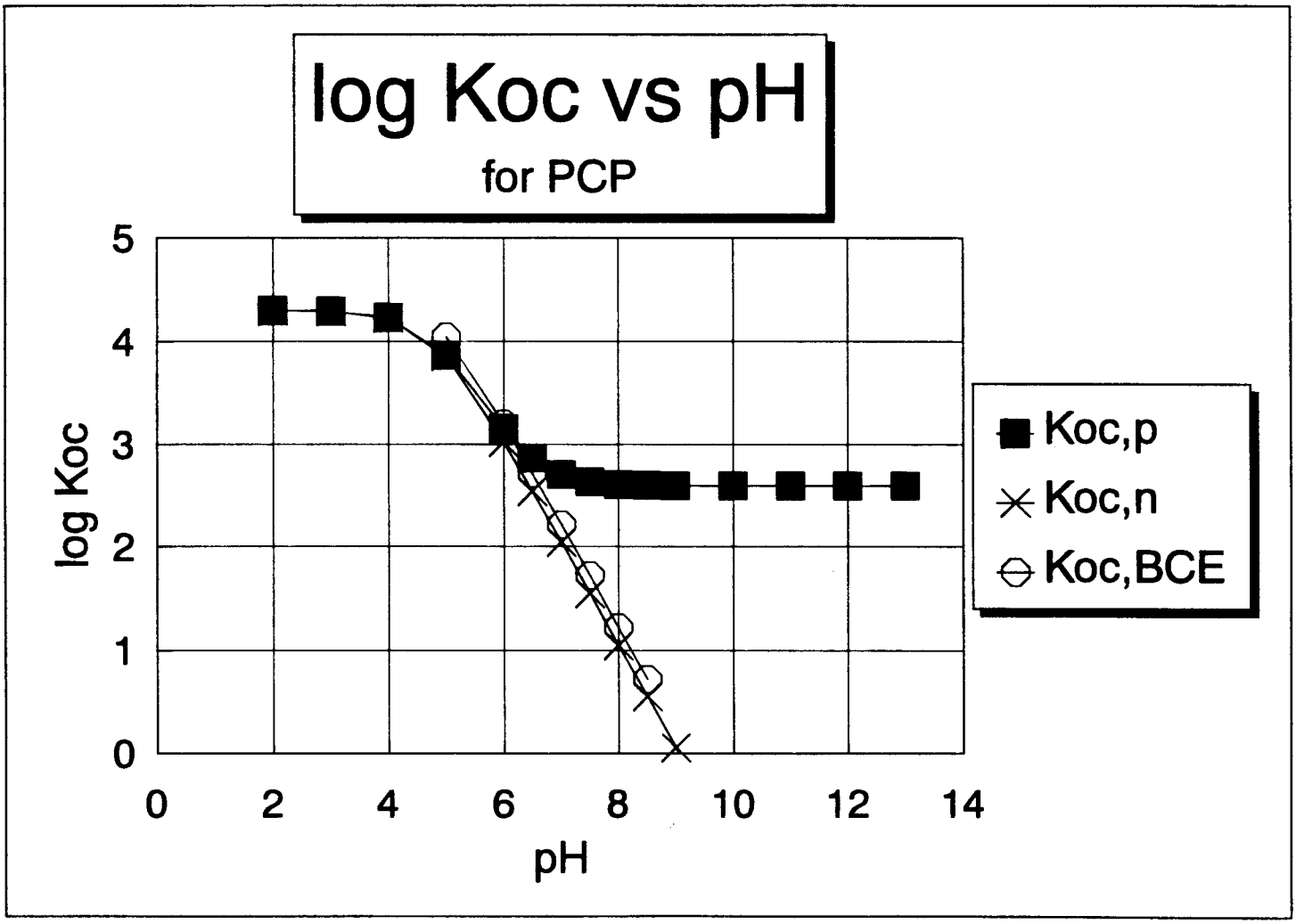
I trust these comments are helpful and would be pleased to discuss them with you or the Ministry if there are any questions. I appreciate the opportunity to participate in this process.

Yours truly,
KING GROUNDWATER SCIENCE, INC.

K. Scott King

K. Scott King, M.Sc.

Figure 1


log Koc vs pH
for PCP
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# WRITTEN COMMENTS REGARDING THE SCIENTIFIC BASIS OF THE PROPOSED NUMERICAL STANDARDS FOR IMPLEMENTATION OF BILL 26

*Dennis E. Konasewich, Ph.D.*

## INTRODUCTION

I appreciate the opportunity to have participated as a panel member in the March 20-22, 1996 Contaminated Sites Workshop. The availability of such a transparent review process is essential in the derivation of regulations, so that regulatory standards are scientifically justified. The "state-of-the-science" relating to human health and ecological impacts of chemical substances still remains quite basic, and a framework such as proposed by the Ministry will define where future scientific efforts should focus so that all "standards" will be properly supported.

Nonetheless, there is an immediate need for numerical values to implement Bill 26, and it is the challenge of the Ministry to derive such numerical values on the basis of current science.

The panel was directed to focus on the adequacy of the science used to derive the numerical standards proposed in the most recent draft regulation of Bill 26. I am providing two general comments and several specific comments relating to the scientific basis of the proposed numerical standards.

## GENERAL COMMENTS

1. *There is a need for a rationale scientific assessment to define the true extent of problems posed by contaminated sites in British Columbia.*

The issue of contaminated sites has taken a major life of its own, relative to other environmental issues. Major resources have been expended by governments and the private sector on this issue, possibly at the expense of other resource requirements.

Is there scientific evidence that contaminated sites in B.C. have caused human health and ecological impacts? Without doubt, there has been evidence of human health risk due to contaminated sites, such as in cases where gasoline has entered sewage distribution lines and consequently into homes. Other sites with, for example, lead dust and free-phase coat tar pose potential risks particularly if human exposure was to occur. The frequency of contaminated site causing ecological impacts is less evident and I am unaware of a contaminated site in B.C. which has unequivocally been demonstrated to have had an ecological impact. Are sites, which do or may cause human health or ecological effects, a minority? Obviously, there is a need to identify such sites. But does the regulatory net, which must capture sites of concern, also capture too many properties which have little, or no potential for any real effects?

