Ministry of Environment and Parks

PROTOCOL 1
FOR CONTAMINATED SITES

Detailed Risk Assessment

Version 5.0

Prepared pursuant to Section 64 of the
Environmental Management Act

Approved:

April 13, 2026

Director of Waste Management

Date

Effective Date: January 15, 2027

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"
February 1, 2021	February 1, 2021	2	Major revisions to support CSR Stage 13 amendment
May 13, 2021	May 13, 2021	3	Revisions to reflect application of the *Professional Governance Act*
February 1, 2023	February 1, 2023	3.1	Updated qualified professional definition
March 23, 2023	March 1, 2023	4	Minor revisions to align with CSR Stage 14 amendment
April 13, 2026	January 15, 2027	5	Amendments to incorporate DRA-specific Protocol 13 tables, Protocol 20 and Protocol 30. Minor amendments to include consideration of climate change effects and First Nations' uses and interests, and to improve protocol structure and clarity.

Table of Contents

Appendices

1. Definitions

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

"Acceptable risk" means, in the context of detailed risk assessment (DRA), 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 ratio that is:
(a) assigned to a substance to measure bioaccumulation;
(b) calculated as:
    (i) the concentration of the substance in an organism, to
    (ii) the concentration of the substance in the organism's exposure media, based on uptake from the surrounding environmental medium and food; and
(c) 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 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 than or equal to 2000; or
(b) the substance is determined by best professional judgment of the qualified professional preparing a report to have the potential to bioaccumulate 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 environmental media to which the organism is exposed.

"Bioconcentration factor" [BCF] means a ratio that is:
(a) assigned to a substance to measure bioconcentration;
(b) calculated as:
    (i) the concentration of the substance in an organism, to
    (ii) the concentration of the substance in the organism's exposure media, based only on uptake from the surrounding environmental medium; 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 pH, hardness, range of concentrations.

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

"Carcinogenic" means likely or potentially cancer-causing substances classified in accordance with Appendix A-1.

"Complete exposure pathway" means an exposure pathway for which all 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) a substance that is present in media at a site at levels that exceed 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 section 11, or
(b) a substance otherwise identified with the potential to cause adverse effects on human health or the environment, 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.

"Detailed risk assessment" [DRA] means an ecological risk assessment and/or human health risk assessment carried out in accordance with this protocol 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 (DRA) report" means an environmental risk assessment report as referred to in sections 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 DRA.

"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 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)" means the concentration of a substance causing X% effect to the organisms exposed, including inhibitory concentrations at a specified effects level (ICx).

"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 or 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 medium by which a contaminant is conveyed to a receptor.

"Food chain modelling" means the quantitative estimation of the dose of contaminant received due to uptake from lower trophic levels within a food chain.

"High-water mark" means:
(a) for freshwater; the visible high-water mark of a waterbody where the presence and action of the water is so common and usual, and typically enduring, as to mark on the soil of the bed of the waterbody a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself, and includes the active floodplain associated with a site;
(b) for marine water: the high-water mark as defined by the most elevated High Water Mean Tide by Fisheries and Oceans Canada and as mapped on Canadian Hydrographic Services navigational charts; and
(c) for estuarine water: the high-water mark is whichever of the freshwater or marine water high-water mark is further inland.

"Human health risk assessment" means the process used to estimate the nature and probability of adverse health effects in humans who may be exposed to substances in contaminated environmental media, now or in the future.

"Incomplete exposure pathway" means an exposure pathway for which one or more of the five elements of a complete exposure pathway is not present.

"Insignificant exposure pathway" means a complete exposure pathway where a concentration of a substance in a medium is unquantifiable, the point of exposure is limited (e.g., dermal contact in some ecological receptors), or the route of exposure is unlikely such that the contribution from that pathway is likely to be negligible.

"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) limits the use of soil, water, sediment, vapour or a resource at the site or parcel, or

(b) limits access or exposure to substances at the site or parcel; and includes, 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 *Federal Species at Risk Act*, or
b) constitutes sensitive habitat for designated endangered or threatened aquatic species under the *British Columbia Wildlife Act*.

"Potential contaminant of concern" [PCOC] means any contaminant which might be expected to occur at a site based on the historical use of the site, whether that substance has been measured in any environmental medium or has been determined to exceed the numerical standards of the Contaminated Sites Regulation (CSR).

"Potential terrestrial habitat" means any part of a contaminated area (the source parcel or the off-site affected parcel(s)) that satisfies any of the following criteria:
(a) the agriculture, wildlands, or urban park land use classification applies; or
(b) 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 undeveloped land; or
(c) lies within 300 m of sensitive habitat where residential, commercial or industrial land use applies at the site.

"Qualified professional" [QP], in relation to a duty or function under this protocol, means an individual who:
(a) is registered in British Columbia with a professional organization, acts under that organization's code of ethics and is subject to disciplinary action by that organization; and
(b) through suitable education, experience, accreditation and knowledge may reasonably be relied on to provide advice within the individual's area of expertise, which area of expertise is applicable to the duty or function.

"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" means an institutional control, intrinsic control, engineering control or monitoring which exists or is implemented to mitigate, eliminate or observe risks from the exposure of receptors to contaminants.

"Screening benchmark" is the concentration of a substance in an environmental medium, above which that substance is identified as a COPC in a risk assessment. This concentration may be based on regulatory standards or guidelines, toxicity effects levels, or background concentrations that apply to the site.

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

"Sediment porewater" means 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 Regulation; or
(e) riparian assessment areas as defined in the Riparian Areas Protection Regulation.

"Site-specific toxicity reference value" means a toxicity reference value that has been:
(a) calculated by a qualified professional using an established procedure or method, and
(b) derived for receptors and conditions specific to the site.

"Species at risk" means 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.*

"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:

(a) Human health risk exceeds the levels specified in CSR sections 18(1), (3) or (5), 18.1(1), (4) and (5.1), or

(b) Health risk from threshold (or non-carcinogenic) substances exceeds one, when calculated as a cumulative hazard index for all substances that share a common target organ or mechanism of toxicity, or

(c) Human health risk from non-threshold (or carcinogenic) substances exceeds one in a 100,000, when calculated as a cumulative total lifetime cancer risk for all substances that share a common target organ or mechanism of toxicity, or

(d) Ecological risk to a receptor from all substances and exposure pathways combined is greater than the protection level required in Section 4.4.2.5 (Table 2).

"Undeveloped land" means any bare or vegetated soil, excluding actively maintained

(a) gravelled walkways,

(b) roadways or highways and associated roadside or highway margins,

(c) parking areas,

(d) planters and similar structures which contain and isolate soil,

(e) storage areas at active commercial and industrial operations, and

(f) railways and associated railway beds.

"Weight-of-evidence" means 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. Introduction

2.1 Authority for and Purpose of this Protocol

This protocol is made under the authority of the *Environmental Management Act* (EMA) section 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 (DRA) 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 provides information required for the purposes of CSR sections 18(6), 18(7), 18.1(5), 18.1(6), 47(2), 47(3) and 49(2) as applicable.

Protocol 1 set outs legal requirements in accordance with the CSR and Part 4 of EMA as described above. This protocol does not provide detailed technical procedures for conducting a human health or ecological risk assessment, nor does it provide the necessary risk equations. Practitioners are referred to the technical guidance documents listed in Section 4.0 for detailed instructions on conducting risk assessment.

