Contaminated sites policy framework

Alberta

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1.0 Introduction

1.1. Purpose

This document presents the Government of Alberta's policy framework for the management of contaminated sites. It applies when developing and assessing options for management of contaminated lands in Alberta. The framework informs on Director Requirements under Part 5, Release of Substances in the *Environmental Protection and Enhancement Act* (EPEA), (Government of Alberta, 2022a, as amended) as it relates to Sections 110, Duty to Report a Release, 111, Manner of Reporting, and 112, Duty to take Remedial Measures. It supports the requirements for the Remediation Regulation (Government of Alberta 2022b). This document is not intended to provide information regarding other regulatory requirements outside of Part 5 of the EPEA and the Remediation Regulation. It does not provide information on enforcement actions for non-compliance.

For energy activities, the Alberta Energy Regulator (AER) as a provincial regulator will use the Contaminated Sites Policy Framework to ensure the department's objectives are met. The AER operationalizes the department's policies, including policies for contaminated site assessment, risk management and remediation. The AER provides feedback on, and input into, the department's policies from an operational perspective.

1.2. Relationship to other guideline documents

This document provides the framework for the Alberta Tier 1 Soil and Groundwater Remediation Guidelines (Alberta Tier 1) (AEP 2022a, as amended), Alberta Tier 2 Soil and Groundwater Remediation Guidelines (Alberta Tier 2) (AEP 2022b, as amended), the Exposure Control Guide (AEP, 2016b, as amended), the Environmental Site Assessment Standard (AEP, 2016a, as amended) and the Risk Management Plan Guide (AEP 2017a, as amended) (see Figure 1). This document supersedes the Draft Policy for Management of Risks at Contaminated Sites in Alberta (AENV, 1999).

1.3. Legislation

Two key acts, the EPEA, and the *Water Act* (Government of Alberta, 2022c, as amended) form the legislative basis of Alberta Environment and Protected Areas (EPA), also referred to as "the department," policy on the management of contaminated soil and groundwater. Alberta's Remediation Regulation (Government of Alberta, 2022b, as amended) forms key legislative requirements for taking remedial measures on substance releases to soil or groundwater.

1.3.1. *Environmental Protection and Enhancement Act*

The EPEA lays out the regulatory requirements related to substance releases, remediation, and reclamation in Alberta. The purpose of the EPEA is "to support and promote the protection, enhancement and wise use of the environment." The EPEA allows the Minister to establish guidelines and objectives.

1.3.1.1. Substance release provisions

The EPEA prohibits the release of substances in an amount that causes or may cause a significant adverse effect. "Release," "substance," and "adverse effect" are defined in the EPEA. The release of a substance to the environment can occur rapidly (as in the rupture of a vessel containing the substance) or over a longer period (as with a gradual leak from an underground pipeline that goes undetected). The duty to report a release is stated in section 110 of the EPEA. Remedial measures must be implemented whenever a release may cause, is causing, or has caused an adverse effect (EPEA Section 112). Additional guidance on release reporting to EPA can be found in A Guide to Release Reporting (AENV, 2005). For the AER, additional information can be found at www.aer.ca.