On April 3, 1996, Dr. John Blatherwick, Medical Health Office of Vancouver, made another of his presentations, questioning the need to cleanup soils. He frequently states that the benefits of resources expended on contaminated sites would be far out-weighed by benefits which would be gained if those resources were expended on services, such as reducing traffic risks, improving education, etc.. Is he right? Is he wrong? Is he partially right? Similar questions exist in the minds of the public. During a panel meeting scheduled within the March workshop, Dr. Rubin of the U.S. EPA, related the findings of a scientific panel which was requested by the U.S. EPA to set priorities on 100 environmental issues. Dr. Rubin stated that Superfund sites (contaminated sites) ranked 97, well below issues such as global warming and depletion of the ozone layer.

It is therefore incumbent upon the Ministry to have an objective scientific review of issues relating to contaminated sites in B.C.. Does the science support the resources the Ministry already placed on this issue, and the resources which will be required by government, landowners and industry to implement the proposed regulation? Are the proposed standards too conservative and are too many sites subject to unnecessary investigation and remediation? Is the regulatory net too tight in its attempt to identify "real problem" sites? It is my estimate that financial resources expended towards the contaminated site issue in the past five years in B.C. are in the order of 100's of millions of dollars. This is no small sum.

Given the related huge financial impacts related to property values and remediation, these questions deserve a proper hearing.

There must also be the perspective that many of the contaminated site investigated in B.C. are contaminated because of "practices of the day", which were prevalent from 20 to 130 years ago. Have the contaminants, at such sites, already done their "damage"? Are the contaminants still bioavailable with potential for human health or ecological effects? Should such sites have lower priority? Supposedly, recent site contamination is limited to events such as tank leaks, spills and improper handling practices. There are other regulatory mechanisms to deal with such current situations. The scientific review should separately address historical contaminated properties and recent site contamination events.

2. *Science is likely being pushed beyond its limits in order to derive Province-wide legal standards for contaminated sites.*

To a reasonable extent, the standard setting process has worked for regulatory control of food, water, and air quality. Can a similar simplistic approach be used for contaminated sites? I suggest it cannot. If politicians, lawyers, accountants and others can only relate to "hard numbers" (and hence the perceived need for standards), I can only say that in the case of contaminated sites, they are asking for the impossible.

Science has struggled to predict ecosystem effects within water, which is a relatively homogeneous medium. However, regulators must still resort to toxicology tests and actual field environmental impact assessments to evaluate the real effects of any substance releases to a water

## SPECIFIC COMMENTS

To my understanding, standards in a regulatory context are legally enforceable, and in my view should therefore be legally and scientifically defensible. I know of no instance of legal challenges to B.C. regulations or standards. Assuming that such challenges are possible, which of the proposed "standards" could withstand intensive reviews to ascertain that the "standards" are both reasonable and reflect current scientific knowledge?

### *Human Health "Standards"*

The "standards" with best possibility for defensibility are the proposed human health protection matrix numerical soil "standards" and the drinking water generic numerical water "standards".

The soil "standards" are based on accepted and conservative human health risk assessment protocols. A brief review of the approach suggests that the assumptions are reasonable. Some "nit-picking" may be possible such as the use of child body weights in commercial scenarios, however I accept the judgements of the Contaminated Sites Soil Task Group (CSST) group with regard to the human health "standards".

The drinking water "standards" have been derived as guidelines by Health Canada. The Health Canada review process is thorough and multidisciplinary, and I accept the scientific validity of the guidelines derived for protection of human health. To my knowledge, this will likely be the first time the guidelines have been designated as "standards" in any Canadian jurisdiction.

A concern relates to the lack of soil standards for protection of industrial workers. I assume the Workers' Compensation Board (WCB) will adopt the CSST approach. If WCB does not, and chooses to use another model, what will CSST's response be?

### *Livestock Ingesting Soil and Fodder "Standards"*

The assumption used to derive the "standards" are conservative and appear reasonable. However, I am concerned about the sole reliance on Pul's document for toxicity information.

body such as a river or lake. For example, the 96-hr $LC_{50}$ bioassay remains the main test for compliance of discharges under the Fisheries Act. Chemical analytical data are used to support the toxicity test results.

A soil/groundwater system is much more complex. For example, a chemical dissolved in water is likely bioavailable (and easily measurable). However, a chemical in soil and groundwater is subject to an extremely complex fate process and bioavailability is much less predictable. There are many variables at a site (e.g., soil type, porosity, groundwater depth, etc.), and each may have a significant impact on fate and transport mechanisms, hence will affect the actual human health or ecological impacts. Science has come a long way in understanding complex fate and transport mechanisms of chemical in soil and groundwater. However, many site-specific factors must be accounted for, and a simplistic one-value standard applicable to all soils in B.C. is not scientifically defensible. At best, the regulatory mechanism can only "screen" soil/groundwater quality and direct the need for subsequent follow-up if the "screening values" are exceeded. In addition, I have a personal concern about hard numbers as "standards" because of the past history of misuse, particularly by the financial community, of previous soil and groundwater criteria in B.C..

It is therefore my professional scientific opinion that the requirement of Bill 26 to derive "standards" for contaminated sites is unreasonable, and pushes science to oversimplify complex real-life systems. At best, the proposal numerical "standards" which were derived on the basis of conservative assumptions, are "screens" and should only be used as such.

It is also noted that the standard setting process as defined by other jurisdictions, the National Academy of Science and the National Academy of Engineering, includes the necessity of documentation of scientific rationale for each proposed standard and evaluating socio-economics, best available technology, analytical capability and background concentrations. As indicated during the workshop, the socio-economic impacts of the proposed regulations have not been assessed. Documentation of scientific rationale for some parameters is not thorough.

B.C. Environment has essentially re-defined the word "standard" on its own terms, and in my opinion the B.C. "standards" differ from the context of environmental standards as derived and defined in other jurisdictions. Subsequently, in my text I will use quotations in reference to the B.C. "standards".

Wide ranges of toxicity values for various livestock are reported in Pul's document, along with a curious referencing system. The actual sources of toxicity information should be retrieved and evaluated.