This protocol applies to the preparation and contents of ecological and human health risk assessments conducted as part of a DRA. The resulting DRA report may be submitted as an environmental risk assessment report for the purposes of CSR sections 18(6) or 18.1(5).

Throughout this protocol, the phrase "must consider" is used. This phrase is used to describe a requirement to carefully evaluate information based on the current best available science and professional judgement of site-specific factors. Appropriate rationale must be provided to support the conclusion reached.

Except where a Screening Level Risk Assessment (SLRA) 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 DRA report.

2.2 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 section 56. They must also consider how climate change effects may impact the factors identified in EMA sections 56(1)(a), (b) and (c). 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 be used in combination for 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 the remaining complete exposure pathways. The completion of a DRA requires that all exposure pathways be considered, regardless of whether a SLRA has been previously completed. A DRA that ends at the conclusion of the problem formulation step may be an acceptable risk assessment report submission. The DRA must not reference Protocol 13. This protocol contains requirements for DRA. For more information on SLRA refer to Protocol 13.

The primary goal of ecological risk assessment and/or ecological risk management is to ensure the continued presence, or successful re-introduction, of a biologically diverse, functional, self-sustaining, and interdependent community or ecosystem as an essential component of the remediation of contaminated sites as appropriate to the land use.

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

2.3 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 section 41 and CSR section 59.

2. The DSI must assert, in addition to the general requirements for a DSI,
   (a) that for each 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.

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.

2.4 Risk Assessment to Support Certification

EMA section 53 authorizes the Director to issue an Approval in Principle or a Certificate of Compliance if various conditions are met. Those conditions include the proposed or completed remediation of a contaminated site to numerical or risk-based standards. Risk-based standards are set out in the CSR section 18, or 18.1 for substances and sources specified for an environmental management area.

CSR section 18(6) also requires an applicant that is relying on risk-based standards to prepare a DRA report that identifies the potential on- and off-site environmental risks of substances causing contamination. As per CSR section 18(6), and in order to maintain satisfactory public records for contaminated sites, it is necessary to quantify the magnitude and severity of risks from residual contamination before and after risk controls are implemented. Clear statements indicating how risk management or mitigation measures have been factored into calculations must be included.

The Director may impose additional 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 6.1, Risk Management). Remediation orders may also be used.

3. 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.: numerical standards prescribed in CSR Schedules 3.1 to 3.4, and risk-based standards. Risk-based standards pertain both to the protection of ecological 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 that risks are at or below the acceptable protection levels listed in Table 2 in Section 4.4.2.5. 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 section 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 (WQG) to water, porewater, and sediment in the aquatic receiving environment. B.C. has Approved and Working WQG to protect water quality, biota, and sediment. WQGs must be considered in a risk assessment for submission of an application regarding a Director's decision affecting water quality made within the ministry (Water Quality Guidelines Policy). WQGs apply in the aquatic receiving environment, which is defined herein as a receiving environment that lies within the boundaries of the high-water mark and captures both surface water, porewater, and sediment.

Sufficient protection of aquatic life within the receiving environment is considered to have been achieved when the following can be demonstrated:

- Substance concentrations along the groundwater to surface water flow pathway are less than the aquatic life standards in schedule 3.2 of the CSR at all depths that are at least 10 metres inland from the high-water mark of any receiving environment (where the source of contamination is located at least 10 metres inland from the high-water mark); or
- The concentrations of a substance in groundwater are confirmed to be local background concentrations established under Protocol 9 "Establishing Local Background Concentrations in Groundwater."

If the above criteria cannot be met, a DRA 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 B.C. WQG at all depths before the groundwater enters the aquatic receiving environment at the high-water mark; or
- substance concentrations are below B.C. WQGs at the location where groundwater with the highest contamination levels enters the aquatic receiving environment (e.g., concentrations are less than the WQGs at all depths at the high-water mark); or
- 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 2 in Section 4); 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., EC_{20}).

Substance concentrations in the receiving environment and groundwater should be determined in accordance with Technical Guidance 15, version 2.0.

For sediment and sediment porewater, if the DSI demonstrates that concentrations of contaminants exceed applicable numerical limits as set out in Technical Guidance 15, version 2.0, a detailed ecological risk assessment must demonstrate that no unacceptable ecological risks exist. A detailed human health risk assessment must demonstrate no unacceptable human health risks exist when the exposure pathway is considered complete.

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. Risk Assessment Components

The DRA report must include the following risk assessment components unless it concludes upon completion of the problem formulation:

- problem formulation (see Section 4.1)
- conceptual site model for current and/or future land, soil, vapour, water, and sediment uses (see Section 4.2)
- exposure assessment (see Section 4.3)
- toxicity/effects assessment (see Section 4.4)
- risk characterization (see Section 4.5)
- uncertainty analysis (see Section 4.6), and
- conclusions (see Section 4.7).

The complexity of the risk assessment must correspond 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.

When conducting a human health risk assessment QPs must consider the following Health Canada documents for deterministic human health risk assessment:

- Federal Contaminated Site Risk Assessment in Canada: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 4.0 (2024)
- Federal Contaminated Site Risk Assessment in Canada: Toxicological Reference Values, Version 3.0 (2021)
- 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)
- Federal Contaminated Site Risk Assessment in Canada: Supplemental Guidance for Soil Vapour Intrusion Assessment at Federal Contaminated Sites, Version 2.0 (2023)
- 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)

When conducting ecological risk assessment QPs must consider the following guidance documents:

- Ecological Risk Assessment Guidance Document (CCME, 2020)
- Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance (2012)
- FCSAP - Ecological Risk Assessment Guidance, Module 1: Toxicity Test Selection and Interpretation (2010)
- FCSAP - Ecological Risk Assessment Guidance, Module 2: Selection or Development of Site-specific Toxicity Reference Values (2010)
- FCSAP - Ecological Risk Assessment Guidance – Module 3: Standardization of wildlife receptor characteristics (2012)
- FCSAP - Ecological Risk Assessment Guidance – Module 6: Ecological Risk Assessment for Amphibians on Federal Contaminated Sites, Version 1.0 (2019)
- FCSAP - Ecological Risk Assessment Guidance - Module 7: Default Wildlife Toxicity Reference Values Recommended for Federal Contaminated Sites, Version 1.0 (2021).

In addition to considering the guidance documents above, the following subsections provide specific requirements for risk assessment of B.C. sites.

4.1 Problem Formulation

All contaminant-pathway-receptor combinations must be identified and described in the problem formulation component of the DRA report. All relevant environmental media must be included. When developing the problem formulation, applicants must consider First Nations use and interests of the site.

4.1.1 Contaminants of Potential Concern (COPC)

The problem formulation must clearly describe COPC screening. All contaminants of concern must be carried forward to COPC screening in the DRA report. COPCs must be listed in the problem formulation component of the DRA report.

Statistics described for site investigation in Technical Guidance 2 should not be used to identify COPCs within a DRA; however, statistics may be used in a DRA with supporting rationale following COPC screening in the Problem Formulation. Further information is provided in Section 4.1.5.

Substances for which no prescribed standards are available and are known to be associated with site activities must be identified as COPCs if they cause or have the potential to cause adverse effects on human health or the environment (EMA 56 and CSR 59(2)a). These substances can be included on a risk-based Certificate of Compliance as long as risk-based standards have been met and the site is or was a contaminated site as defined under EMA due to the presence of some other prescribed substance.

