
Ministry of
Environment and
Climate Change Strategy

# PROTOCOL 1
# FOR CONTAMINATED SITES

## Detailed Risk Assessment

Version 2.0

Prepared pursuant to Section 64 of the
*Environmental Management Act*

Approved: _____ _____

Director of Waste Management — Date

## 1.0 Definitions

Terms defined in the *Environmental Management Act* (EMA) and the Contaminated Sites Regulation (CSR) apply to this protocol, with the addition of the following:

"**acceptable risk**" means a level of exposure to contaminants which does not produce unacceptable risk.

"**bioaccumulation**" means the progressive increase in the amount of a substance in an organism, or part of an organism, which occurs because the substance's rate of intake by an organism exceeds the rate at which the organism is able to degrade or eliminate the substance.

"**bioaccumulation factor**" [**BAF]** means a number that is:
(a) assigned to a substance to measure bioaccumulation;
(b) calculated as the ratio of:
    (i) the concentration of the substance in an organism, to
    (ii) the sum of concentrations of the substance in environmental media and food; and
(c) is supported by a detailed rationale showing that the chosen factor represents best available science and is appropriate for relevant species and the site conditions including factors such as soil or water pH, hardness, range of concentrations.

**"bioaccumulative substance"** means a substance in which:
(a) the logarithm (base 10) of the octanol-water partition coefficient (log Kow) is greater than or equal to 4.5, or the Bioaccumulation Factor is greater than or equal to 2000, or the Bioconcentration Factor is greater to or equal to 2000; or
(b) the substance is determined by best professional judgment of the qualified professional preparing a report to potentially cause bioaccumulation based on relevant scientific information.

"**bioconcentration**" means the process leading to a higher concentration of a substance in an organism compared to the concentration of the substance in the aquatic environmental media to which the organism is exposed.

**"bioconcentration factor" [BCF]** means a number supported by best available science that is:
(a) assigned to a substance to measure bioconcentration;
(b) calculated as the ratio of:
    (i) the concentration of the substance in an organism, to
    (ii) the sum of concentrations of the substance in aquatic environmental media; and
(c) is supported by a detailed rationale showing that the chosen factor figure represents best available science and is appropriate for relevant species and the site conditions including factors such as pH, hardness, range of concentrations.

"**biomagnification**" means the incremental process within a food chain by which progressively higher contaminant concentrations are attained in organisms located at respective higher trophic levels in the food web.

"**complete exposure pathway**" means an exposure pathway for which all of the following five elements are present:

(a) a source of contamination;
(b) an environmental medium, and a transport mechanism for the contamination, such as movement through groundwater;
(c) a point of exposure for the contamination, such as a private well;
(d) a route of exposure to a receptor, such as drinking, and
(e) the presence of a receptor to be exposed.

"**conceptual site model**" means a written description and/or an illustrated diagram of the biologic, geologic, hydrogeologic, and environmental conditions of a site as it relates to actual or potential exposure to contamination which identifies all potential receptors and complete or incomplete exposure pathways for all contaminants of concern.

"**contaminant of concern**" means a substance that is present in media at a site at levels that exceed generic numerical standards prescribed for that media and the applicable land, water, vapour, and sediment use for the purposes of the definition of contaminated sites in CSR s. 11, typically documented in the DSI or other investigation reports.

"**contaminant of potential concern**" **[COPC]** means any chemical for which the maximum concentration exceeds the appropriate screening benchmark (e.g., guideline and/or standard) in a risk assessment.

"***de novo* toxicity reference value**" or **[*de novo* TRV**] means a toxicity reference value (TRV) that has a) been calculated by a qualified professional using an established procedure or method, and b) not previously been published by a regulatory agency.

"**detailed risk assessment" [DRA]** means an ecological risk assessment and/or human health risk assessment carried out in accordance with this protocol and Protocol 20 that provides a systematic and detailed evaluation of potential adverse effects and related risks on human health and/or ecological health resulting from exposure to contaminants in environmental media.

"**detailed risk assessment report**" means an environmental risk assessment report as referred to in section 18 and 18.1 of the CSR that includes both ecological risk assessment and human health risk assessment that is prepared in accordance with this protocol based on a detailed risk assessment.

"**ecological risk assessment**" means an assessment that quantitatively evaluates the actual or potential impacts, hazards, or risks of contaminants on biota other than humans completed in accordance with Protocol 20 and this protocol.

"**ecosystem services**" means the processes and conditions by which humans benefit from the natural or engineered ecosystems around us.

"**effect concentration on x% of organisms (ECx)**", the concentration of a substance causing a specified effect to a percentage of the organisms exposed.

"**engineering control**" means a risk management measure for controlling risks to human health and the environment resulting from exposure to substances at a site by the use of a technology that: (a) controls or contains the migration of a substance, or (b) prevents, minimizes or mitigates the release of a substance, and includes, without limitation: soil, sediment caps, solidification methodologies, chemically reactive barriers, impermeable artificial covers, surface water dikes, trenches, leachate collection systems, water treatment systems, vapour barriers, ventilation covers.

"**exposure pathway**" means the pathway through an environmental media by which a contaminant is conveyed to a receptor.

"**food chain modelling**" means the quantitative estimation of the dose of contaminant received due to bioconcentration, bioaccumulation and biomagnification by each member of a food chain.

"**human health risk assessment**", a quantitative appraisal of the actual or potential impacts, hazards and risks of contaminants to humans.

"**incremental lifetime cancer risk" [ILCR]** means an estimate of cancer risk from exposure to a substance through a specific exposure pathway.

"**institutional control**" means a risk management measure for controlling risks to human health and the environment from exposure to substances at a site or parcel by the imposition of legal or administrative requirements that (a) limit the use of soil, water, sediment, vapour or a resource at the site or parcel, or (b) limit access or exposure to substances at the site or parcel; and include, without limitation, fences, signs, easements, covenants, zoning restrictions, contingency or emergency response plans or actions, orders, notices in records, and notifications to persons and government agencies.

"**intrinsic control**" means an inherent feature at a site or parcel which without the use of engineering or institutional controls, controls risks to human health and the environment from exposure to substances and includes, without limitation (a) a natural physical barrier, and (b) an inherent feature which modifies (i) the physical, chemical or biological behaviour or properties of a substance, or (ii) the environmental media in which a substance is contained.

"**maintained watercourse**" means a constructed ditch or constructed pond that:

(a) conveys irrigation water on agricultural land,
(b) contains, conveys or treats effluent, or
(c) conveys, drains or stores storm water or surface water on agricultural, residential, commercial, or industrial land;

unless the constructed ditch or constructed pond:

a) has been designated as critical habitat for aquatic species at risk under the Canadian *Species at Risk Act*, or

b) constitutes sensitive habitat for designated endangered or threatened aquatic species under the B.C. *Wildlife Act*.