***Environmental Protection - Toxicity to Soil Invertebrates and Plants***

The challenge facing the CSST group in deriving "standards" for this category is appreciated. The approach is bold (by combining plant and animal kingdoms) and indeed challenges any critics to propose alternative approaches.

However, I am concerned when poor correlations are used to derive "standards", particularly when there is minimal evidence of response - chemical dose relationships. For example:

- The regression correlation coefficient ($R^2$) for cadmium is 0.29 for non-lethal effects. In fact the no-slope plot of observed median non-lethal effects suggests that simplified response - dose relationships may not exist.

- The regression correlation coefficient $R^2$ for pentachlorophenol is 0.000179 for non-lethal effects. The database is obviously weak with the median $EL_0$-NL being greater than the $EL_{50}$-NL. In one case, the $EL_0$-NL for radish is 30 mg/kg PCP versus an $EL_{50}$-NL of 5 mg/kg, suggesting uncertainty in the database. Given that this "standard" will be the controlling factor for non-commercial sites without groundwater issues, more data is required. Possibly the PCP industry could undertake studies to provide the Ministry with a more appropriate database.

- The regression correlation coefficient $R^2$ for lead during one assessment ranges from 0.0186 for lethal distribution and 0.068 for non-lethal distribution. Correlations similar to cadmium are observed - i.e. no-slope in plots of median exposure concentrations versus effect (% response). A second assessment showed better correlation coefficients. The limiting "standard" for lead is for human protection, versus plant/invertebrate protection (i.e. the human health standard is more restrictive), and the issue of the correlations for lead are not as significant as for cadmium and PCP.

Correlations for other substances appear reasonable.

The CSST approach for derivation of the "standards" is novel, and at best the concentration limits should only be used as a "screen". Science includes visual observation and a basic site assessment should include at least a cursory overview of the ecosystem health of the site - e.g. do earthworms live in the soil? Do grass and shrubs grow? What happens if someone shows the presence of a viable ecosystem but in contravention of the numbers? Conversely, what if all "standards" are met, but the soil does not support any life?

Furthermore, there is no recognition of bioavailability. As noted previously many of the contaminated sites in B.C. are due to historical contamination and bioavailability of remaining contaminants may be minimal[1]. Additionally, several sites are contaminated with slag, sand blasting material and roofing grit - most of which are essentially vitrified and non-bioavailable. The issue of bioavailability is very significant in the proposed regulation.

The use of the soil invertebrate and plant standards for industrial sites is difficult for industry to accept. Even the simplest scientific observations at most industrial sites would suggest the likelihood of plant and invertebrate viability as minimal - due to aspects such as complete pavement, extensive activity such as log hauling, pipe storage, etc.. Industry should have no ability to contaminate to a certain level, but nor should it have to clean-up historical contaminants to levels for plants and invertebrates if such lands continue to be used for industrial purposes.

***Odour Protection***

The odour protection soil "standards" are based on mathematical models which assume factors such as: uniform distribution of contamination from soil surface to a specific depth; and uniform bulk density, porosity, organic carbon and moisture throughout the soil column. In reality, very few sites, particularly historically contaminated sites, could meet the conditions of the assumptions. The models are essentially being pushed to work outside of their limitations in order to derive "soil odour standards". The Jury model, for example, will not account for subsurface contamination covered by a layer of clean soil which, in reality, commonly occurs..

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[1] Alexander, M., 1995. How Toxic are Toxic chemicals in Soil. Environ. Sci. Technol. 29(11) 2713-2717.

The exercise of deriving soil "standards" for odour protection provides a very clear example of the practical limitations in requesting science to provide a "standard" which could be used at any site in the province of British Columbia. It would be more meaningful to actually measure concentrations of volatile substances at a site and to compare those measurements with the lowest odour threshold limits. The field study could be designed to accommodate a scenario such as overturning of soil. The measurements would furthermore account for background levels of volatile organics now commonly found in air of urban centres[2].

There is also the need to ascertain that human health risk is acceptable regardless of the odour threshold. Would, for example, the cancer risk be within acceptable limits if benzene concentrations in soil are at the odour threshold level?

Overall, it is my opinion that the task of deriving a Province-wide soil "standard" for odour protection is onerous and beyond the practical limitations of science. The proposed numerical values as standards are not defensible, and at best can only function as "screens".

*Water Standards*

The proposed water standards in Schedule 6 are of extreme significance to the regulation because:

- sites with groundwater or surface waters which contain concentrations greater than Schedule 6 "standards" may be designated as contaminated;

- the water "standards" are used within the chemical transport model to derive soil "standards" for protection of aquatic life and drinking water. The resulting numerical values are frequently the most restrictive soil standards within the matrix soil standards; and,

- remediation to Schedule 6 "standards" will be required.

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[2] Dann T.F. and D.K. Wang, 1995. Ambient Air Benzene Concentrations in Canada (1989-1993): Season and Day of Week Variations, Trends and Source Influences. J. Air and Waste Management Assoc. 45: 695-702

I recognize that the Ministry has responded to industry and Envirochem comments about the water "standards" and has enabled the concept of a ten-fold dilution factor for protection of aquatic life. This response is welcomed as it is more consistent with other Ministry discharge limits.

However, I still have concerns about the water quality "standards", in particular, those in Column II (Aquatic Life) of Schedule 6. The "standards" are based on the B.C. Environment ambient water quality criteria which:

- are subject to minimal, if any, peer review or review by affected parties;
- have little or no recognition of background concentrations;
- have little or no recognition of existing analytical capabilities; and
- are extremely conservative by frequent application of safety factors.

As an example, the B.C. Environment ambient water criteria for pentachlorophenol range from 0.02 to 0.3 $\mu$g/L (ppb). It is curious that other agencies, such as the International Joint Commission (IJC) and the U.S. EPA, which use multidisciplinary expertise, have derived ambient water quality criteria which range from 0.4 to 6.2 $\mu$g/L (ppb), and B.C. Environment has a criterion of 6 $\mu$g/L in stormwater from lumber treatment operations. A review of the scientific rationale indicates that B.C. Environment used a series of two conservative application factors to derive its criteria for pentachlorophenol. The approach is said to be verified by reference to a "no-effect levels" for PCP estimated by Niimi *et al.* A review of Niimi *et al's* scientific paper indicates that the investigators were not investigating "no-effect levels", but rather long-term uptakes of trace amounts of PCP. Reference to growth rates impacts quoted in the B.C. Environment Criteria are not scientifically supported in the paper of Niimi *et al.* Additionally, the "practical quantitation limit" for pentachlorophenol in groundwater is 5.9 $\mu$g/L[3], which is well above the Ministry criteria. Such information indicates why peer review is important.