Human health risk assessment must also identify COPCs in sediment for human exposure. As there are currently no sediment standards protective of human health, Schedule 3.1 Soil Standards for the protection of human health (Parts 1 and 2) must be used to identify human health COPCs in sediment. Land use in intertidal zones must default to residential/parkland use, unless site specific circumstances determine the actual land use to be otherwise (e.g., water lots leased for industrial land use). If land use other than residential/parkland is proposed for the intertidal area, detailed rationale in accordance with CSR section 12(5) must be provided.

COPC screening as described above does not identify bioaccumulative substances. Bioaccumulative substances must be identified as described in Section 4.1.5.3.

4.1.2 Beneficial Use

The QP conducting a DRA must consider if any beneficial use scenarios described in Table 1 below apply.

Table 1.
Substances and Corresponding Eligible Beneficial Uses

Substance	Eligible Beneficial Use
zinc	galvanized materials (used to prevent rusting)
copper	copper pipe or bare copper wire (used for water supply or for cathodic protection to prevent corrosion)
boron, chromium, copper, arsenic, chlorophenols, or constituents of creosote (including petroleum hydrocarbon carrier solutions)	treated or preserved wood utility poles, structural timber or pilings
chloride, sodium	road salting (lateral distance as measured from the pavement edge or from the edge of the travelled portion of unpaved roads)

The problem formulation component of the DRA report must identify eligible beneficial uses (including associated contaminants and contaminated media), and location and extent of contamination. Risk characterization must be completed for beneficial use areas when complete exposure pathways exist; however, beneficial use areas may be exempted from physical remediation and risk management at the discretion of the Director.

Rationale for beneficial use are not applicable when the use is historical and no longer serves its intended purpose, or when the materials associated with the beneficial use are no longer being used. Contamination which may be included in a beneficial use exemption is limited to a 3 m radius from the beneficial use. Beneficial use does not apply at sites where the beneficial use materials were produced or stored.

4.1.3 Field Study

4.1.3.1 Sample Collection and Analysis

Sampling to support risk assessment must follow the ministry's B.C. Field Sampling Manual and any applicable protocols. The number of samples collected must be commensurate 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 analyzed for the purpose of a DSI or other investigation for the purposes of DRA must be analyzed:

(a) by a "qualified laboratory", as defined in the Environmental Data Quality Assurance Regulation, and

(b) in accordance with B.C. Environmental Laboratory Manual.

4.1.3.2 Ecological Study Requirements

The DRA must evaluate if potential terrestrial habitat or an aquatic receiving environment of concern is present, and Step 1 of Appendix B-2 or Appendix B-3, respectively, must be completed and submitted with the DRA. If potential terrestrial habitat or an aquatic receiving environment of concern is not identified in Step 1 of Appendices B-2 and B-3, the Professional Statement in Appendix B-4 is not required.

An ecological field study of the site must be completed where it has been determined that potential terrestrial habitat or an aquatic receiving environment of concern is present. These habitats must be assessed to identify which species may be present at the site and receiving environments. The level of detail required in this field study should be commensurate with the complexity of the site. Rationale outlining the study design must be provided. In the case that 'potential terrestrial habitat' is identified, the entire site is covered (e.g., paved, building, etc.), and no complete exposure pathways have been identified, rationale may be provided to limit the ecological field study.

The field study must:

1. be completed by a QP who has relevant demonstrable experience and has signed the Professional Statement in Appendix B-4.
2. contain a seasonally appropriate survey program to evaluate all habitat characteristics relevant to potential receptors of concern.
3. be included and documented in the DRA 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.

4.1.4 Receptor Identification

DRAs must identify all potential human and ecological receptors known, or reasonably inferred, to be present at a site under the current or future scenario, 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), and species at risk.

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

4.1.4.1 Human Receptors

In human health receptor selection, QPs must include all relevant receptors and most sensitive life stages. When selecting human health receptors, QPs must consider recommendations in *Federal Contaminated Site Risk Assessment in Canada: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 4.0* (Health Canada, 2024), except where the QP completing the assessment considers it inappropriate. When the selection process deviates from this document, the DRA report must justify the deviation.

4.1.4.2 Ecological Receptors

When potential terrestrial habitat or an aquatic receiving environment of concern has been identified as per Section 4.1.3.2, species forms (Step 2) in Appendix B-2 and B-3, respectively, and Appendix B-4 must be included in the DRA report.

The QP must assess the potential presence of species and identify which must be evaluated in the risk assessment. All species must be considered when identifying potential ecological receptors at a site, including higher trophic level wildlife, when applicable. Ecological receptors, including species at risk, must be selected based on the potential for their presence at the site. Ecological receptors which are identified as being of cultural significance must also be considered in the DRA.

When identifying and selecting species for evaluation in an ecological risk assessment, best practices must be considered, such as those presented in the Ecological Risk Assessment Guidance Document (CCME, 2020).

4.1.5 Exposure Pathways

The DRA 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. A detailed rationale must be provided for each COPC not retained for risk characterization (section 4.5). Detailed rationale may include, but is not limited to, the spatial distribution of COPCs, the potential for cumulative effects, fate and transport of COPCs, and/or the presence of risk controls. Statistics may be appropriately used in conjunction with the aforementioned rationale. COPCs carried forward to risk characterization are considered retained COPCs.

The QP must consider if and how potential exposure pathways will change through the effects of climate change.

4.1.5.1 Human Health Exposure

Drinking water

When a current or future drinking water exposure pathway is complete or operative, the ministry expects the DRA report to contain an assessment of risks and hazards associated with the drinking water pathway (including fully documented exposure risk calculations). For volatile substances, additional inhalation exposure pathways (e.g., inhalation during showering, etc.) must be evaluated if applicable.

If the current and future drinking water exposure pathway is considered incomplete (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 section 18(6) and 18.1(5), which requires that calculations be provided before and after remediation, the Director may require this information (CSR section 52(1)).

If the drinking water pathway is deemed incomplete and risk estimates are not provided, the risk assessment must clearly state that "future drinking water risks were not calculated" and full documentation must be provided for the rationale.

Pathway to subsurface media

Human health risk assessments are not generally expected to include acute or subchronic exposure scenarios for subsurface workers (e.g., utility, trenching, and construction personnel). Chronic (> 90 days) occupational exposure pathways must be included for subsurface workers in risk assessments for CSR regulatory purposes.

Worker health and safety is regulated by WorkSafeBC under the *Workers Compensation Act* and the Occupational Health and Safety Regulation. Owners of contaminated sites should be aware that there are specific obligations in section 25 of the *Workers Compensation Act*. WorkSafeBC requirements must be met at contaminated sites.

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 4.0. In addition, Technical Guidance 4, "Vapour Investigation and Remediation" Version 2 should be followed.

4.1.5.2 Ecological Exposure

For ecological exposure pathways, the Ecological Risk Assessment Guidance Document (CCME, 2020) must be considered, and the Detailed Ecological Risk Assessment (DERA) checklist in Appendix B-1 must be completed.

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

Sediment within the biologically active zone must be characterized with a high level of confidence to adequately assess exposure of ecological receptors.

For many wildlife receptors, fur and feathers are effective at blocking exposure to environmental media and prevent direct contact with the skin unless the animal becomes soaked in water or other carrier. Dermal exposure of wildlife should be considered for some species (e.g., amphibians and reptiles) when relevant and reliably quantifiable for COPCs that can be absorbed readily through this pathway.

The inhalation pathway of exposure is not required 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.