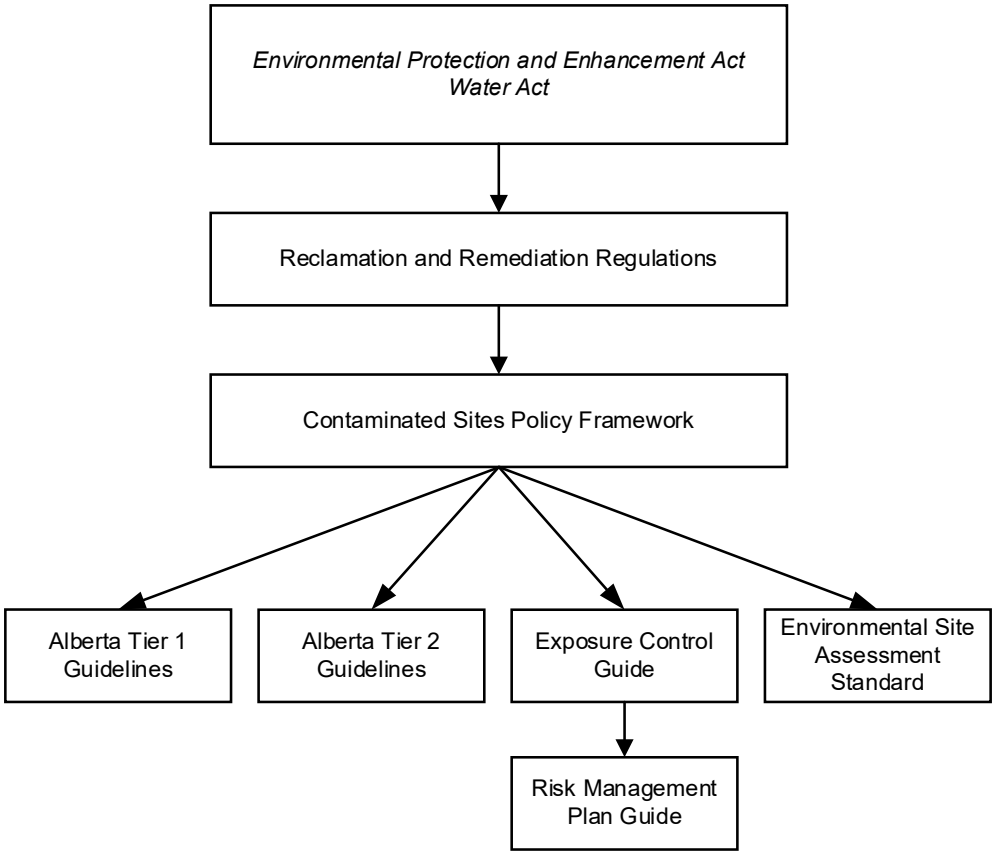

FIGURE 1: RISK MANAGEMENT FOR CONTAMINATED SITES: RELATIONSHIP BETWEEN POLICY DOCUMENTS

Reclamation and Remediation Regulations: include existing or future regulations under the EPEA that pertain to reclamation or remediation in Alberta.

Contaminated Sites Policy Framework: provides policy guidance for the management of contaminated sites in Alberta. It provides overall policy links to site assessment guidance (Environmental Site Assessment Standard) and the options for management of contaminated sites (Alberta Tier 1, Alberta Tier 2, and Exposure Control Guide). It applies when developing and assessing options for management of contaminated lands in Alberta.

Alberta Tier 1 Guidelines: Alberta Tier 1 Soil and Groundwater Remediation Guidelines are generic remediation guidelines. They are developed to protect sites at the more sensitive end of the range and can be used at most sites without modification.

Alberta Tier 2 Guidelines: Alberta Tier 2 Soil and Groundwater Remediation Guidelines apply the same protection objectives as Tier 1 but allow for modification of the Tier 1 Guideline value based on site-specific conditions.

Exposure Control Guide: exposure control involves risk management through exposure barriers or administrative controls based on site-specific risk assessments. This document clarifies the Government of Alberta's expectations for exposure control plans if this is to be considered as an option for management of risks at a contaminated site.

Environmental Site Assessment Standard: outlines minimum requirements for conducting environmental site assessments (ESAs) in Alberta. It is intended to assist in planning, implementation, and interpretation of the results of Phase 1 and 2 ESAs, remediation and confirmatory investigations.

1.3.1.2. Remediation Regulation

Whenever a release may cause, is causing, or has caused an adverse effect, appropriate remedial measures must be taken (EPEA, Section 112) as soon as the person responsible becomes aware of or ought to have become aware of the release. Under Section 2 of the Remediation Regulation, the following documents are incorporated for this purpose:

1. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. (AEP, 2022a, as amended)
2. Alberta Tier 2 Soil and Groundwater Remediation Guidelines (AEP, 2022b, as amended)
3. Environmental Site Assessment Standard (AEP, 2016a, as amended)
4. Exposure Control Guide (AEP, 2016b, as amended)
5. Risk Management Plan Guide (AEP, 2017a, as amended)

Section 2.3 of the Remediation Regulation requires that land *must* be remediated to meet the requirements of the Tier 1 Guidelines. However, section 2.4 of the Regulation specifies that a person *may* remediate an area of land or site in accordance with the Tier 2 Guidelines if:

- The Tier 2 Guidelines meet the equivalent protection of environment and human health as outlined in the Tier 1 Guidelines to the satisfaction of the director.
- The area of land or site is remediated to the satisfaction of the director.

If the site cannot be remediated to the satisfaction of the director within a two-year period after a person responsible becomes aware of or ought to have become aware of the release, a remedial action plan acceptable to the director must be immediately submitted in accordance with the requirements of the Guidelines.

Section 117 of the EPEA authorizes the director or inspector to issue a remediation certificate when contaminated land has been remediated. Two types of remediation certificates are available:

- Limited Remediation Certificate: addresses only a single substance release and a single area of potential environmental concern.
- Site-based Remediation Certificate: addresses all Contaminants of Potential Concern and Areas of Potential Concern associated with the site.