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[3] Keith, L.H., 1991. Compilation of EPA's Sampling and Analysis Methods, Lewis Publishers, CRC Press, Boca Raton, Fl.

It is likely that it was the intent of the Water Quality Branch to only assemble all available scientific information and to suggest conservative criteria for the protection of "all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to water', as cited in the CCME 1995 Water Quality Guidelines.

It is also likely that the Branch anticipated further reviews, such as analytical capabilities, socio-economics, etc., before the criteria would be adopted as standards. Another example, is that of arsenic, which is adopted from the CCME guidelines. Typically, for most aquatic species, effect levels of arsenic occur at concentrations greater than 500 $\mu$g/L and most effect levels are in excess of 1,000 $\mu$g/L. The U.S. EPA reported an arsenic effect level of 40 $\mu$g/L on a frog species found in the southeastern U.S.. CCME, in its derivation of a water quality guideline, defers to a 1979 guideline recommended by Demayo *et al*, i.e. 50 $\mu$g/L. Retrieval of Demayo's document indicates little evidence for aquatic impacts at such concentrations and Demayo *et al* simply state, "The level of arsenic recommended for public water supplies (0.05 mg/L) is below levels of arsenic that have been shown to have no detrimental effects on aquatic organisms and thus should provide a safe level for aquatic organisms."

The direct adoption of such criteria or guidelines as "standards" without peer review of background information, and without knowledge of background concentrations and analytical capabilities, is unacceptable.

For the purpose of this regulation, the Ministry has responded by reviewing background concentrations and analytical capabilities for preparation of its Draft 4 standards. However, a review of site assessment reports prepared by Envirochem indicates that background concentrations of groundwaters may still exceed the proposed "standards" for copper, iron, manganese, and zinc at many sites despite the use of a ten-fold multiplier on the B.C. Water Quality Criteria for protection of aquatic life. A compilation of groundwater analyses for numerous B.C. sites will be provided by Envirochem for Ministry information.

Iron is included in drinking water guidelines as an aesthetic parameter not a health parameter. The aesthetic guideline is set at 0.3 mg/L to avoid iron staining of fixtures, etc.. In actuality, iron staining will occur somewhat above this level, usually above 0.5 to 0.6 mg/L, but the aesthetic guideline is set conservatively at 0.3 mg/L for guideline purposes. Adopting this number as a contaminated site standard for human health is a complete misinterpretation of the

purpose and intent of the drinking water guideline. Many regions of the Province have groundwater with naturally occurring iron concentrations at or above 0.3 mg/L. It would appear that much unnecessary effort and expense will be devoted to a parameter which is not a health parameter, particularly since the methodology for demonstrating background has not been clarified. This same argument can be made for manganese, which is also an aesthetic parameter (also for staining reasons), not a health parameter, and like iron occurs naturally above the drinking water guideline in many regions of the Province.

It is therefore unfortunate that Schedule 6 was somewhat "glossed over" during the March workshop. It appears that during the preparation of the draft regulation, the groundwater "standards" were given minimal attention relative to the soil "standards". This is exemplified in Draft 3 of the regulation whereby an upper numerical limit of 4 mg/L for calcium was erroneously assumed necessary for protection of aquatic life. The number was since removed for reasons of background concentrations rather than the recognition that the Water Quality Branch noted the concentration was essentially a lower value for protection from acid inputs. There are, therefore, reasons for doubts about the science of the Schedule 6 "aquatic life" standards, and every effort should be made to:

- briefly review the rationale for the B.C. ambient water quality criteria;
- assess the degree of conservatism in each criterion;
- further assess the background concentrations in B.C.; and,
- further assess real analytical "practical quantitation limits" in groundwater.

It is predicted that the groundwater "standards" will have a significant role in the assessment and remediation of sites. Due to the likely high costs associated with groundwater remediation and site depreciation, it is necessary to carefully review the proposed standards.

***Groundwater Modelling***

B.C. Environment compiled a groundwater transport model in which flow is assumed to be essentially one dimensional while "still incorporating the major transport and attention processes

affecting contaminant movement" (CSST, 1996). This model was used to derive matrix soil standards for protection of groundwater. A review of the proposed soil matrix "standards" indicates that for each of the six metals, the default (or most stringent) soil "standards" are always a result of the use of the groundwater transport model. The use of the groundwater transport model has also resulted in the most stringent of soil protection "standards" for pentachlorophenol and benzene.

The groundwater transport model is also significant in that it is to be used for the derivation of site specific standards. A proper review of the groundwater transport model is therefore of great significance in the evaluation of the scientific basis for derivation of standards.

During the workshop, I expressed numerous concerns about the transport model. I am not a groundwater hydrogeologist and to aid me in this written submission, I have sought the counsel and experience of Mr. Rick Guiton, M.Sc., P.Geo., who has 19 years of experience in contaminated site hydrogeology in British Columbia, and Dr. Ed Sudicky, Professor of Earth Sciences, University of Waterloo and the 1994 AGWSE Henry Darcy Distinguished Lecturer. Dr. Sudicky was retained by the U.S. EPA to evaluate groundwater models for use in the evaluation of contaminated sites. The following constitutes a joint statement of Mr. Guiton, Dr. Sudicky and myself.