"**potential contaminant of concern**" [**PCOC**], any contaminant which might be expected to occur at a site based on the historical use of the site, whether or not that substance has been measured in any environmental medium or determined to exceed the numerical standards of the Contaminated Sites Regulation (CSR).

"**qualified professional**" [**QP**], a person who (a) is registered in British Columbia with an appropriate professional association, acts under that professional association's code of ethics, and is subject to disciplinary action by that professional association, and (b) through suitable education, experience, accreditation and knowledge may be reasonably relied on to provide advice within their area of expertise.

**"receiving environment"** means any air, land, water, sediment (including porewater), wetland, or muskeg containing receptors, excluding artificial watercourses or impoundments that are maintained and whose primary purpose is to convey or contain storm water or treat and convey effluent, or natural water courses in circumstances approved by the director.

"**receptor**" means a living organism that may be exposed to a substance.

"**risk-based standards**" means the standards prescribed in CSR sections 18 and 18.1.

"**risk control**", an institutional control, intrinsic control, engineering control or monitoring which exists or is implemented to mitigate, eliminate or observe risks from the exposure of humans, animals and plants to contaminants.

"**screening benchmark**" is the concentration of a substance in a particular medium, above which that substance is identified as a COPC for the purpose of conducting a risk assessment. This concentration is identified by the risk assessment based on site-specific characteristics and can be selected based on regulatory standards or guidelines, toxicity effects levels, or background concentrations.

"**screening level risk assessment**" [SLRA], a screening level risk assessment and report made in accordance with Protocol 13.

"**sediment porewater**", the interstitial water within the uppermost 1 metre of sediment within an aquatic receiving environment.

**"sensitive habitat"** includes**:**
(a) national, provincial, regional and municipal parks;
(b) sensitive ecosystems identified by Federal, Provincial Sensitive Ecosystem Inventories, or local governments;
(c) habitat supporting red and blue listed species identified via B.C. Species and Ecosystem Explorer;
(d) habitat used for sensitive sediment use as defined in the Contaminated Sites Regulation; or
(e) riparian assessment areas as defined in the Riparian Areas Protection Regulation.

"**species at risk**", an extirpated, endangered, threatened species, or a species of special concern as designated under the authority of the B.C. *Wildlife Act* or Canadian *Species at Risk Act.*

"**terrestrial habitat**" means land on any part of the contaminated site (the source parcel or the off-site affected parcel(s)) that satisfies any of the following conditions:

(a) the agriculture, wildlands, or urban park land use classification applies;
(b) contains terrestrial sensitive habitat;
(c) contains over 50 $m^2$ (where residential land use applies at the site) or over 1,000 $m^2$ (where commercial or industrial land use applies at the site) of contiguous undeveloped land; or
(d) lies within 300 m of sensitive habitat where residential, commercial or industrial land use applies at the site.

"**toxicity reference value**" [TRV], means a maximal estimate of exposure to a substance which would not elicit an unacceptable adverse toxicological effect in an organism, including without limitation: acceptable daily intake [ADI], benchmark dose [BMD], cancer potency slope factor [CPSF], ecological soil screening level [Eco-SSL], lowest observed adverse effect level [LOAEL], minimum risk level [MRL], no observed adverse effect level [NOAEL], reference dose [RfD], reference concentration [RfC], risk specific dose [RSD], tolerable daily intake [TDI], tumorigenic concentration 05 [TC05], tumorigenic dose 05 [TD05] and unit risk [UR].

**"unacceptable risk"** means either:

(a) a combination of contamination and complete exposure pathways that result in levels of human health risks exceeding levels specified in CSR sections 18(1) (3) or (5), 18.1(1) (4) and (5.1), or
(b) the existence of potential risks to human or ecological receptors (which will not be mitigated by implementation of the measures specified in a DRA) to levels:
    (i) for humans, where the cumulative hazard index is greater than or equal to one for all substances that share a common target organ or mechanism for toxicity;
    (ii) for ecological receptors, where the total of all effects of all contaminants on any receptor is exceeding the level of protection identified in Section 4.2, Table 1 for the relevant land and water uses.

**"undeveloped land"** means any bare or vegetated soil, excluding
(a) gravelled walkways,
(b) roadways or highways and associated roadside or highway margins,
(c) parking areas,
(d) soil contained and isolated in planters and similar structures, and
(e) storage areas at active commercial and industrial operations.

"**weight-of-evidence**", a structured framework approach for evaluating and assigning the relative or proportional contributions or weightings to each of multiple lines of evidence influencing the qualitative or quantitative estimation of risk or hazard in a risk assessment.

## 2.0 Introduction

### 2.1 Authority for and Purpose of this Protocol

This protocol is made under the authority of the Environmental Management Act (*EMA*) s. 64 (1)(c)(d) and 64 (2)(e),(f),(g),(h) and (o).

Consistent with *EMA* and the Contaminated Sites Regulation (CSR) this protocol:

1. establishes substantive and procedural requirements for persons conducting detailed risk assessment for the purposes of Part 4 of *EMA*; and
2. provides a mechanism for demonstrating no unacceptable risks exist or will exist in relation to a site and provide information required for the purposes of CSR s. 18 (6), 18 (7), 18.1 (5), 18.1 (6), 47 (2), 47 (3) and 49 (2) as applicable.

This protocol applies to the preparation and contents of ecological risk assessment and human health risk assessments conducted as part of a detailed risk assessment. Protocol 20, "Detailed Ecological Risk Assessment Requirements" (Protocol 20) establishes additional requirements for the ecological risk assessment component. The resulting detailed risk assessment report may be submitted as an environmental risk assessment report for the purposes of CSR s. 18 (6) or 18.1 (5).

Except where a Screening Level Risk Assessment has been completed in accordance with Protocol 13,"Screening Level Risk Assessment" (Protocol 13), an applicant for an Approval in Principle or Certificate of Compliance that is based on the site being remediated in accordance with risk-based standards must provide the director with a detailed risk assessment report.

Also, either a detailed risk assessment report, or a screening level risk assessment report, showing that no unacceptable risks will exist at a receiving site, must be completed and submitted in support of any application for a contaminated soil relocation agreement made in the circumstances referred to in CSR s. 43 (5).

### 2.2 Risk Assessment to Support Certificates of Compliance

Section 53 of the *Environmental Management Act* (*EMA*) authorizes the director to issue a Certificate of Compliance if various conditions are met. Those conditions include the contaminated site being remediated to numerical or risk-based standards. Risk-based standards are set out in the CSR s. 18, or 18.1 for substances and sources specified for an environmental management area.