The remediation certificate is a voluntary process of regulatory closure. Further information on the requirements for and limitations on the application for Remediation Certificates is available in the Remediation Regulation and Alberta's Remediation Certificate Program (Government of Alberta, 2019c). For EPA regulated activities, the Alberta Limited Remediation Certificate Guide (Government of Alberta, 2019a) and Alberta Site-Based Remediation Certificate Guide (Government of Alberta 2019b) provide additional information on the application for remediation certificates. For AER regulated activities, refer to the remediation process outlined on the AER's "Contamination Closure" website and within AER Manual 021: Contamination Management (AER, 2021).

1.3.1.3. Conservation and reclamation

The EPEA includes requirements for the conservation and reclamation of specified land. Specified land is defined in the EPEA and in the Conservation and Reclamation Regulation (C&R Regulation; Government of Alberta, 2022d). The EPEA and the C&R Regulation require reclamation of specified land to an equivalent land capability. Equivalent land capability is defined in the C&R Regulation.

With respect to soil and groundwater contamination on specified land, Alberta Tier 1 establishes generic remediation guidelines for achieving equivalent land capability. The process for developing site-specific remediation guidelines for achieving equivalent land capability is described in Alberta Tier 2.

1.3.2. *Water Act*

Water is a public resource and is owned and regulated by the Government of Alberta. The *Water Act* provides the regulatory requirements related to the management of water supplies and water quality. The purpose of the *Water Act* is "to support and promote the conservation and management of water, including the wise allocation and use of water". The *Water Act* allows the Minister to establish guidelines for water management.

1.4. Desired outcomes

Alberta's framework for the management of contaminated sites is designed to achieve three policy outcomes:

- Pollution prevention: avoid impairment of, or damage to the environment, human health or safety, or property.
- Health protection: take action on contaminated sites that is commensurate with risk to human health and the environment.
- Productive use: encourage remediation and return of contaminated sites to productive use.

Pollution prevention is a critical factor in maintaining a healthy environment. The department's policy emphasizes the importance of proactive efforts that keep soil and groundwater clean and free of contaminants rather than relying on remediation after contamination has occurred. Remediation programs are often costly and, in the case of large and complex contaminant releases, may not be capable of fully restoring the quality of contaminated land or water leading to a loss of land or water use options. Soil and groundwater contamination may be prevented or minimized by exercising care and control through the following:

- Proper siting for facilities and chemical storage areas.
- Secondary containment of contaminants of potential concern (COPC).
- Regular inspections and maintenance of facilities, tanks and pipelines.
- Soil and groundwater monitoring programs.
- Early source identification and removal or management.
- Proper waste disposal and management.

One of the purposes of the EPEA is "to support and promote the protection, enhancement and wise use of the environment." Proactive prohibition on release of substances is a critical step for contamination prevention. Part 5 of the EPEA prohibits "the release of substances in an amount that causes or may cause a significant adverse effect."

If contamination has occurred, three key elements of Alberta's framework for management of contaminated sites are employed: source control, contamination delineation, and contaminant management, including remediation.

Under productive use, the goal is to preserve as wide a range of options for use of the land when a substance release has occurred. There are many competing needs for land. Contamination can restrict land use or even prevent any form of productive land use. The goal of contaminant management is to return land to unrestricted use wherever feasible. Where this is not feasible, the highest and best use of the land needs to be considered in how the land is remediated.

1.5. Alberta's Contaminated Sites Policy Framework

Where a substance release has occurred, the department's policies promote the return of contaminated sites to productive use and ensure that risks to human health and the environment are minimized. For energy activities, the AER, as the provincial regulator will use these policies to ensure the same objectives are met for these activities. Figure 2 provides an overview of the requirements for reporting, site assessment and contaminant management in Alberta.

A detailed overview of reporting requirements is beyond the scope of this document, but reporting has been included in Figure 2 for completeness. Sections 110 and 111 of EPEA provide the basis for reporting substance releases. Alberta's Release Reporting Regulation (Government of Alberta, 2021) specifies what must be reported, when how and to whom. A Guide to Release Reporting (AENV, 2005) provides further information about Alberta's reporting requirements. Alberta's Remediation Regulation further clarifies the duty to remediate under Section 112 of the EPEA and ongoing reporting requirements to the Director. Alberta's Environmental Site Assessment Standard (AEP, 2016a, as amended) provides additional information regarding requirements for Phase 1 and Phase 2 Site Assessments. Where risk management options are used, the Exposure Control Guide (AEP, 2016b, as amended) and Risk Management Plan Guide (AEP, 2017a, as amended) further clarify reporting requirements for risk management plans.