**Re: Proposed Tiered Approach**

The simple, analytical transport model of Domenico and Robbins (1984) is used by B.C. Environment to develop generic soil matrix standards for a *fixed* set of input parameters such that a soil will be deemed contaminated if the calculated concentration in the discharging groundwater in contact with a receptor exceeds specific water quality criteria. The input parameters in this case are *not* site specific. The immediate problem with this deterministic approach is that there is a strong possibility that many sites will be unnecessarily deemed contaminated simply because of the values of the generic parameters that are input to the model. Such sites must then be subjected to a costly site specific assessment even though the sites may not be adversely impacting the environment. The second problem is that even after a site specific assessment is carried out and appropriate hydrogeological/chemical data have been collected, a technical expert is still constrained to using the simple Domenico and Robbins model even though it may not be applicable because of the restrictive assumptions upon which it is

based. Dr. Sudicky states, "As a University professor devoted to the training of technical experts in the area of groundwater flow and transport model development and application, I find it objectionable that experts conducting a site specific assessment who are trained with regard to the selection and application of the most suitable model, cannot do so."

The CSST documentation refers to a draft "Soil Screening Guidance, 1994" document produced by the US EPA and mentions that the EPA approach was used as framework. Dr. Sudicky was involved in the development of a model for use by the EPA Office of Solid Waste in regulatory decision making to determine if a contaminated site should be delisted. The EPA approach was very different in that a 3D model was developed and used in a probabilistic framework (meaning that all relevant input parameters were not fixed as the CSST has elected to do, but were allowed to vary probabilistically according to an extensive survey conducted by the EPA; allowable organic contaminated concentrations in the waste were thus selected based on the results of the probabilistic/risk-based modelling). The numerical model itself was much more sophisticated than the Domenico and Robbins analytical model in that variably-saturated flow and transport was simulated in the unsaturated zone, and flow and transport in the saturated zone was fully 3D. A description of this model is given by Kool, Huyakorn, Sudicky and Saleem (Jour. Contam. Hydrol., vol. 17, 69-90, 1994) and it is intended only for regulatory decision making (i.e., not for site specific analysis since site specific data would be required).

**Re: The Selected Transport Model**

The proposed model considers vertical 1D *steady-state* advective-dispersive transport in the unsaturated zone to the watertable, coupled with 2D areal, transient advective-dispersive transport in the saturated zone. The model is much more simple than the Kool *et al.* (1994) model mentioned above and has imbedded in it numerous assumptions and limitations. First, and perhaps foremost, the model will be applied to both organic chemicals and metals, with sorption being based on a Kd approach. Dr. Sudicky stressed the point that, "It is well known in the literature that the Kd approach is inherently flawed when applied to the problem of metals sorption because of the myriad of geochemical reactions that come into play during their movement in the subsurface." Second, the model ignores the dilution effect caused by the infiltration of "clean" water outside the source area and, in addition, neglects the process of vertical dispersion altogether. Essentially, the transport model is like a pipe (filled with soil) which extends from the source area to the receptor. This scenario is most unlikely. Another

difficulty is that the linking of the unsaturated and saturated zone "modules" may *not in fact be mass conservative* because the soil water migrating vertically downward must abruptly make a "right-angled turn" in the saturated zone where the flow is assumed to be constant and horizontal. The model currently assumes an arbitrary "mixing zone" at the unsaturated/saturated zone interface. The early stages in the development of an initial EPA model attempted to address this issue, and it was abandoned because of technical flaws. Clearly, this linking problem should not be present, and to resolve it requires a more sophisticated approach.

The following is a technical comment of Dr. Sudicky which I do not fully understand but I include it for the information of the Ministry: "I object to the fact that the longitudinal dispersivity value is taken to equal one-tenth of the travel distance (or distance to the receptor). While generic plots have appeared in the literature that attempt to relate dispersivity to scale, and we know that a scale effect exists theoretically, such empirical relations must be treated with great caution in a site specific context because it is the geological heterogeneity which controls dispersion. The empirical relation proposed by the CSST causes the dispersivity to increase without bounds with increasing distance which is not likely to be the case."

The last comment on the model is that it assumes that organic chemicals degrade according to first-order kinetics. This is also a major assumption in that aromatic hydrocarbons, and perhaps other halogenated organics, generally do not degrade in this way. For example, the degradation of aromatic organics depends very strongly on the presence or absence of oxygen (which serves as the electron acceptor in a biologically mediated reaction).

Given all of the above, it is not recommended that the proposed steady-state model be used in a site specific analysis given that most sites are considerably more complex than the model allows for. For site specific analysis, the technical expert investigating the site *must* be given the freedom to select the most appropriate model, including its dimensionality, which can best represent hydrogeological and chemical conditions at the site.

***Designation of "Contaminated Sites"***

During the brief isolated meetings of the Workshop Panel, there was considerable discussion and continued uncertainty as to when a site would be designated as "contaminated". It was our consensus, based on the wording of Section 9 of the regulation, that if a site did not meet any

of the generic numerical soil standards, the matrix numerical soil standards or the Schedule 6 water standards, then the site would not be labelled as "contaminated" because of the option of deriving site specific standards. Is this consensus correct?

The question of the panel was, "if the site specific standards are exceeded" will the site be labelled as "contaminated" even though a risk assessment approach is pursued? It appears so, because the Ministry associates risk assessment with risk management, hence the certificate of compliance would be conditional. Is this consensus correct?

Supposing the science shows risk management is not required. Such scenarios include:

- the presence of vitrified solids (such as roofing grit and sand blasting material) where bioavailability is likely close to "zero"; and,

- by use of 2 and 3 dimensional groundwater transport models, it is proven that the groundwater standards at the receptor are within acceptable limits.

Will then any of the above sites be labelled as "contaminated" even in the presence of scientific evidence to the contrary?

*Use of Generic Numerical Soil "Standards"*

It will be important to phase out Schedule 4 as soon as possible because there is limited or no known scientific rationale for the numerical values. In the immediate term, however, barium should be listed as barium (hot water soluble), as per WCB analytical protocols. Insoluble barium salts, such as barium sulphate, are orally ingested by patients prior to gastrointestinal radiography. Therefore, the "standards" should not refer to total barium.

## CONCLUSIONS AND RECOMMENDATIONS

1. B.C. Environment has been confronted with a massive and difficult task. To place the task in perspective, the International Joint Commission (IJC) developed 26 water quality objectives for the Great Lakes in a two year period followed by a six month hearing and review process, prior to submission of final recommendations. The 1975-77 effort was supported by no less than two full-time individuals and extensive participation by individuals from thirteen (13) regulatory agencies.