CSR section 18 (6) also requires the applicant for a Certificate of Compliance that is relying on risk-based standards to prepare a detailed risk assessment report that identifies the potential on- and off-site environmental risks of substance causing contamination before and after remediation, and procedures designed to mitigate any significant potential risks. The director may then impose requirements to prevent or mitigate the identified risks. Requirements may be imposed through conditions in Certificates of Compliance, restrictive covenants on land titles and/or requirements to prepare Performance Verification Plans (see section 5.0 Risk Management). Remediation orders may also be used.

## 2.3 Risk Assessment as Remediation

It is not the intent of the EMA, the CSR, or this protocol to recommend risk assessment as a remedial strategy in preference of other options that may remediate a contaminated site permanently to the maximum extent practicable. Remedial strategies must be selected in accordance with EMA s. 56. Risk assessment is generally intended to address residual contamination on a contaminated site. Risk based remediation that does not provide a permanent solution to contamination should only be used where alternatives that provide permanent solutions are not practicable.

Two types of risk assessment may be used as a remedial strategy at B.C. contaminated sites. SLRA and DRA are discrete tools and cannot both be used in the same submission in a contaminated sites application under the CSR. For example, risk assessors cannot eliminate exposure pathways in SLRA and then initiate a DRA for remaining complete exposure pathways. The completion of a DRA requires that all exposure pathways be considered, regardless of whether SLRA has been previously completed. A DRA that ends at the problem formulation may be an acceptable risk assessment report submission.

This protocol and Protocol 20 contain requirements for DRA. For more information on SLRA refer to Protocol 13.

Remediation by way of risk assessment is considered complete when, based on a detailed risk assessment report, the director determines that there are no unacceptable risks present on the site.

## 2.4 Conditions for Selecting Risk Assessment as Remediation

To select risk assessment as a remedial strategy, at minimum the below conditions must be met:

1. A Detailed Site Investigation (DSI) must be completed and a DSI report prepared by a qualified professional (QP) according to *EMA* s. 41 and CSR s. 59.

2. The DSI must assert, in addition to the general requirements for a DSI,
   (a) that for each potential contaminant of concern, the horizontal and vertical extent of contamination has been delineated, and
   (b) that the contamination present at the site is stable or decreasing in concentration and extent in accordance with section CSR s. 59. The DSI must show stable or decreasing contamination in concentration and extent to demonstrate readiness for development of risk-based standards.

3. A QP must be responsible for all aspects of the risk assessment. Risk assessment is a systematic process that integrates toxicology, chemistry, ecology, statistics and modelling into an estimate of hazard or risk to organisms. To be considered qualified, a person and/or the team conducting risk assessment must have demonstrable expertise in these fields of science.

# 3.0 Environmental Quality Standards and Risk Assessment

## 3.1 Application of Risk-Based Standards

Two types of environmental quality standards apply at contaminated sites in B.C.: generic numerical standards prescribed in CSR Schedules 3.1 - 3.4, and risk-based standards. Risk-based standards pertain both to the protection of the environment (ecological health) and human health. The risk-based standards take the form of specified risk levels for human health risk assessments. For ecological risk assessments, the director requires evidence that any significant ecological risks have been mitigated to the point where they are no longer a significant potential risk. Human health and ecological risk assessment reports may be combined into one environmental risk assessment report that meets CSR 18 (6) and 18.1 (5).

Unlike numerical standards, risk-based standards cannot be used to determine if a site is contaminated. However, they can be used to confirm if a site has been remediated as per CSR s. 18 and 18.1.

## 3.2 Risk-Based Standards in the Aquatic Receiving Environment

This section describes how to specifically apply risk-based standards and B.C. Water Quality Guidelines to water, porewater, and sediment in the aquatic receiving environment. B.C. has Approved and Working Water Quality Guidelines (WQG) to protect water quality, biota, and sediment. WQGs must be considered in a risk assessment for submission of an application regarding a decision affecting water quality made within the ministry (Water Quality Guidelines Policy, 2019). WQGs apply in the aquatic receiving environment and ambient environment. The relationship to contaminated site compliance points and DRA is described below.

A detailed risk assessment report can demonstrate that no unacceptable risks to aquatic life exist or will exist by showing one of the following:

- the dilution of substance concentrations along the groundwater to surface water flow pathway results in concentrations less than the aquatic life standards in schedule 3.2 of the CSR at all depths that are at least 10 metres towards the source of contamination from the high water mark of any receiving environment;
- the dilution of substance concentrations along the groundwater to surface water flow pathway results in concentrations less than 1/10th of the aquatic life standards in schedule 3.2 of the CSR at all depths before the groundwater enters the aquatic receiving environment;
- groundwater quality meets a site-specific risk-based standard in a detailed ecological risk assessment with a protection level appropriate for aquatic receiving environments (i.e., protection levels listed in Table 1 in Section 4.0);
- substance concentrations are below B.C. Water Quality Guidelines at the location where groundwater with the highest contamination levels enters the receiving environment; or
- if substance concentrations in the receiving environment are above B.C. WQGs, then site-specific risk-based standards must demonstrate no unacceptable risks in a detailed ecological

risk assessment with a protection level appropriate for aquatic receiving environments (i.e., protection levels listed in Table 1 in Section 4.0).

Substance concentrations in the receiving environment and groundwater must be determined in accordance with Technical Guidance 15 "Concentration Limits for the Protection of Aquatic Receiving Environments", version 2.0 (Technical Guidance 15).

For sediment and sediment porewater, the detailed risk assessment report must either demonstrate that concentrations of contaminants do not exceed applicable numerical standards as set out in Table 2 of Technical Guidance 15, version 2.0, or alternatively use detailed ecological risk assessment to demonstrate that no unacceptable ecological risks exist. Detailed human health risk assessment must demonstrate no unacceptable human health risks exist when the exposure pathway is considered complete.

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| CSR numerical and risk-based standards apply on a contaminated site and B.C. Water Quality Guidelines apply in the aquatic receiving environment. Risk-based standards may be used for off-site migration to the aquatic receiving environment, if acceptable to the director. |

## 4.0 Risk Assessment Components

### 4.1 Overall

The complexity of the risk assessment must be related to the complexity of the contaminated site. A deterministic or probabilistic risk assessment may be used. When probabilistic methods are used, the ministry expects that rationale related to the selection of input parameter distributions and their applicability to B.C. will be adequately documented.

Sampling methodologies for the risk assessment must follow the ministry's B.C. Field Sampling Manual or any applicable protocols. The number of samples collected must be commiserate with the complexity of the site undergoing risk assessment. The number of samples must ensure a high level of confidence in any relevant toxicological, chemical, or statistical calculations in the risk assessment report including modelling.