4.1.5.3 Bioaccumulative Substances

Substances must be assessed for their potential to bioaccumulate based on the definition provided in Section 1.0. Rationale supporting this assessment (e.g., bioaccumulation factors and their citations) must be provided. Site-specific bioaccumulation factors and bioconcentration factors are preferred when justified based on the scope and complexity of the site. When a complete exposure pathway exists between a human or ecological receptor and bioaccumulative substance (e.g., human exposure to sediment COPCs), 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.

4.2 Conceptual Site Model

The DRA report must include a complete conceptual site model (CSM). It is recognized that these models are unique to each site and presentation may differ due to differences in the chemical, physical, and environmental fate and transport properties of the contaminants.

The CSM must include:

- A visual representation (e.g., box or pictorial diagram) of contaminant sources, routes of transport, exposure media, exposure pathways, and receptor groups, supported by a written description of pertinent physical, chemical, and biological processes which influence the effects of contaminants;

- Clearly illustrated exposure pathway types such as complete, incomplete, and insignificant, and rationale to support these labels in the text of the risk assessment;
- Clear descriptions of how risk controls are assumed to prevent exposure to contaminated media; and
- An indication of how specific exposure pathways and receptor groups may be separated by spatial boundaries where migration of contaminants occurs (for example, site vs. off-site).

4.3 Exposure Assessment

Contamination at the site must be adequately characterized to evaluate all identified receptors and exposure pathways. For every complete exposure pathway and receptor combination the DRA report must assess exposure, effects and risk. Current and reasonable potential future land, soil, water, sediment, and vapour use must be evaluated in both the ecological and human health risk assessments.

The DRA report must specify how the exposure concentrations used in the risk assessment were determined for each complete exposure pathway and receptor combination (e.g., identify whether the maximum or 95% upper confidence limit of the mean concentration of the contaminant in soil was used). Exposure concentrations may be the maximum concentration or a statistic that represents maximum reasonable exposure for the receptor being evaluated. Average concentrations are rarely considered acceptable as an exposure concentration. Detailed rationale must be provided to support the statistic selected for the exposure concentration.

4.3.1 Human Health

4.3.1.1 Bioavailability

When estimating exposure to human receptors, the oral relative absorption factor must be assumed to be 100% for all substances, with the exception of arsenic where 60% absorption may be assumed with supporting rationale. Site-specific oral bioavailability adjustments based on robust data may be considered by the Director.

Bioavailability through inhalation must be assumed to be 100%.

For dermal exposure, the relative absorption factors referenced in Health Canada (2024) must be used.

4.3.1.2 Exposure Parameters and Scenarios

The human health exposure assessment must:

1. Consider Health Canada (2024) as a default source for human exposure characteristics,
2. Ensure that exposure scenarios are appropriate for the site, and
3. Ensure that exposure characteristics are scientifically defensible and appropriate for the site.

If Health Canada (2024) values for human characteristics, exposure duration and frequency are deemed unsuitable for the site, rationale, references, and limitations must be provided for the values used in calculating human exposure. It is the responsibility of the QP to ensure that the DRA is site

specific and adequately evaluates a realistic and conservative exposure scenario based on the best available science.

4.3.2 Ecological Health

The ecological exposure assessment must:

1. Consider and evaluate wildlife exposure factors, taking into account guidance published by FCSAP "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 the site-specific wildlife receptors and intake characteristics that are appropriate;
3. Identify chosen wildlife characteristics; and
4. Provide scientific rationale and references for the chosen wildlife characteristics.

The ministry's website provides some resources to evaluate additional exposure parameters for ecological receptors. Rationale related to the selection of these supplemental exposure parameters must be included in the DRA report.

4.3.3 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 is shown that concentrations in lower trophic levels are insignificant or other rationale is provided. All exposure parameters used in the model must be referenced and explained.

4.4 Effects Assessment

The most appropriate human health and ecological toxicity reference values (TRVs) must be selected based on criteria set out below.

4.4.1 Human Health Effects Assessment

4.4.1.1 Classification of Substances

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. To identify whether a substance is considered carcinogenic, it must be evaluated as described in Appendix A. For carcinogenic substances that elicit both carcinogenic and non-carcinogenic effects, both endpoints must be assessed in human health risk assessments where suitable TRVs are available. However, the route(s) of exposure that are relevant for each endpoint should be carefully considered.

4.4.1.2 Human Health TRV Selection

The HHRA report must identify and provide scientific justification for the most appropriate TRV. The ministry requires that QPs consider TRVs from the following sources (in hierarchical order):

1. Health Canada (e.g., *Federal Contaminated Site Risk Assessment in Canada: Toxicological Reference Values (TRVs), Version 4.0* (2025));
2. US EPA (e.g., Regional Screening Levels (RSLs), Integrated Risk Information System (IRIS), Risk Assessment Information System (RAIS)) or United States State Departments;
3. Other select agencies (in no particular order):
    - World Health Organization (WHO) Internationally Peer Reviewed Chemical Safety Information (INCHEM)
    - Joint FAO/WHO Expert Committee on Food Additives (JECFA; Food and Agriculture Organization of the United Nations)
    - European Food and Safety Agency (EFSA)
    - Rijks Instituut voor Volkgezondheid en Milieu (RIVM; National Institute for Public Health and the Environment, Netherlands)
    - Agency for Toxic Substances and Disease Registry (ATSDR)

The source of the selected TRV as well as relevant study details on which it is based (including target organ or system) must be provided in the DRA report.

If TRVs were not selected according to the hierarchy above, the DRA report must:

1. Identify potential TRVs.
2. Consider whether the TRV and exposure duration are appropriate for the site;
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.
5. Include exposure assumptions and/or target risk levels and adjustments (e.g., adjustment from 1/1,000,000 cancer risk to 1/100,000 cancer risk).

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 (see Section 4.4.3). The DRA report must provide justification for derivation and selection of any *de novo* TRVs.

4.4.2 Ecological Effects Assessment

4.4.2.1 Ecological TRV Selection

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

When selecting an EcoTRV from the preferred sources or supplemental sources listed below, the most stringent EcoTRV must be selected, or if a less stringent EcoTRV is considered more applicable, detailed rationale must be provided. QPs must consider the following preferred sources of EcoTRVs:

Soil

- FCSAP - Ecological Risk Assessment Guidance - Module 7: Default Wildlife Toxicity Reference Values Recommended for Federal Contaminated Sites, Version 1.0 (2021).
- Canadian Council for Ministers of the Environment (CCME): 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; and Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision
- Ontario Ministry of Environment, Conservation and Parks: 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 Parks: Approved and Working Water Quality Guidelines
- CCME: Canadian Environmental Quality Guidelines
- Environment and Climate Change Canada: Federal Environmental Quality Guidelines (FEQGs)

Sediment – Aquatic Life

- CCME, 1999, Environmental Quality Guidelines: Scientific Criteria Documents for Deriving Sediment Guidelines

Supplementary Sources of EcoTRVs

When 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: https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/01/Eco_Btag-mammal-bird-TRV-table-1.pdf
- 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

4.4.2.2 Derivation of Site-specific EcoTRVs

A QP may demonstrate that available EcoTRVs are not appropriate and a site-specific EcoTRV 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. Greater extent of supporting rationale and documentation.

For site-specific EcoTRVs, the following must be included in the report:

1. The source of all ecological toxicity data,
2. The methodology for compiling ecological toxicity data (e.g., search parameters, experimental methods),
3. The rationale for inclusion and exclusion of data (e.g., certain species, endpoints, etc.), and
4. The derivation method (e.g., species sensitivity distribution), including scientific support for the methodology.