   B.C. Environment has developed matrix standards for sixteen (16) substances for nine (9) exposure scenarios in addition to water quality. B.C. Environment's effort since August 30, 1994 could be stated as approximately six-fold greater than the IJC effort and is an example of the dedication by the Contaminated Sites Unit in Victoria.

2. Given the diverse geological/hydrogeological/climate settings of British Columbia, there is very little justification for having one set of contaminated site standards based on conservative input parameters which are intended to be a worst case representation of one particular setting. Unless a regional and probabilistic approach to contaminated site standards is adopted, it is unjustified to employ the matrix numbers as contaminated site standards since many sites will unnecessarily be deemed contaminated. If one set of conservative numbers is to be employed, then these numbers should be used as screening numbers and possibly referred to as "Environmental Screening Standards". Such screening standards could then be employed to trigger site specific assessments. If the scale of the problem is small (ie. a small amount of contaminated soil), the owner should have the flexibility to adopt the screening standards as remediation standards if the cost of clean-up is obviously less than the cost of conducting a site specific assessment. I would have less problem with the regulation if the proposed numerical values were to be used as "screening standards" instead of "contaminated site standards".

3. The matrix numbers were calculated using analytical transport equations which are recognized as being appropriate for screening level analysis. Use of these equations for regulatory purposes (ie. to set contaminated site standards) is beyond the generally accepted purpose and applicability of the equations. It can also be stated that use of these equations to predict transport of polar or ionic substances (ie. metals) is a flawed and invalid approach which cannot be technically defended. The Ministry should not be requiring analysis of metals transport with these equations nor should consultants be employing these equations for analysis of metals transport as this would be considered below the accepted standard which the professional is required to meet. The analytical equations which the Ministry has introduced could be employed as an initial assessment tool for non-polar contaminants which may eliminate many sites under assessment however, other, more sophisticated, methods of analysis must not be precluded particularly for metals.

4. It is clearly a huge step forward to adopt the site specific assessment approach to contaminated site management. However, the consultant should be free to employ the most appropriate method of analysis to best characterize transport at the site and not be constrained to limited analytical equations.

   It appears that limited technical resources within the Ministry is a major motive for constraining site specific assessments to use of these equations. It is improper to legislate the use of simplistic or limited models, instead of improving technical expertise. There is a real opportunity to develop and improve the level of expertise within the Ministry and consequently within the consulting community. That opportunity will be lost with the present approach.

5. There is a need for a review of the proposed water standards prior to their use in the regulation. The standards have a major role in classifying sites, and furthermore have a major influence on soil standards. The basis of the B.C. Environment ambient water criteria should be reviewed in addition to background concentrations and real analytical capabilities, i.e. in terms of practical quantitation limits in groundwaters.

6. There should be a mechanism for provision of site-specific scientific information which would be out of the realm of a final stage risk assessment as defined in the Regulation. Such information could include:

- assessment of soil invertebrate and plant life at a site as an alternative to the "standards" derived for protection of soil invertebrates and plants;
- actual air monitoring data for volatile compounds as an alternative to "standards" derived for protection from odour;
- more sophisticated numerical and speciation modelling to truly assess chemical transport in groundwater systems in place of the proposed analytical transport model; and,
- bioavailability for use in assessment of human health impacts via ingestion and for assessment of toxicity to soil invertebrates and plants.

To state that such information can only be incorporated with a risk assessment for which the Ministry will charge up to $28,000.00 for review is unfair to a landowner.

7. A technical advisory panel should be formed and used by the Ministry to advise on complex issues, such as transport modelling.

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April 3, 1996

M. M. Dillon Limited
130 - 10691 Shellbridge Way
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V6X 2W8

**Attention:** **David J. Clark**
**Regional Manager**

**COMMENTS IN RELATION TO THE MARCH 20 - 22, 1996 CONTAMINATED SITES REGULATION FRAMEWORK OF STANDARDS REVIEW WORKSHOP**

Dear Sir;

As requested at the end of the workshop, I have provided the following comments, on behalf of UDI, in regard to the presentations, other discussion, and our opinions on certain matters related to the contaminated sites policies, regulation and legislation that arose during the course of the workshop. At the outset, We would like to thank BC Environment and the Ministry of Health for providing the opportunity for expert review of the proposed standards and our participation in that review. The three days of the review were very intense and worthwhile. The presentations by the ministries and the ensuing discussions were thoughtful and demonstrated an understanding of the technical issues raised in relation to the proposed standards as well as a willingness to discuss and consider other matters that arose during the workshop. It was also clear that the changes to standards and the regulation responded to concerns identified as part of the stakeholder review of Draft 3 of the regulation. We applaud the proposed changes and believe that they substantially improve the standards and regulation. In addition, we regard the recognition that most contaminated sites have had histories that cause them to no longer be pristine or unaffected by activity and agree with this recognition in the policy and procedure of setting standards.

Following are my specific comments arising from the workshop. These comments are largely those provided during the course of the workshop.

Sites should not be identified as contaminated during the course of investigations to determine their status. The labelling of a site as being contaminated has a significant effect on the value of that property. Any designation of being contaminated should be assigned only after the various options of determining standards for the site that are available to the owner are completed.

The determination of site specific standards should allow the use of several models and other testing to determine mobility and bioavailability of substances at the particular site. Such work would provide much needed scientific information at no cost to the provincial government and could be used in future evaluation of standards and processes established in the regulation. This process would also go a long way in the establishment of "reality checks" for substances found in the soil. The modelling of metals in groundwater as proposed in the method for establishing soil site specific standards is questionable. Modelling of this process is extremely difficult and should allow latitude on the part of the owner to determine the most appropriate method of arriving at soil standards.

Our experience in site investigations since the introduction of new groundwater criteria in July, 1995 has been that most sites examined fail the criteria in either iron, manganese, or aluminum or all of these parameters. The standards, including the revision presented at the workshop do not alter the failure of most sites for the above parameters. We would be willing to share data with BC Environment to assist in the evaluation of these or other groundwater parameters.

An effort needs to be made by BC Environment to reconcile groundwater standards with other provincial discharge standards. Site specific standards should also allow the principle of mixing zones as allowed in other BC Environment regulations.