Requirements related to reclamation of specified land under Part 6 of the EPEA are also beyond the scope of this document and have not been included in this overview. A Phase 2 Environmental Site Assessment and/or remediation report(s) may be required as part of a reclamation certificate application for specified land.

Under the Contaminated Sites Policy Framework, strategies for the management of risks at contaminated sites in Alberta include Tier 1 Guidelines, Tier 2 Guidelines, and Exposure Control. As outlined in the Tier 1 Guidelines, remediation may meet generic objectives. These guidelines were developed to protect more sensitive receptors expected to be present within a given land use; therefore, they can be used at most sites without modification.

Alternatively, the proponent may employ modified risk-based remediation objectives as outlined in the Tier 2 Guidelines. Under Tier 2, it may be possible to screen out certain exposure pathways and/or modify the Tier 1 Guidelines based on site conditions. The Alberta Tier 2 Guidelines describe how the Tier 2 approach might be used to develop remediation objectives for a site. Development of site-specific remediation objectives requires more detailed planning and a more detailed site-specific ecological and human health risk assessment. For this option, more interaction with the appropriate regulator for the industry sector is expected. General principles for Tier 2 site-specific risk assessment are provided in the Alberta Tier 2 Guidelines. More detailed guidance on the site-specific risk assessment option is provided in the Supplemental guidance on site-specific risk assessments in Alberta (Government of Alberta, 2022e, as amended).

The Exposure Control Guide (AEP, 2016b, as amended) outlines requirements if exposure control is used as an option as opposed to remediation to Tier 1 or Tier 2 objectives. It also outlines requirements for source control, mitigation of off-site contamination, regulatory and stakeholder input and agreement, and lists other fundamental requirements independent of risk. If exposure control is used as an option for management of risks, a risk management plan must be submitted to and accepted by the regulator. Further information on the requirements for risk management plans is contained in the Risk Management Plan Guide (AEP, 2017a, as amended). Under this policy, risk management will lead to conditions or restrictions which would preclude regulatory closure.