Substances in environmental media samples analysed for the purpose of a detailed site investigation or other investigation made for the purposes of detailed risk assessment must be analysed:

(a) by a "qualified laboratory", as defined in the Environmental Data Quality Assurance Regulation.
(b) in accordance with B.C. Environmental Laboratory Manual.

For deterministic human health risk assessment, QPs must consider the following Health Canada documents:

- Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (2012)
- Part II: Health Canada Toxicological Reference Values (TRVs), Version 2.0 (2010)

- Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0 (2010)
- Part V: Guidance on Complex Human Health Detailed Quantitative Risk Assessment for Chemicals ($DQRA_{CHEM}$) (2010)
- Part VI: Guidance on Human Health Detailed Quantitative Radiological Risk Assessment for Chemicals ($DQRA_{RAD}$) (2010)
- Part VII: Guidance for Soil Vapour Intrusion Assessment at Contaminated Sites (2010),
- Interim Guidance: Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites (2013)
- Supplemental Guidance on Human Health Risk for Country Foods (HHRA Foods) (2010)
- Supplemental Guidance Checklist for Peer Review of Detailed Human Health Risk Assessments (HHRA) (2010)
- Supplemental Guidance on Human Health Risk Assessment of Oral Bioavailability of Substances in Soil and Soil-Like Media (2017)
- Supplemental Guidance on Human Health Risk Assessment on Contaminated Sediments: Direct Contact Pathway (2017)

For ecological risk assessment the ministry requires the use of Protocol 20.

## 4.2 Sections

The risk assessment report must be organized in consideration of, and include pertinent and comprehensive information related to, the following risk assessment components:

- problem formulation (see section 4.2.1)
- conceptual site model for current and/or future land, vapour, sediment and water uses (see section 4.2.2)
- exposure assessment (see section 4.2.3)
- toxicity/effects assessment (see section 4.2.4)
- risk characterization (see section 4.2.5)
- uncertainty analysis (see section 4.2.6), and
- conclusions (see section 4.2.7).

### 4.2.1 Problem Formulation

**Overall**

All COPC-pathway-receptor combinations must be identified and described in the problem formulation component of the detailed risk assessment report. All relevant environmental media must be included.

**Contaminants of Potential Concern**

All COPCs must be listed in the problem formulation component of the detailed risk assessment report and a detailed rationale must be provided for each COPC not carried through to the risk assessment.

**Beneficial Use**

The QP conducting a detailed risk assessment must consider if any beneficial use scenarios apply as described in Protocol 13, "Screening Level Risk Assessment". If contamination caused by a beneficial use would be covered by the beneficial use exemption in Protocol 13, the problem formulation component of the DRA report must identify these (if any) eligible beneficial uses (including associated contaminants and contaminated media) including location and extent of contamination; and, despite anything else in this protocol, the QP is not required to consider ecological or health risks associated with the beneficial use.

**Pathways**

The detailed risk assessment report must identify and provide scientific justification for what the QP considers (a) all relevant environmental media, and (b) the potential exposure pathways to receptors, taking into consideration requirements listed in Protocol 20 and guidance listed in Federal Contaminated Sites Action Plan (FCSAP) "Ecological Risk Assessment Guidance (2012)".

**Drinking water**

Where site contaminated water is used as a drinking water source, (i.e., where a current or future drinking water exposure pathway is considered to be complete or operative), the ministry expects the detailed risk assessment report to contain an assessment of risks and hazards associated with the drinking water pathway (including fully documented exposure risk calculations).

If the future drinking water exposure pathway is considered incomplete or inoperative (e.g., a municipal water supply is present as the main drinking water source, all site impacted drinking water wells have been decommissioned, or the risk management approach for the site is ongoing prohibition of use of site impacted water as drinking water), exposure risk calculations and associated risk estimates for the future drinking water pathway may optionally not be included in the risk assessment for the site. Note, as per CSR s. 18(6) and 18.1(5), which requires that calculations be provided before and after remediation, the director may require this information (CSR s. 52 (1)).

If the drinking water pathway is deemed incomplete and risk estimates are not provided, it is required that the risk assessment clearly state that "future drinking water risks were not calculated" and provide full documentation of the rationale by which the future drinking water pathway was determined to be incomplete or inoperative.

**Bioaccumulative Substances**

When a complete exposure pathway exists between a receptor and bioaccumulative substance, the potential for food chain impacts must be evaluated and quantified. Even when a substance is not

considered to biomagnify to higher trophic levels, food chain impacts from lower trophic level organisms must be evaluated. Detailed rationale must be provided if food chain impacts are not quantitatively evaluated.

A rationale must be provided when BAF and BCF values are cited in a risk assessment to ensure the BAF and BCF are appropriate for the site conditions. Site-specific BAFs and BCFs are preferred when the scope and complexity of the site allows.

**Human health pathway to subsurface media**

It is not required to include acute/subchronic exposures for subsurface (utility, trench, and construction) workers in quantitative human health risk assessments for CSR regulatory purposes. Worker health and safety is the responsibility of WorkSafeBC under the *Workers Compensation Act* and the Occupational Health and Safety Regulation. WorkSafeBC requirements must be met at contaminated sites. Operative chronic (> 90 days) occupational exposure pathways must be included for subsurface workers in risk assessments for CSR regulatory purposes.

**Inhalation pathway of exposure**

Worst case conditions for current and potential future breathing zone air for human health must be evaluated when vapour contamination is present at the site. Evaluation of the vapour pathway must be completed in accordance with Protocol 22, "Application of Vapour Attenuation Factors to Characterize Vapour Contamination" Version 1.0. In addition, QPs must follow Technical Guidance 4, "Vapour Investigation and Remediation" Version 2.

The inhalation pathway of exposure is not usually evaluated for ecological receptors unless site-specific conditions indicate that the pathway can be considered the primary exposure route for a population of a species, or if an individual of a rare and endangered species frequents or resides (e.g., burrows, hibernates) at the site.

**Receptor Identification**

Detailed risk assessments must identify all potential human and ecological receptors known, or reasonably inferred, to be present at a site, including uniquely sensitive or exposed human or ecological receptor subgroups such as:

- sensitive life stages (e.g., young and elderly people, pregnant women; egg and larval stages),
- vulnerable individuals known to suffer compromised health impacts (e.g., chemical hypersensitivity, impaired pulmonary function, immunodeficiency),
- uniquely exposed individuals (e.g., subsistence consumers such as Indigenous Peoples), and species at risk as per Protocol 20.

Rationale for site-specific inclusion or exclusion of any relevant receptor is required.