The bioavailability and mobility of substances, particularly metals, needs to receive considerably more evaluation. I know that BC Environment has committed to providing analytical protocols for the determination of bioavailability analytically, however I would encourage the allowance of the use of other procedures as well. These other procedures could be employed at the site specific standards stage of an investigation as described above. These latter data would be invaluable in the development of real world or reality checks as discussed above and in the workshop.

Odour standards have been introduced as a mandatory standard in matrices for some substances. There was considerable discussion about the models used to derive these standards and there was an alternate model proposed that had been developed by USEPA to model odour during the course of an excavation. This latter model seemed, from the discussion that ensued, to more appropriately model the incident that was attempting to be protected against. I would recommend the consideration of that model in the establishment of the odour standards in the regulation.

It is also apparent that a number of protocols are yet to be developed for the regulation. These protocols will be critical in the implementation of the legislation. I would encourage BC Environment to continue the consultation process on these very important documents as they are developed.

The standards in the regulation refer to NAPL in the soil. Some additional clarification/guidance would be useful.

It was stated by BC Environment during the course of the workshop that background values of substances would be determined at sites where activities had occurred by the concentrations of substances in the disturbed areas. For example, the concentration of metals in a tailings pond at a former mine site would establish the background for the site. This is a significant statement and needs confirmation.

With the implementation of Bill 26 it will be important to provide training to regional staff and others involved in the process on the interpretation of the bill and regulation to avoid different interpretations of the legislation. I encourage BC Environment to provide this training upon implementation of the legislation.

I would encourage a periodic review of the regulation and standards. This review should be more frequent near the implementation of the regulation and would be required on a less frequent basis with time. It would be advisable to establish a joint BC Environment and stakeholder review panel to assess the performance of the regulation and recommend alterations to the regulation based on new scientific information or performance of the process.

UDI would appreciate having the comments from the panelists being made available to all of the panelists. In addition, UDI would appreciate feedback from BC Environment regarding the inclusion of comments into the draft regulation or standards, that is what changes are being made to the regulation in response to the comments. While it would be informative to have specific responses to comments it is more important to make any needed changes to the regulation and standards and proceed with the implementation of the legislation.

UDI appreciates the opportunity to contribute to the further evaluation and finalization of the regulation and looks forward to the implementation of the legislation. If any clarification of the above comments are needed please contact the undersigned at 681-1672.

Yours very truly,

**NORECOL, DAMES & MOORE, INC.**

per: J. G. Malick

J. G. Malick, Ph.D.
Manager, Western Canadian Operations

cc: Sophie Megalos, UDI

ipsco inc.



8 April 1996

File No.: 10-047-14-BCM-M

Mr. D. Clark, M. Sc., P. Eng.
Regional Manager
M.M. Dillon Limited
130 - 10691 Shellbridge Way
Richmond, BC
V6X 2W8

Dear Mr. Clark;

**RE: B.C. Contaminated Sites Draft Regulations Numerical Standards**

Thankyou for the invitation to the panel for the review of the above. B.C. Environment, Lands and Parks is to be commended for their efforts to make the bases for the Standards transparent. This will help immensely to arrive at credible criteria for soils. It should be continued in the development of the protocols related to the Regulation.

Per the Mar. 16 - 18/96 discussions of the Draft 3.1 B.C. Contaminated Sites Regulations soil quality standards, attached are the points which it is suggested be addressed to allow that portion of the Regulation to reasonably proceed. The changes suggested are not to be construed to mean that we should continue with the July 15, 1995 adoption of the $CMCS_6$ criteria as the standards under the Waste Management Act.

Should you have any questions regarding the attached, please call (306-924-7483).

Sincerely,

IPSCO Inc.

R. J. Schutzman
Director, Environmental Affairs

cc: L. Hubbard, D. fast
Attach.

P.O. Box 1670 Regina, Saskatchewan, Canada S4P 3C7, Phone: (306) 924-7700 Fax: (306) 924-7500

1. For a risk control scheme to be appropriate, it is difficult to 'scientifically' justify simple 'look-up' values as applicable across the entire province, because of its diversity. (Thus, for example, Superfund rejected U.S.-wide soil values.) It is acknowledged that B.C. Environment, Lands and Parks (BCELP) has now proposed a set of standards which will be much more flexible and adaptable than those of the Canadian Council of Ministers of the Environment (CCME) or many other provinces which have only single criteria values for a given land use and chemical parameter. Recognizing that there are limitations if one wishes to maintain relative administrative simplicity/effectiveness, it would likely be helpful to add at least a layer of categories for soil type or soil/geologic zones. Other layers which might be considered in addition to that include:
    - soil organic content ranges
    - soil Red.-Ox. state ranges
    - ecological zones

2. Given the large data gaps, especially in the knowledge of the background ecological status and toxicology information relative to varied soils, there should be a requirement in the Regulation for BCELP to review and expeditiously update the standards every five years, perhaps for the next 20 years. During the intervening periods, BCELP and other stakeholders should be working cooperatively to fill these gaps. This effort should focus on field-based 'real world' measurements rather than laboratory or theoretical studies. Field bioassays are particularly needed.

   It is recognized that BCELP may need a mechanism to force heavily contaminated, higher risk sites to be redressed. The Regulation could include a section allowing BCELP to require the evaluation of a site(s) against the criteria, within a reasonable time-frame, if they have reasonable and probable grounds to believe that a site(s) is (are) in that category. If the site owner(s) did not complete the required evaluation within a reasonable time, then the Regulation could allow for BCELP to complete it and recover the costs from the site owner(s).

3. Section 9 of the draft Regulation should be revised to allow that a site will not be officially designated as "contaminated" until after it is evaluated to the owner's level of choice. (In the interim, a site could be classified as 'under evaluation'.) This will help to address the generalization of the science in providing simplified 'look-up' values for the generic/matrix screening standards. It will also avoid many of the liability and real estate costs which would otherwise be attached to a 'false positive' designation of a site as 'contaminated' while 'site-specific' or 'risk assessment' evaluations are done.

4. The flexibility of the 'site-specific method of establishing standards should be increased. This should especially include allowances, perhaps through the Director's

discretion, for the use of more applicable or sophisticated groundwater models and/or ecosystem surrogate measures. This would allow for improved science through implementation.