Site-specific EcoTRVs are not transferable to another site without full rationale.

When deriving a site-specific EcoTRV, QPs must consider best practices presented in the following guidance documents:

- Environment and Climate Change Canada: FCSAP Supplemental Guidance for Ecological Risk Assessment, Module 2: Selection or Development of Site-Specific Toxicity Reference Values (June 2010),
- 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)

In deriving site-specific EcoTRVs, arbitrary uncertainty factors must not be used except when the QP considers it essential to provide conservatism due to limited data, or when extrapolations are required among taxonomic groups. When uncertainty factors are used, the report must document how factors have been chosen in a manner consistent with the Ecological Risk Assessment Guidance (CCME, 2020).

4.4.2.3 EcoTRV Reporting Requirements

When selecting or deriving an EcoTRV, the QP must include the following in the report:

1. Toxicity profiles for each substance. 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) Potential toxic effects from exposure to the media of concern,
   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 specified effects levels and types 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). This must include the form of exposure (e.g., dose, tissue residue, concentration, environmental media).

4.4.2.4 Toxicity Testing for Ecological Risk Assessment

Toxicity tests may be used as part of an ecological risk assessment to evaluate potential risks to ecological receptors. When selecting toxicity tests the *FCSAP - Ecological Risk Assessment Guidance, Module 1: Toxicity Test Selection and Interpretation (2010)* must be considered. Rationale must be provided for the selection of toxicity test applicability to the site and its receptors and include the following:

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 series of toxicity tests are used.

Standardized toxicity test methods must be selected from the following agencies:

- B.C. Ministry of Environment and Parks: British Columbia Environmental Laboratory Manual (2023)
- Environment and Climate Change 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

4.4.2.5 Toxicological Endpoints

In ecological risk assessment (e.g., TRV derivation, toxicity test selection), all relevant toxicological endpoints (effects concentrations, ECx) must be considered. Preference must be given to sub-lethal endpoints. The toxicological endpoints selected must be applicable to receptors at the site. 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.

4.4.2.6 Ecological Effects Concentrations

Ecological receptors must be protected to levels equivalent to or, more protective than, the levels of protection (Effect Concentration; ECx) identified in Table 2 below. The DRA report must include specific details of the selected ECx levels.

Table 2: 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 causing a 50% effect to the organisms exposed (EC_{50})
Commercial	EC_{50}
Residential[1]	Concentration causing a 20% effect to the organisms exposed (EC_{20})
Urban Park	EC_{20}
Agriculture	EC_{20}
Wildlands	Natural: concentration causing a 15% effect to the organisms exposed (EC_{15}); Reverted: concentration causing a 25% effect to the organisms exposed (EC_{25})
Sediment	Typical: a 50% probability of observing an EC_{20} 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[2]
Species at Risk (all land and water uses)	Protected at the individual level (to live, reproduce and thrive)

1. Both high density and low density land uses.

2. Adverse effects to livestock are considered as functional impairment or pathological lesions which may affect the performance of the organism or reduce its ability to respond to additional stressors (Protocols for deriving water quality guidelines for the protection of agricultural water uses; CCME, 1993).

4.4.3 *De novo* TRVs

In the case where no credible TRV can be found, a *de novo* TRV may be derived. A *de novo* TRV derivation requires extensive primary research (e.g., toxicity studies, epidemiological studies) for each of the receptors for which the *de novo* TRV is to apply.

The application for Director's approval of a *de novo* TRV submitted under this protocol must include the following:

1. Details for each study used in the derivation (including methods, results, statistical analysis),
2. Derivation method (including calculations, statistical analysis), and
3. The intended use of the *de novo* TRV.

4.5 Risk Characterization

Risk characterization must include risk estimates (Section 4.5.1) for each COPC retained from the Problem Formulation. A weight-of-evidence approach (Section 4.5.2) may also be used for risk characterization.

4.5.1 Risk Estimates

For DRA reports, the calculation of risk metrics is required to estimate the magnitude and severity of risks and inform risk management and decision making. Risk metrics include hazard quotients (HQs), hazard indices (HI), and/or human lifetime cancer risks (known as incremental lifetime cancer risks (ILCRs)).

The risk characterization section of the DRA report for human receptors exposed to environmental media with and without risk controls must include:

1. Non-carcinogenic substances
   a) A calculation of a HQ for each retained COPC and complete exposure pathway; and,
   b) A calculation of a hazard index for each retained COPC equal to the sum of HQs for each substance over all exposure pathways (regardless of whether retained COPC concentrations exceed CSR standards in all exposure media), unless toxicity is pathway specific; and,
   c) A cumulative hazard index for retained COPCs and exposure pathways when there is a common target organ or mechanism of toxicity.

2. Carcinogenic substances
   a) A calculation of ILCRs for each carcinogenic substance for each complete 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 from all exposure pathways combined for each carcinogenic retained COPC; and,
   c) A cumulative lifetime cancer risk for retained COPCs and exposure pathways when there is a common target organ or mechanism of toxicity.

For carcinogens, both carcinogenic and non-carcinogenic risk estimates must be provided unless robust rationale can be provided for the exclusion.

The risk characterization section of the DRA report for ecological receptors exposed to environmental media with and without risk controls must include:

1. For each retained COPC,
    a. A calculation of HQs for lower trophic level organisms with direct contact in the environmental media and no measurable ingestion pathway (e.g., invertebrates and plants); and,
    b. A calculation of HQs for higher trophic level organisms for each retained COPC and complete exposure pathway; and,
    c. A calculation of a cumulative hazard index for higher trophic level organisms where multiple exposure pathways are complete and can be summed (e.g., soil and food ingestion); and,
2. A cumulative hazard index for retained COPCs when best available science indicates a common target organ or a shared mechanism of toxicity.

A clear interpretation of all cumulative risk estimates must be provided, and risk estimates must be categorized as acceptable or unacceptable as defined in Section 1.0.

If the requirements specified in items 1 or 2 above, for either human or ecological receptors, are determined to be unfeasible, the DRA must provide detailed rationale for consideration by the Director. This must be accompanied by an alternative assessment supported by thorough analysis for whether the risks are acceptable or unacceptable.

4.5.2 Weight-of-Evidence in Ecological Risk Assessment

Ecological risk assessments may use a weight-of-evidence approach which involves consideration of multiple sources of information and lines of evidence. 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.

QPs must document in the DRA 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
- Canadian Council of Ministers of the Environment (CCME): Ecological Risk Assessment Guidance Document (2020)

When weight-of-evidence is used to estimate the level of ecological risk for the site, clear and preferably quantifiable, *a priori* weightings must be assigned and supported by rationale and an associated uncertainty assessment.

4.6 Uncertainty Analysis

Uncertainty in the risk assessment must be stated as a number or in writing. Uncertainties for the exposure and effects assessment datasets (e.g., uncertainty in TRVs) and statistical analysis, and risk characterizations must be identified. The implications of the identified uncertainties for the conclusions and acceptability of human or ecological risk must be included in the analysis. The uncertainty analysis must also consider how the conclusions of the DRA may change with variable climate change projections.

The complexity of the uncertainty analysis must be commensurate with the complexity of the DRA.

4.7 Risk Interpretation and Conclusions

Risk assessment conclusions must be clearly summarized and categorized as acceptable or unacceptable risk as defined in Section 1.0. Conclusions must correspond to measurement and assessment endpoints identified in the problem formulation.

The DRA 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).