**Selection of Ecological Receptors**

Ecological receptors which are identified as being of cultural significance must be specifically addressed in accordance with any requirements set out by the director. Additional context can be found on the "Technical Guidance for Risk Assessors" website.

Ecological receptors must be selected based on the potential for their presence at the site. Protocol 20 requires the site be assessed for likely use by red and blue listed species. Aquatic ecological receptors must be assumed to be present in aquatic receiving environments. However, terrestrial receptors are only considered to be present when sufficient habitat is available, which must be determined using the habitat assessment procedure described in Protocol 13. The habitat assessment (including for habitat specific to red and blue listed species) must be completed by a Registered Professional Biologist whose area of practice includes demonstrable experience in the assessment of habitat.

When sufficient terrestrial habitat has been identified using the habitat assessment procedure for the site, a Registered Professional Biologist must decide on potential species to include in the risk assessment. Further consideration must be given to the Canadian government's Federal Contaminated Sites Action Plan (FCSAP) "Ecological Risk Assessment Guidance (2012)" to support specific species selection requirements.

**Selection of Human Health Receptors**

In human health receptor selection, QPs must include all relevant receptors and most sensitive life stages. When selecting human health receptors, QPs must follow recommendations in Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 (2012), except where the QP completing the assessment considers it inappropriate. Where the selection process deviates, the detailed risk assessment report must justify the variation.

### 4.2.2 Conceptual Site Model

The detailed risk assessment report must include a complete conceptual site model identifying all complete or incomplete exposure pathways for all contaminants of potential concern. It is recognized that these models may differ due to differences in the chemical, physical, and environmental fate and transport properties of the contaminants.

The ministry's website "Technical Guidance for Risk Assessors" lists guidance documents to support risk assessment at B.C. contaminated sites.

### 4.2.3 Exposure Assessment

**Overall**

- For every complete exposure pathway and receptor combination the DRA report must assess exposure, effects and risk as per section 4.2.

- Current and reasonable potential future land, sediment, vapour and water uses must be evaluated in both ecological and human health risk assessment.

- Contamination at the site must be adequately characterized to evaluate all identified receptors and exposure pathways.

- At a minimum, the detailed risk assessment report must specify how the exposure concentration used in the risk assessment was determined for each complete exposure pathway and receptor combination (e.g., identify whether the maximum or 95$^{th}$ percentile concentration of the contaminant in soil was used).

- A detailed field study must be completed at the site as described below.

**Human Health Exposure Assessment**

Evaluation of both non-carcinogenic and carcinogenic effects related to exposure to contamination at a site is a necessary component of detailed human health risk assessment performed under the *EMA.* Refer to Protocol 30, "Classifying Substances as Carcinogenic" (Protocol 30) for details on carcinogenic classification.

**Exposure Parameters and Scenarios**

The human health exposure assessment must:

1. consider Protocol 28: "2016 Standards Derivation Methods" (Protocol 28) as the default source of human health risk exposure parameters and scenarios;
2. consider whether site specific human receptors and their intake characteristics are appropriate; and
3. identify in the detailed risk assessment report any human receptor characteristics that are different from those identified in Protocol 28 and provide justification for the difference.

In additional to the requirements set out in Protocol 20, the ecological exposure assessment must:

1. consider and evaluate wildlife exposure factors, taking into account guidance published by FCSAP "Ecological Risk Assessment Guidance, Module 3: Standardization of Wildlife Receptor Characteristics", United States Environmental Protection Agency, California Environmental Protection Agency, United States Geological Survey, Environment and Climate Change Canada, and California Department of Toxic Substances Control.
2. consider whether site specific wildlife receptors and their intake characteristics are appropriate;
3. identify chosen wildlife characteristics; and
4. provide scientific justification for the chosen wildlife characteristics.

Ecological and human health exposure parameters specific to scenarios not presented in Protocol 28 are available from other jurisdictions and peer reviewed scientific literature. The ministry's website "Technical Guidance for Risk Assessors" provides some resources to evaluate additional exposure

parameters. Rationale related to the selection of these supplemental exposure parameters must be included in the detailed risk assessment report.

**Field Study**

A detailed ecological field study of the site must be completed.

In addition to the requirements in Protocol 20, the field study must:

1. be completed by a Registered Professional Biologist who has demonstrable experience in habitat assessment.
2. contain a seasonally appropriate sampling program to evaluate the target species of concern.
3. be included and documented in the detailed risk assessment report, including the rationale for selection of and use of all ecological surveys such as plant and/or soil invertebrate community analysis, birds, fish, and benthic community analysis (including methods, sampling locations and relevant seasonality, etc.).

Field studies must be designed to, as far as practicable, obtain data appropriate for exposure and food chain modelling, and to reduce uncertainty by measuring specific data, such as chemical concentrations, types of organisms inhabiting the area, and toxicity.

Soil in the top 1 m must be characterized with a high level of confidence to adequately assess exposure to ecological and human receptors. Where deep-rooting vegetation or burrowing animals are present, soil characterization beyond 1 metre may be required.

**Food Chain Models**

A detailed food chain model or other exposure model may be used to supplement the field study and to further assess substances found at a site. A food chain model must be completed at large or complex contaminated sites where habitat is present unless it can be show that concentrations in lower trophic levels are insignificant or other rationale can be provided. All exposure parameters used in the model must be referenced and explained.

#### 4.2.4 Effects Assessment

**Overall**

- Effects assessment may include TRV selection, biological considerations, and bioassays.
- The most appropriate human health and ecological TRVs must be selected based on criteria set out below.

**Human Health TRVs**

The HHRA report must identify and provide scientific justification for the most appropriate TRV. The ministry requires the consideration of human health TRV sources as listed in Protocol 28, Chapter 8 for

soil, water, and vapour, with the exception of those substances for which the ministry derived drinking water standards and where drinking water TRVs are provided in Protocol 28 Appendix 8C.

A detailed risk assessment report must:

1. identify potential TRVs;
2. consider whether site specific TRVs are appropriate;
3. identify a chosen TRV based on the following criteria:
   a) existence of a comprehensive and contemporary published science assessment on which the TRV is based,
   b) extent of supporting rationale and documentation pertaining to the scientific derivation of the TRV, and
   c) extent and rigor of scientific peer review provided for the TRV.
4. provide scientific justification for the chosen TRV.

In the case where no credible human health TRV can be found, a *de novo* TRV may be derived using an established procedure and based on the scientific literature related to the toxicity of the substance. The detailed risk assessment report must provide justification for derivation and selection of any *de novo* TRVs. For any derivation of a *de novo* TRV to support detailed risk assessment as remediation of a non-high risk site, QPs must submit a Protocol 6, "Applications with Approved Professional Recommendations and Preapprovals" preapproval application.