It should be recognized that most land owners will prefer 'clear title; i.e., a Certificate of Compliance (CoC) will be more often needed than a Conditional CoC. Therefore it will be necessary to create a system where it is not often requisite to go beyond the 'site-specific' or even the 'look-up' values, as the only method of escaping excessively conservative control values.

5. The analytical, sampling and statistical evaluation protocols for implementing the regulations need to be prepared as soon as possible. Early completion of these will also provide feedback into the process of review and revision of the standards. Such guidance documents should also include details of the choices of pathways to be considered in risk evaluations.

6. The key parameters and assumptions (e.g. bioavailability =1, conservative to use total parameters from 'background' groundwater data to check on the reality of dissolved parameter standards, Kd values, etc.) used in the models should be evaluated and a list prepared which shows a ranking and value for the degree of effect (e.g. for average and worst case values) upon the model outputs. Uncertainty levels for risk control factors (e.g. uncertainty factors, application factors, etc.), used as the basis for each standard, should be explicitly stated. These risk level statements and sensitivity analyses will help to provide guideposts for the site-specific and/or risk assessments parts of this risk management exercise.

   Since it is known that bioavailability is less than 1, we should initially estimate it in that range. This could be started by choosing a value based upon a literature search, and updating it later as better data become available.

7. If 'capping' is used to avoid setting standards below background values, the same percentile values should be used for soil values as for groundwater values. To be a practical management tool, the system cap levels should be set to generate very few or no false positives and perhaps a few false negatives; e.g. 10 false positives of 245 soil values is too many. The concern is compounded by the lack of much data.

   It is suggested that a capping margin of 3 (rather than 2) standard deviations from the mean background values be used. Discomfort with the generality of this could be reduced by increasing the data set and partitioning it appropriately (see item no. (1) above). For consistency, the same margin protocol should be applied to sets of soil test data being used to measure against the standards, i.e. the same confidence interval for the sample group used to determine a pass/fail for the statistical population being tested.

8. It will be important for mixing zone allowances for groundwater flowing to surface waters to yield results consistent with current standards for other discharges to surface water, including for Schedule 6 to be consistent with the Schedule for discharges from Special Waste facilities.

9. Sections 34 and 35 and Schedule 7 apply the strict control of a residential generic standard (Col. II) or most strict of the industrial standards (Col. IV) to trigger soil transfer agreements. This needs to be changed to not trigger for other scenarios that would be allowed under Schedules 4 and 5 for a receiving site, nor for a site-specific criteria developed for a receiving site. This would provide consistency and avoid 'red tape', putting responsibility on soil movers to adhere to the quality criteria that would be applied to a receiving site according to its zoning, in straightforward cases where detailed risk assessment was not being used.

   The Regulation should also clarify that soil sent to an area controlled to specific use such as a mine tailings area, and which is of equal or better quality than the controlled area, would not 'contaminate' the area per se. Neither should a transfer agreement be required for such soil movement.

10. The protection of ecosystem integrity should be a 'big picture' exercise. The Regulation should recognize that some commercial/industrial use of sites may validly remove them from the productive ecosystem (e.g. in city interiors), and allow for such to be exempted from ecosystem protective standards. It would be better to focus the ecosystem protection efforts upon wider zones such as an aggregate of adjacent sites, (remember that the size of a "site" is highly variable, and not controlled by the Ministry), river shorelines or ecologically reserved areas, than to force the soil standards to protect surrogate organisms at all sites. Further, the use of total chemical parameter values, (estimated with tenuous models to be protective of a particular soil organism assumed to be a representative surrogate for ecosystem health), as control standards is not a very good tool for the task. Better for the job would be such parameters as species diversity indices, total productivity, respiration values and the presence/abundance of appropriate indicator species.

11. The renewal of the CCME values, which are 'no effect' concentrations with large factors of safety, is scheduled to begin in 1996. They made the following statement in their 1993 - '94 report on the National Contaminated Sites Remediation Program:

> "The Interim Canadian Environmental Quality Criteria for Contaminated Sites provide the current generic criteria for use under the .... Program. However, many of the interim criteria for soil are not yet supported by complete scientific rationale and require an improved scientific derivation basis for application in this program."

The development and discussion of some of the current draft Regulation standards has shown the lack of good data and methods with which to arrive at soil chemistry parameter values which would be practicable in respect of protecting biota, or of reflecting soil and groundwater interactions. It is therefore suggested that for such parameters it would be better to retain the current models and draft standards as guidelines and enter 'NS' values in the Regulation for the interim, until the effort is made to increase the scientific data and improve the models upon which they are based. It is important to recognize that the use of a 'NS' value does not represent a failure; rather, it is an honest statement of the current level of knowledge, and will fit well to the revision approach noted in item no. (2) above.

12. There must be an intensive effort made in upcoming years to obtain much more field empirical data upon which to base our soil standards and evaluations. The effort should be focused in areas where support data for the proposed criteria is thin. The information needs to represent varied soil types/zones, ecological zones and meteorological regimes. Parameters for evaluation should include:
    - all soil chemistry, chemical state (e.g. pH, Red.-Ox., etc.) and content (e.g. organics, clay/silt/sand, etc.) parameters
    - all groundwater chemistry parameters
    - ecological parameters
    - biological uptake factors

    The work should document actual background data through field measurements, and integrate data which is in files for environmental impact assessments. Supplemental information could be solicited from consultants' and University files. Data from other places should be assembled as well (e.g. Ab. environmental impact assessments, clean-up of the zinc processing facility at Palmerton in the U.S.A., etc.).

13. Section 12 of the Draft Regulation should be revised so that it will not create Special Waste soil. This Section should rather only exempt soils from becoming Special Waste.

14. The soil ingestion pathway should only be used in analyses if the soil is at (or within, say, 1 m of) the surface to enable ingestion, or likely to become so.

15. It appears that the odour control values should be based upon an excavation type of model, and checked against field data. The inclusion of these values does not seem urgent. Further, we should consider carefully whether and why we would protect the most sensitive olfactory receptors versus not acting on some odour complaints. Perhaps these values should be used as screening, rather than classification criteria.