5. Detailed Risk Assessment Report Submission Requirements

This protocol must be followed in the preparation and submission of a complete DRA report as required by the EMA, and CSR section 18 and 18.1 described in Section 2.0 of this protocol.

5.1 Requirements for Report Completeness

DRA 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 4.0 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 DRA 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.

4. Contain the Appendix B-1 checklist and Appendix B-2 and B-3 forms as per Sections 4.1.3.2 and 4.1.4.2 when an ecological risk assessment has been completed.

5. Provide sufficient methodological detail (e.g., sample calculations) to allow risk equations and calculated risk estimates to be independently reproduced and validated for each receptor and pathway.

6. Include the professional statement in Appendix B-4 of this protocol if a habitat and receptor assessment and field study were completed; is duly signed and where applicable bears the Professional Society stamp of the QP risk assessor(s) who completed the habitat assessment.

7. Include the professional statement in Appendix C of this protocol; is duly signed and where applicable bears the Professional Society stamp of the QP risk assessor(s) who completed the risk assessment.

5.2 Errors and omissions

Table 3 lists the most frequently noted errors and omissions specific to DRA reports. The DRA report must be sufficiently comprehensive and representative of current site substances, conditions, receptors, exposures, and risks and present information on future site conditions and risk.

Table 3. Most frequently noted examples of errors and omissions in contaminated site DRA reports submitted to the ministry

Common examples of major errors or omissions	Common examples of minor errors or omissions
• Risk assessment does not evaluate risk before and after risk controls are implemented • Risk assessment does not include or evaluate all sources, substances, transport or exposure pathways • Vapours addressed in the detailed site investigation with attenuation factors other than those required by Protocol 22 "Application of Vapour Attenuation Factors to Characterize Vapour Contamination" were not included in the risk assessment • Risk assessment lacks a conceptual site model or the conceptual site model provided does not evaluate all exposure pathways and receptors • Risk assessment does not evaluate the potential for bioaccumulation, bioconcentration or biomagnification • Risk calculations are not included for all receptors, environmental media or retained COPCs • Risk assessment does not assess credible exposure scenarios 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, 90th percentile and 95% upper confidence limit of the mean estimates • Conceptual site model for current and future land, vapour, and water use(s) contains minor errors or omissions • TRVs are not supported by a rationale for their selection • TRVs are not provided with a valid citation • TRVs are derived without adequate rationale for excluding data

Common examples of major errors or omissions	Common examples of minor errors or omissions
simplistic or otherwise unreasonable for use in risk management decisions • Risk estimates are not summed for all retained COPCs (1) that share an identical mechanism of toxicity and target organ, (2) across exposure pathways and (3) across environmental media • Risk estimates are calculated incorrectly	• A worked example for all types of calculations performed to produce risk estimates is not provided

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 based on completeness or errors is not limited by the content of this protocol.

DRA reports found to be incomplete or contain a major error will be returned 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.

6. Risk Management

6.1 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 section 18 and 18.1 require a plan for containing, controlling and monitoring any substances remaining on the site in excess of standards 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 requires applicants for an 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. All risk controls must be in place and operating effectively prior to submitting an application for a Certificate of Compliance.

A PVP must be included in applications for certification documents supported by a DRA that relies on engineered or institutional risk controls to meet risk-based standards. The PVP must consider:

- the site's vulnerability to hazards (e.g., to natural disasters, climate change impacts,); and
- how those hazards could potentially affect the risk controls selected.

The PVP must also contain contingency actions to ensure risk-based standards are met and will continue to be met.

6.2 Decision Process

Risk management decisions for contaminated sites are made based on the outcome of human health and ecological heath risk assessments. In some cases, stakeholder concerns and ecosystem services may be considered at a contaminated site to assist in decision making for risk management. QPs recommend to the ministry whether risks are acceptable on a contaminated site. The Director's decision on whether 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 the reviewer (Approved Professional, ministry reviewer, and/or the Director) with the results supporting risk management decisions.

EMA section 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.

Human Health Risk Assessment Appendices

Appendix A-1:
Classifying Substances as Carcinogenic

1.0 Introduction

A "carcinogenic substance" is defined in the Contaminated Sites Regulation as *any chemical classified as carcinogenic in accordance with a Director's protocol*. This section of Protocol 1 provides the criteria for identifying a carcinogenic substance for the purpose of performing human health risk assessments at contaminated sites in B.C.

2.0 Carcinogens

A substance is considered to be a carcinogenic substance if any of the criteria in section 2.1, 2.2 or 2.3 below are met. When a substance is not identified as a carcinogen, classifications from each of the organizations below must be provided.

A substance is considered to be a carcinogenic substance if classified in **any** of the groups listed in Table 1 below.

Table 1: Criteria for classification of substances as carcinogenic

Organization/ Agency	Classification	Reference
IARC	• Group 1: Carcinogenic to humans, or • Group 2A: Probably carcinogenic to humans	UN WHO, 2025
Health Canada	• Group I: Carcinogenic to humans, or • Group II: Probably carcinogenic to humans	Health Canada, 1994
US EPA	• Carcinogenic to humans, or • Likely to be carcinogenic to humans	US EPA, 2005
	• Known or likely human carcinogen	US EPA, 1996
	• Group A: Human carcinogen, or • Group B1: Probable human carcinogen, with limited evidence of carcinogenicity from epidemiological studies	US EPA, 1986

Notes:

Health Canada. 1994. Canadian Environmental Protection Act. Human Health Risk Assessment for Priority Substances. https://publications.gc.ca/collections/collection_2018/eccc/En40-215-41-eng.pdf

United States Environmental Protection Agency (US EPA), 1996. Proposed Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. Washington, DC. April 1996.

US EPA, 1986. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. Washington, DC. September 1986.

US EPA, 2005. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. Washington, DC. March 2005.

US EPA. Integratated Risk Information System (IRIS) Database. https://cfpub.epa.gov/ncea/iris/search/index.cfm?keyword=

United Nations World Health Organization (UN WHO), 2025. IARC (International Agency for Research on Cancer)Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol. 1 – 138. International Agency for Research on Cancer. Lyon, France. Last update: 16 April 2025. Available from: https://monographs.iarc.who.int/list-of-classifications

2.1 United Nations World Health Organization, International Agency for Research on Cancer classification

The substance has been evaluated by the International Agency for Research on Cancer (IARC; UN WHO, 2025 and has been classified as:

a) Group 1: Carcinogenic to humans, or
b) Group 2A: Probably carcinogenic to humans.

2.2 Health Canada

The substance has been classified by Health Canada using human health risk assessment under the *Canadian Environmental Protection Act (CEPA)* to be in one of the following groups described by Health Canada (1994):

a) Group I: Carcinogenic to humans,
b) Group II: Probably carcinogenic to humans,

2.3 United States Environmental Protection Agency evaluations and classifications

The United States Environmental Protection Agency (US EPA) has classified the likelihood that a substance may cause cancer using different descriptors during the development of their carcinogen risk assessment guidelines. Substances that were evaluated after 1999 (US EPA 2005) were assigned a weight-of-evidence descriptor. Substances evaluated between 1986 and 1999 were assigned an alphanumeric descriptor. When using the US EPA IRIS Database, the descriptors in sections 2.3.1 and 2.3.2 may be encountered.