**Ecological TRVs**

Ecological TRVs (EcoTRVs) for each substance and ecological receptor must be selected with consideration for the best available science and obtained from a regulatory, peer-reviewed source. EcoTRVs must be equivalent to or more protective than the protection levels listed below in Table 1. The detailed risk assessment report must identify and provide scientific justification for the selection of each EcoTRV.

QPs must consider the following preferred sources of EcoTRVs:

Soil

- Canadian Council for Ministers of the Environment: Scientific Criteria Documents for Deriving Soil Guidelines
- United States Environmental Protection Agency: Interim Ecological Soil Screening Level Documents
- Oak Ridge National Laboratory: Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision; Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision
- Ontario Ministry of Environment: Rationale for the Development of Soil and Groundwater Standards for use at Contaminated Sites in Ontario, 2011

Water - Aquatic Life

- British Columbia Ministry of Environment and Climate Change Strategy: Approved and Working Water Quality Guidelines
- Canadian Council for Ministers of the Environment (CCME): Canadian Environmental Quality Guidelines
- Canadian Ministry of the Environment and Climate Change: Federal Environmental Quality Guidelines (FEQGs)

Sediment – Aquatic Life

- Canadian Council for Ministers of the Environment, 1999, Environmental Quality Guidelines: Scientific Criteria Documents for Deriving Soil Guidelines

Where EcoTRVs from the above preferred sources are lacking for a substance, the QP must consider the following supplemental sources:

- Oak Ridge National Laboratory: The Risk Assessment Information System, Ecological Benchmark Tool
- United States Environmental Protection Agency, Region 9: Biological Technical Assistance Group (BTAG) Recommended Toxicity Reference Values for Mammals and Birds
- Centre d'Expertise en Analyse Environnementale du Québec: Valeurs de Référence pur les Récepteurs Terrestres
- CCME: Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota

The most stringent applicable EcoTRV from the above preferred sources or supplemental sources, if applicable, must be selected unless it can be shown by the QP that an alternate value is more appropriate based on:

1. the existence of a more comprehensive and contemporary published scientific assessment,
2. enhanced relevance (study design, exposure route, etc.) to the site,
3. enhanced scientific credibility, or
4. or greater extent of supporting rationale and documentation.

With respect to EcoTRVs, the QP must include the following in the report:

1. Toxicity profiles of the contaminants to be evaluated. These toxicity profiles should form the basis for the selection of appropriate EcoTRVs to be used in the toxicity assessment component of the ecological risk assessment. At a minimum, QPs must consider including the following information in the toxicity profiles:
   a) toxic effects expected from exposure,
   b) sensitivities of the different receptor groups exposed, and
   c) the range of toxicities reported in the scientific literature for similar species to those present at the site under assessment.

2. The form of exposure on which the EcoTRV is based (e.g., dose, tissue residue, concentration, environmental media).

3. The specified effects levels on which the EcoTRVs are based (e.g., Effective Dose (EDx), Lethal Dose (LDx), Effective Concentration (ECx) or Lethal Concentration (LCx) for a set percent (x) of exposed organisms).

**Use of *de novo* Derived EcoTRVs**

In the case where no credible EcoTRV can be found, a *de novo* EcoTRV may be derived. The detailed risk assessment report must demonstrate that the creation of the *de novo* TRV and the procedure used for derivation was scientifically justified based on:

1. the scientific literature related to the ecotoxicity of the substance, or
2. ecotoxicological experimental data obtained for the substance on a site specific basis (e.g., *in-situ* bioassay data obtained for a site).

QPs must consider the following documents in derivation of a *de novo* EcoTRV:

- United States Environmental Protection Agency: Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Eco-SSL Standard Operating Procedure #6: Derivation of Wildlife Toxicity Reference Value (TRV) (June 2007)
- Environment Canada: FCSAP Supplemental Guidance for Ecological Risk Assessment, Module 2: Selection or Development of Site-Specific Toxicity Reference Values (June 2010)

In deriving a *de novo* EcoTRV for a substance lacking an EcoTRV from a preferred source, the QP must consider the best available science for sources of ecological toxicity data.

In deriving *de novo* TRVs, arbitrary uncertainty factors must not be used except where the risk assessor considers it professionally appropriate given limited data, or where extrapolations are required among taxonomic groups. Where uncertainty factors are used, the report must document how factors have been chosen in a manner consistent with Environment and Climate Change Canada's FCSAP guidance on Ecological Risk Assessment.

**Toxicity Testing**

The ministry requires the use of toxicity test methods established by the following agencies in ecological risk assessment:

- B.C. Ministry of Environment: British Columbia Environmental Laboratory Manual (2020)
- Environment Canada: Biological Test Method Series
- United States Environmental Protection Agency: Whole Effluent Toxicity – Methods for Measuring Acute Toxicity to Freshwater and Marine Organisms
- United States Environmental Protection Agency: Office of Chemical Safety and Pollution Prevention: OCSPP Harmonized Test Guidelines
- American Society for Testing and Materials (ASTM): Environmental Toxicology Standards,

- Organization for Economic Cooperation and Development (OECD): OECD Guidelines for the Testing of Chemicals, Section 2: Effects on Biotic Systems, and
- International Organization for Standardization (ISO): TC 147/SC 5 – Biological Methods

In selecting appropriate toxicity tests from the above-mentioned agencies, the ministry requires QPs to select the best available toxicity test for the contaminated site based on:

1. relevance of test species to species present at the site;
2. sensitivity of test species to the contaminant(s) of concern for the site;
3. relevance of test exposure duration;
4. use of test or toxicological effect endpoints appropriate to the mechanism of toxicity of the contaminant(s) of concern for the site; and
5. extent and representativeness of site phylogenetic diversity when batteries of toxicity tests are used.

**Toxicological Endpoints**

All relevant toxicological endpoints (effects concentrations, ECx) must be considered. Preference must be given to sub-lethal endpoints. Endpoints must match receptor characteristics.

Toxicological endpoints include but are not limited to:

- any reproductive endpoint (e.g., number of offspring, number of eggs laid, eggshell quality, fruit size and yield, presence of deformities in embryos or young),
- growth rates,
- lethality,
- tumour formation or other gross deformities in embryos or young,
- phototoxicity,
- olfactory impacts,
- hypoxia, or
- scoliosis.

**Effects Concentrations**

Ecological receptors must be protected according to the levels of protection (ECx) identified in Table 1 below. The detailed risk assessment report must include specific details of the selected ECx levels.

**Table 1: Protection levels by land and water use for ecological receptors in risk assessment on contaminated sites in B.C.**

| Land or Water Use | Level of Protection |
|---|---|
| Industrial | Concentration that affects 50% of the organisms exposed ($EC_{50}$) |
| Commercial | Terrestrial receptors: $EC_{50}$;<br>Aquatic receptors: Concentration that affects 20% of the organisms exposed ($EC_{20}$) |
| Residential | $EC_{20}$ |
| Urban Park | $EC_{20}$ |
| Agriculture | $EC_{20}$ |
| Wildlands | Natural: concentration that affects 15% of the organisms exposed ($EC_{15}$);<br>Reverted: concentration that affects 25% of the organisms exposed ($EC_{25}$) |
| Sediment | Typical: a 50% probability of observing an $EC_{20}$<br>Sensitive: a 20% probability of observing an $EC_{20}$ |
| Aquatic life | $EC_{20}$ |
| Irrigation Water | No adverse effect over the course of one growing season |
| Livestock Watering | No adverse effect to population of livestock from chronic exposure |
| Species at Risk (all land and water uses) | Protected at the individual level (to live, reproduce and thrive) |

**Weight-of-Evidence**

Weight-of-evidence Risk Assessments use a method for decision-making that involves consideration of multiple sources of information and lines of evidence. Using a weight-of-evidence approach avoids relying solely on any one piece of information or line of evidence in describing risk on a contaminated site. Weight-of-evidence is a tool QPs can use in risk assessment to describe a fulsome risk scenario.

QPs must document in the detailed risk assessment report the use of scientifically defensible approaches and sources of information for any risk assessment using a weight of evidence approach. QPs must consider the following guidance:

- Science Advisory Board for Contaminated Sites in B.C.: Guidance for Weight of Evidence Approach (2010)
- Environment and Climate Change Canada's (FCSAP): Ecological Risk Assessment Guidance (2012), Chapter 5.5

### 4.2.5 Risk Characterization

**Hazard Quotients**

For both ecological and human health detailed risk assessment reports, calculation of hazard quotients (HQs) and subsequently Hazard Indices (HI), and human lifetime cancer risks (known as incremental lifetime cancer risks (ILCRs)), are required to provide the magnitude and severity of risk to inform risk management and decision making. Protocol 30 contains requirements on identifying a carcinogenic substance.

The following must be included in the risk characterization section of the detailed risk assessment report for human receptors:

1. Non-carcinogen:
   a) A calculation of HQs for each COPC and complete exposure pathway;
   b) A calculation of Hazard Index for each COPC equal to the sum of HQs for each substance over all exposure pathways (regardless of whether COPC concentrations exceed CSR standards in all exposure media, unless toxicity is pathway specific); and
   c) When a common target organ or mechanism of toxicity is shared by multiple exposure pathways or COPCs, a cumulative Hazard Index for those COPCs.

2. Carcinogen:
   a) A calculation of ILCRs for each carcinogenic substance for each exposure pathway. If applicable to the site, ILCRs may be required to evaluate each sensitive lifestage; and,
   b) A calculation of total lifetime cancer risk due to exposure to each carcinogenic COPC.

Where a QP preparing a DRA considers that the information specified in 1 or 2 above is either inappropriate or unfeasible, the DRA must provide an explanation of why this is true and provide analysis and justification for whether risks are acceptable or unacceptable. A clear interpretation of all cumulative risk estimates must be provided and risk estimates must be categorized as acceptable or unacceptable.

The following must be included in the risk characterization section of the detailed risk assessment report for ecological receptors:

1. A calculation of HQs for each COPC based on cumulative exposures from all complete exposure pathways;
2. Where best available science indicates a common target organ or mechanism of toxicity is shared by multiple COPCs, a cumulative hazard index for all those COPCs and pathways.

Where a QP preparing a DRA considers that the information specified above is either inappropriate or unfeasible, the DRA must provide an explanation of why this is true and provide analysis and justification for whether the risks are acceptable or unacceptable. A clear interpretation of all

cumulative risk estimates must be provided and risk estimates must be categorized as acceptable or unacceptable.

#### 4.2.6 Uncertainty Assessment

Uncertainty in the risk assessment must be stated as a number or in prose explicitly, including implications of the identified uncertainties. Uncertainties for the exposure and effects assessment datasets (e.g., uncertainty in TRVs) and statistical analysis, and risk characterizations must be identified.

#### 4.2.7 Risk Interpretation and Conclusions

Risk assessment conclusions must be clearly summarized and categorized as acceptable and unacceptable risk. Conclusions must be consistent with endpoints identified in the risk assessment.

The detailed risk assessment report must include interpretation of statistics (and trends where applicable) for contamination. Tools may be used to assist with risk characterization and interpretation (e.g., graphical or tabulated communication of risk assessment conclusions). In addition to the requirement that a QP must conduct the risk assessment and reporting, any interpretation of biological data must be completed by a Registered Professional Biologist.

## 5.0 Risk Management

### 5.1 Risk Controls and Performance Verification Plans

Risk controls ensure that risk-based standards are met and continue to be met at a site. The maintenance of risk mitigation measures and specific risk controls are supported by Performance Verifications Plans (PVPs).

Section 53(3)(c) of EMA and CSR sections 18 and 18.1 require a plan for containing, controlling and monitoring any substances remaining on the site as a pre-condition to issuance of a Certificate of Compliance or the director's acceptance of risk-based standards. CSR section 49 (2) requires information on the quality and performance of remediation measures on completion of remediation. CSR section 47 also require applicants for Approval in Principle to provide a proposed remediation plan and additional information necessary for the director to determine whether remediation standards are likely to be complied with. An application for a Certificate of Compliance or Approval in Principle will generally be considered incomplete if it does not include a PVP in the circumstances set out in ministry guidance. Note: If engineered risk controls are used to ensure risk-based standards are met and continue to be met, the PVP must contain contingency actions. A PVP that supports a risk assessment report should be submitted with the application for contaminated sites services.

### 5.2 Decision Process

Risk management decisions for contaminated sites are made based on the outcome of human health and ecological heath risk assessments. QPs recommend to the ministry whether or not risks are

acceptable on a contaminated site. The director's decision on whether or not risks are acceptable is a pivotal point in contaminated sites remediation. The finalization of risk conclusions may be an iterative process between the applicant and ministry with the results supporting risk management decisions.

To assist in the interpretation of the detailed risk assessment report, statistical analyses of the levels of contamination in environmental media and associated impacts are critical for decision-making purposes. Ecosystem services may be taken into account at a contaminated site to assist with decision making.

*EMA* s.60 reserves the right for the director to take further action including issuance of remediation orders in certain situations, including if activities occur on a site that may change its condition or use, a responsible person fails to exercise due care in managing contamination, or information becomes available leading to a reasonable inference that the site poses a threat to human health or the environment. For example, subsequent monitoring could indicate discrepancies in assumptions used in the risk assessment or risk assessment assumptions and recommendations could prove to be incorrect. Adequate risk characterization and uncertainty analysis assists with mitigating the potential for a site to trigger follow up action by the ministry.