2.3.1 US EPA weight-of-evidence descriptors

The substance has been evaluated under the US EPA Guidelines for Carcinogen Risk Assessment (US EPA 2005) and has been classified based on the weight-of-evidence evaluation as:

a) Carcinogenic to humans, or
b) Likely to be carcinogenic to humans.

or

The substance has been evaluated under the US EPA Proposed Guidelines for Carcinogen Risk Assessment (US EPA 1996) and has been classified as a: “Known or likely human carcinogen”.

2.3.2 US EPA alphanumeric descriptors

In the case that a US EPA weight-of-evidence evaluation is not available, the substance has been evaluated under the US EPA Guidelines for Carcinogen Risk Assessment (US EPA 1986) and has been classified as:

a) Group A: Human carcinogen, or
b) Group B1: Probable human carcinogen, with limited evidence of carcinogenicity from epidemiological studies.

3.0 Non-carcinogens

Substances not classified as carcinogenic substances under Section 2 of this protocol are considered to be non-carcinogenic substances under the Contaminated Sites Regulation.

Ecological Risk Assessment Appendices

Appendix B-1:
Detailed Ecological Risk Assessment Checklist

Instructions:
For each subsection, Column I of Section IV lists the relevant Detailed Ecological Risk Assessment (DERA) Checklist elements. A response to the question in Column I is required if "Mandatory" is listed beside that element in Column II. In Column III, the applicant's response to the checklist element must be recorded as either "yes" or "no." Column IV provides the applicant with an opportunity to include comments related to the answer provided in Column III.

A negative response to a mandatory checklist element may jeopardize a recommendation to issue a contaminated site legal instrument. In the case that a negative response is provided to a mandatory item in column III, a rationale justifying deviation from the mandatory element must be provided in Column IV. For example, if no complete ecological pathways exist now or in the future at a site, this lack of operative pathways would justify a "no" answer to exposure related mandatory elements in the checklist.

Checklist elements identified as "Optional" in Column I of Section I of the checklist may or may not be answered at the discretion of the qualified professional. These optional elements involve general good DERA practice, which, while recommended, are not considered by the ministry to be critical to completion of detailed ecological risk assessments under the CSR.

The checklist is designed to provide an opportunity for the qualified professional(s) to demonstrate that the risk assessment includes the required elements of a detailed ecological risk assessment. Determining if a particular required element of the risk assessment has been adequately addressed is the responsibility of the risk assessment reviewer (i.e., the ministry risk assessor or the risk assessment Approved Professional) for the site.

Appendix B-1: Detailed Ecological Risk Assessment Checklist

The Detailed Ecological Risk Assessment checklist below has been completed for the following site:
Site ID Number (if known)
PID or PIN
Civic address

Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
Subsection 1.0 General Requirements			
1.1 Has the DERA been completed by Qualified Professionals identified on the signatory page?	Mandatory		
1.2 Does the DERA describe how the method(s) of assessment and the findings of any previous investigation(s) were used to design and carry out the current assessment?	Mandatory		
1.3 Does the DERA describe the extent to which any previous assessment(s) were/were not relied upon?	Mandatory		
1.4 If ministry preapprovals apply to the DERA, has all required preapproval documentation been provided with the risk assessment?	Mandatory		
1.5 Does the report make it clear what assumptions and risk controls are required (if any) for the ministry certification document being applied for (e.g., Schedule B conditions for a Certificate of Compliance)?	Mandatory		
1.6 Has field data relevant to the ecological risk assessment been provided?	Mandatory		
1.7 Has laboratory data relevant to the ecological risk assessment been provided?	Mandatory		

Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
Subsection 2.0 Problem Formulation			
2.1 Have the objectives of the ecological risk assessment been documented?	Mandatory		
2.2 Were assessment and measurement endpoints for complete exposure pathways warranting further assessment defined?	Mandatory		
2.3 Were assessment and measurement endpoints linked to the risk assessment objectives?	Mandatory		
2.4 Were all current and reasonable potential future land, water and sediment uses identified in the problem formulation and considered in screening for chemical exceedances?	Mandatory		
2.5 Were assumptions associated with current and future land use documented and rationale provided (e.g., development scenario)?	Mandatory		
2.6 Were contaminants of potential concern identified?	Mandatory		
2.7 Was a conceptual site model included?	Mandatory		
2.8 Were all relevant exposure pathways (incomplete, insignificant, complete) identified and considered?	Mandatory		
2.9 If statistics were used in the DERA, was a rationale provided for the statistical methods used?	Mandatory		
2.10 Was a rationale provided for contaminants of potential concern not carried forward beyond the problem formulation?	Mandatory		
2.11 Were the terrestrial and aquatic habitat and receptors forms in Appendix B-2 completed?	Mandatory		
2.12 Were receptors of potential concern identified based on commonly accepted risk assessment practice, including consideration of: ecological relevance, social importance, exposure potential and contaminant sensitivity?	Mandatory		

Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
2.13 Was the site assessed for likely use species at risk?	Mandatory		
2.14 If exposure pathways were excluded from further assessment, was a rationale provided?	Mandatory		
2.15 If bioassays were used, was detailed rationale provided for the selection of the toxicity tests used, (e.g., consideration of: sensitivity of the organism to the contaminants of potential concern; potential confounding factors; taxonomic diversity, etc.)?	Mandatory		
2.16 If the assessment of risk was based on several lines of evidence, was the approach used to evaluate individual lines of evidence and to integrate findings across lines of evidence documented?	Mandatory		
2.17 Were future contaminant concentrations and potential contaminant degradation products considered?	Mandatory		

Subsection 3.0 Exposure Assessment			
3.1 Was each complete exposure pathway evaluated in the exposure assessment?	Mandatory		
3.2 Was each applicable land use scenario (current and future) evaluated?	Mandatory		
3.3 Was supporting rationale provided for methods used to estimate exposure point concentration(s)?	Mandatory		
3.4 If a fate and transport model was used to estimate exposure concentrations, were model equations provided and referenced?	Mandatory		
3.5 Were equations and the input data provided to support an independent quality assurance check for each exposure estimation in the risk assessment?	Mandatory		
3.6 If an exposure model (e.g., food chain modelling) was used, was rationale provided for the selection of each parameter used in exposure estimation (with references where applicable)?	Mandatory		

Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
3.7 If an exposure model was used, were the model's results compared to, or calibrated to, empirical (i.e., measured data) to determine if the model adequately represents reality?	Optional		
3.8 For any models used, was a sensitivity analysis or a rationale for the absence of a sensitivity analysis provided?	Optional		
3.9 Were data quality objectives established for field parameters used in the risk assessment?	Optional		

Subsection 4.0 Effects Assessment			
4.1 If ecological surveys (e.g., plant, soil invertebrate, bird, fish, or benthic communities) were conducted, was the survey methodology used (including sampling locations and seasons) documented?	Mandatory		
4.2 If toxicity reference values (TRVs) were used, was a rationale for the selection and/or development of the TRVs provided and referenced?	Mandatory		
4.3 If site-specific TRVs were derived, was the methodology detailed (e.g., rationale for excluding specific toxicity data) in the risk assessment?	Mandatory		
4.4 If TRVs were used, was the toxicity endpoint associated with each TRV identified?	Mandatory		
4.5 Did the level of protection used in the DERA comply with the level specified in Table 2 for the applicable land use or media?	Mandatory		
4.6 If risks were evaluated relative to: a reference site(s) or reference condition(s), was rationale for the selection of the reference site(s) or reference condition(s) provided? Were confounding variables (e.g., soil: texture, pH, grain size, depth etc.) addressed and considered in the evaluation?	Mandatory		

Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
4.7 If site-specific toxicity testing was conducted, were the methods used considered acceptable to the ministry as per section 4.4.2.3 of this protocol?	Mandatory		
4.8 If site-specific toxicity tests were conducted, did the tests include samples from the most contaminated area of the site?	Mandatory		
4.9 Were potential toxicological interactions (e.g., synergistic or antagonistic effects) between contaminants of potential concern discussed?	Mandatory		
4.10 Were up to date toxicity profiles provided for each contaminant of potential concern?	Mandatory		
Subsection 5.0 Risk Characterization			
5.1 Was sufficient detail provided for equations used to calculate numeric risk estimates so that it is clear how the estimates were derived?	Mandatory		
5.2 Were hazard quotients calculated for each complete exposure pathway identified in the Problem Formulation?	Mandatory		
5.3 If an ecological hazard quotient exceeded one, but the level of risk was considered acceptable, was a rationale provided?	Mandatory		
5.4 Were risks for all complete exposure pathways detailed in the problem formulation assessed and categorized as acceptable or unacceptable?	Mandatory		
5.5 Were the conclusions (i.e., risk characterization) consistent with the assessment endpoints?	Mandatory		
5.6 Does the risk assessment provide an explicit risk conclusion in regard to the significance of the ecological risk posed by the contamination at the site?	Mandatory		

Subsection 6.0 Uncertainty Assessment

Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
6.1 Were uncertainties (e.g., measurement uncertainty, random variations, conceptual uncertainty and ignorance) explicitly evaluated and stated, including their implications on risk conclusions?	Mandatory		
6.2 If an exposure model was used, was uncertainty regarding both: (a) the structure of the exposure model and (b) the parameter values used in the exposure model, considered in any interpretation of the results of the exposure modelling?	Mandatory		
6.3 If a weight-of-evidence approach was used, was preference given to assigning quantifiable, *a priori* weightings to weighted aspects of the DERA?	Mandatory		
6.4 If a weight-of-evidence approach was used, were the weight-of-evidence conclusions determined in a manner consistent with the approach laid out in the problem formulation?	Mandatory		
6.5 If a weight-of-evidence approach was used, were uncertainties associated with the use of the assigned weightings explicitly evaluated and stated, including their implications on risk conclusions?	Mandatory		
6.6 Were impacts from climate change considered and described in the Uncertainty Assessment?	Mandatory		

Appendix B-2
Terrestrial Habitat and Receptor Identification Questionnaire

STEP 1: Potential Terrestrial Habitat			
	Does the Site contain Potential Terrestrial Habitat?	**No - Move to the next question**	**Yes**
a)	Does the Site have Agricultural, Wildland, or Park land use?		
b)	If Residential land use applies, does it have 50 m^2 or more of undeveloped land?		
c)	If Commercial or Industrial land use applies, does it have 1000 m^2 or more of undeveloped land?		
d)	Is residential, commercial or industrial land within 300 m of sensitive habitat?		
Where: "**undeveloped land**" means any bare or vegetated soil, excluding actively maintained (a) gravelled walkways, (b) roadways or highways and associated roadside or highway margins, (c) parking areas, (d) planters and similar structures which contain and isolate soil, (e) storage areas at active commercial and industrial operations, and (f) railways and associated railway beds. "**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 Regulation; or (e) riparian assessment areas as defined in the Riparian Areas Protection Regulation.		If **all questions** were answered 'No', Potential terrestrial habitat is not considered to apply at the Site. **Step 2 not required**.	If **one question** was answered 'Yes', Potential Terrestrial Habitat is considered to apply at the Site. **Go to Step 2.**

STEP 2: Terrestrial Receptor Identification					
	Receptor Group	**Receptor Type**	**Species-at-Risk present or potentially present at the Site?**	**Receptor present or potentially present at the Site?**	**Rationale Summary** (e.g., site observations, species habitat type, etc.)
a)	Primary Producer	Moss, lichen, herbs (grasses, forbs)			
		Shrubs			

		Trees			
		Fungi			
b)	Invertebrate	microorganism community			
		ground-dwelling			
		aerial			
c)	Mammal	herbivorous			
		insectivorous			
		carnivorous			
		omnivorous			
d)	Bird	herbivorous			
		insectivorous			
		carnivorous			
		omnivorous			
e)	Amphibian	carnivorous			
f)	Reptile	carnivorous			

Appendix B-3

Aquatic Habitat and Receptor Identification Questionnaire

STEP 1: Aquatic Habitat Assessment			
	Is risk assessment of the aquatic receiving environment required?	**No - Move to the next question**	**Yes**
a)	Do concentrations of substances in groundwater exceed the aquatic life standards in Schedule 3.2 at any depth ≤ 10 meters inland from the aquatic receiving environment (where the source of contamination is located at least 10 meters inland from the high-water mark)? [1]		
b)	Do substances in water exceed the aquatic life standards in Schedule 3.2 at any point where there is a potential preferential pathway or at any point where less than 1/10th dilution is available prior to discharge to an aquatic receiving environment? [1]		
c)	Do concentrations in sediment exceed the applicable standards in Schedule 3.4? [1]		
d)	Is a non-prescribed substance linked to site activities present in environmental media in a manner that could allow it to enter the aquatic receiving environment and potentially adversely affect human health or the environment?		
Where: 1. As per the CSR section 11(3) and section 17(2), this question does not apply where the concentration of a substance is less than the local background concentration. 2. Step 2 may not be required if detailed rationale can be provided. For example, Step 2 may be omitted if it can be demonstrated that the B.C. Water Quality Guidelines are met at all depths at the high-water mark and the answers from c) and d) are "no."		If **all questions** were answered 'No', aquatic habitat is not a receiving environment of concern for the site. **Step 2 not required.**	If **one question** was answered 'Yes', aquatic habitat is a receiving environment of concern for the site. **Go to Step 2 or provide detailed rationale.**[2]

STEP 2: Aquatic Receptor Identification					
	Receptor Group	**Receptor Type**	**Species-at-Risk present or potentially present at the Site?**	**Receptor present or potentially present at the Site?**	**Rationale Summary** (e.g., site observations, species habitat type, etc.)
a)	Primary Producer	phytoplankton			
		periphyton			
		plants and algae			
b)	Pelagic invertebrate	zooplankton			
		others			
c)	Benthic invertebrate	epifauna			
		infauna			
d)	Fish	benthivorous			
		planktivorous			
		piscivorous			

STEP 2: Aquatic Receptor Identification					
	Receptor Group	**Receptor Type**	**Species-at-Risk present or potentially present at the Site?**	**Receptor present or potentially present at the Site?**	**Rationale Summary** (e.g., site observations, species habitat type, etc.)
e)	Mammal	herbivorous			
		piscivorous			
		omnivorous			
f)	Bird	herbivorous			
		insectivorous			
		piscivorous			
		omnivorous			
g)	Amphibian	carnivorous			
h)	Reptile	omnivorous			

Appendix B-4

Professional Statement and Signature of
Qualified Professional Completing the Habitat and Receptor 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:

1. I have demonstrable experience in, and my area of practice includes, the assessment of the ecological habitat and organisms evaluated in this risk assessment.
2. The habitat and receptor 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 assessment of habitat and ecological organisms 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.>

Detailed Risk Assessment Professional Statement

Appendix C

Professional Statement and Signature of Qualified Professional 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:

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.
3. I am responsible for:
   - ☐ Human Health Risk Assessment
   - ☐ Ecological Risk Assessment

_____	_____	_____
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.