## 6.0 Detailed Risk Assessment Report Submission Requirements

This protocol must be followed in the preparation and submission of a complete detailed risk assessment report as required by the *EMA*, and CSR sections 18 and 18.1 described in Section 2.0 above.

### 6.1 Requirements for Report Completeness

To be considered complete, detailed risk assessment reports must:

1. Take the form of a stand-alone document that provides all results pertinent to the risk assessment performed, contains all the parts set out in section 4 and meets all the requirements of this protocol. If the results of previous investigations, reports or assessments are referenced, a complete summary of the previous results must be included and evaluated.

2. Be accompanied by a DSI indicating that the site meets the criteria set out in section 2.4 of this Protocol. A QP preparing a detailed risk assessment report is not responsible for ensuring that a DSI was completed according to the requirements of the CSR; however, a risk assessment that is not based on a comprehensive DSI as per section 2.4 of this protocol is considered incomplete.

3. Follow, as applicable, ministry risk assessment protocols, policy and associated guidance (e.g., including but not limited to Protocol 20, Protocol 30, and Technical Guidance 15 (to the extent that it is incorporated into this Protocol). It is also strongly recommended that

detailed risk assessments and reports follow ministry guidance, including the Technical Guidance for Risk Assessors and Technical Guidance 15 in order to facilitate approvals.

4. Contain the Protocol 20 checklist where an ecological risk assessment has been completed.

5. Provide sample calculations to demonstrate the determination of risk for each receptor and pathway.

6. Include the professional statements in Appendix 1 of this Protocol; is duly signed and where applicable bears the Professional Society stamp of the QP(s) who completed the risk assessment.

### 6.2 Errors and omissions

Table 2 lists the most frequently noted errors and omissions specific to risk assessment reports.

The detailed risk assessment report must be sufficiently comprehensive and sufficiently recent to reflect current site contaminants, conditions, receptors, exposures, and risks and present information on future site conditions and risk.

**Table 2. Most frequently noted examples of errors and omissions in contaminated site detailed risk assessment reports submitted to the ministry**

| Common examples of major errors or omissions | Common examples of minor errors or omissions |
|---|---|
| • Risk assessment does not include or evaluate all contaminant: sources, contaminants, transport or exposure pathways<br>• Vapours addressed in the detailed site investigation with attenuation factors other than those described in Protocol 22 "Application of Vapour Attenuation Factors to Characterize Vapour Contamination" Version 1.0 were not included in the risk assessment<br>• Risk assessment lacks a conceptual model or the conceptual model provided does not evaluate all site exposure pathways and/or site receptors<br>• Risk assessment does not evaluate the potential for bioaccumulation, bioconcentration and/or biomagnification<br>• Risk calculations are not included for all receptors, environmental media or COPCs<br>• Risk assessment does not assess credible exposure scenarios and/or uses unrealistic exposure assumptions, resulting in risk estimates that are either excessively | • Risk assessment lacks an analytical data summary including: minimum, maximum, median, mode, average, 90$^{th}$ percentile and 95% upper confidence limit of the mean estimates<br>• Conceptual site model for current and/or future land, vapour, and water use(s) contains minor errors or omissions<br>• TRVs are not supported by a rationale for their selection<br>• TRVs are not provided with a valid citation<br>• Risk estimates are calculated incorrectly |

| Common examples of major errors or omissions | Common examples of minor errors or omissions |
|---|---|
| simplistic or unreasonably over-conservative for use in risk management decisions<br>• Exposures are not summed for all contaminants of concern (1) that share an identical mechanism of toxicity and target organ, (2) across exposure pathways and/or (3) across environmental media | • A worked example for all types of calculations performed to produce risk estimates is not provided |

### 6.3 Decision process

This protocol provides criteria and examples relevant to determining if a risk assessment report is incomplete or contains errors of sufficient magnitude to require the return of the report for correction and/or resubmission. Note that the authority of the director to return a submission on the basis of completeness or errors is not limited by the content of this protocol.

Detailed risk assessment reports found to be incomplete or which are found to contain a major error will be returned for resubmission in accordance with ministry policy, the *EMA*, and CSR requirements. The director may return any risk assessment containing multiple minor errors that in combination would potentially act to substantively change the conclusions of the risk assessment.

For enquiries please visit the Land Remediation Contact Us webpage.

### Revision history

| Approved Date | Effective Date | Document Version | Notes |
|---|---|---|---|
| | January 1998 | 1 | Title: "Recommended Guidance and Checklist for Tier 1 Ecological Risk Assessment of Contaminated Sites in British Columbia" |
| DRAFT | | 2 | Major revisions proposed to support CSR Stage 13 amendment |

**Appendix 1**

**Professional Statement and Signature of**
**Risk Assessor Completing the Detailed Risk Assessment Report**

**Professional statement and signature:**

I declare that I am a qualified professional with the required knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

As a qualified professional, I confirm the:

1. Risk Assessment referred to above has been conducted in accordance with the *Environmental Management Act*, Contaminated Sites Regulation, director approved protocols, procedures, guidance and standard professional practice; and
2. Information used in the performance of the risk assessment and the conclusions of the risk assessment reported herein are true based on my knowledge as of the date completed.

| _____ | _____ | _____ |
|---|---|---|
| Print Name | Signature | Date completed |

*<Apply applicable Professional Society stamp>*

*< If multiple signatories, add additional statements and signature blocks on new pages as required.>*

**Note**
The ministry considers all risk assessor signatories to be jointly and equally responsible for all aspects of a detailed risk assessment report submitted in support of an application for an Approval in Principle or a Certificate of Compliance under the *Environmental Management Act* and Contaminated Sites Regulation.

**Professional Statement and Signature of**
**Professional Biologist Completing the Habitat Assessment**

**Professional statement and signature:**

I declare that I am a qualified professional with the required knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

As a qualified professional, I confirm the:

1. I am a Registered Professional Biologist (RPBio) and have demonstrable experience in, and my area of practice includes, the assessment of ecological habitat evaluated in this risk assessment.
2. The habitat assessment done as part of the detailed risk assessment was completed and the report was prepared in accordance with Protocol 1, and any other protocols relevant to the habitat assessment, and are true and accurate based on current knowledge as of the date completed.

| _____ | _____ | _____ |
|---|---|---|
| Print Name | Signature | Date completed |

*<Apply applicable Professional Society stamp>*

*< If multiple signatories, add additional statements and signature blocks on new pages as required.>*