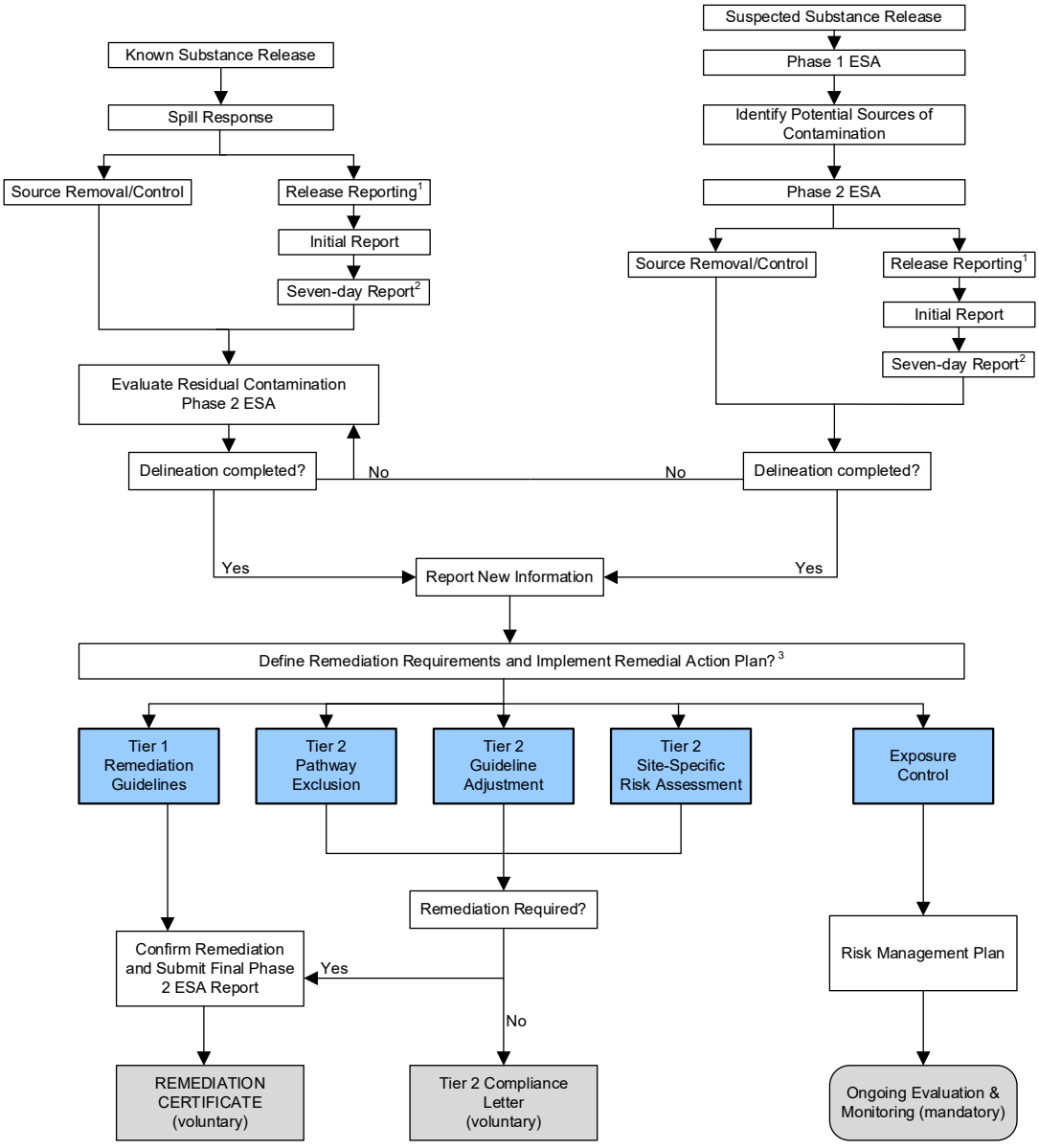

FIGURE 2: FRAMEWORK FOR CONTAMINATED SITE MANAGEMENT IN ALBERTA

[1]Substance releases into the environment that may cause, is causing, or has caused an adverse effect must be reported to the appropriate regulator at the time of discovery. An adverse effect is impairment of, or damage to the environment, human health or safety, or property. Sections 110 and 111 of EPEA provide the basis for Alberta's Release Reporting Regulation (Government of Alberta, 2021), which specifies what must be reported, when how and to whom. A Guide to Release Reporting (AENV, 2005) provides further information about EPA requirements for reporting a release. For activities regulated by the AER, additional information is also available in the Release Reporting Requirements (AER, 2022).

[2]This step will depend on the complexity of the situation. In some instances, such as abandoned well sites or pipelines where contamination is discovered as part of reclamation activities, there may be no need to submit a 7-day report. In other instances, such as small spills that are addressed quickly after the release, sites may move directly from the 7-day report to remediation. For other, more complex sites, this step may result in several iterations of the Phase 2 Environmental Site Assessment prior to remediation.

[3]Since January 1, 2019, the Remediation Regulation requires as soon as possible after the person responsible becomes aware of or ought to have become aware of the release submit a Phase 2 Environmental Site Assessment or complete remediation and submit a report as per the guidelines. Where a site cannot be remediated to the satisfaction of the director within a two-year period after the person responsible becomes aware of or ought to have become aware of the release a remedial action plan acceptable to the director must be immediately submitted. For EPA regulated activities refer to the Remedial Action Plan Guide (AEP, 2021), that includes timelines for completion of a complete site assessment and either remediation or exposure control. For AER regulated activities refer to AER Manual 021: Contamination Management (AER, 2021).

2.0 Stakeholder roles and responsibilities

2.1. Role of proponent

For this document, the term “proponent” is used broadly to encompass any person that is initiating an environmental site assessment (ESA) that must be reported to the appropriate regulator for that industry sector. This may include any of the people responsible, owner, operator as defined in the EPEA or any other person who initiates an ESA that must be reported to the appropriate regulator for the industry sector.

Reports pertaining to energy activities should be directed to the AER.

2.1.1. Duty to report and duty to take remedial measures

As directed in the EPEA, the person responsible is required to report the substance release to the director, other local authorities, and relevant persons as defined in the EPEA, and take timely remedial measures. When the person responsible becomes aware of, or ought to have become aware of the release, the duty to report and take remedial measures would apply at the time of discovery (see Figure 2). When an ESA must be submitted to the appropriate regulator as part of a substance release report, the proponent must fulfill all responsibilities as specified in the Phase 1 ESA Standard published by the Canadian Standards Association (CSA, 2022), the Phase 2 ESA Standard (CSA, 2018) and the department’s Environmental Site Assessment Standard (AEP, 2016a, as amended).

Once the substance has been released, or that responsible person ought to have become aware of the release, it is the responsibility of the person to define the remediation requirements and implement a remedial action plan (Figure 2). During further investigation, it is possible that additional information may be discovered about the nature, effect or extent of the substance release to a person or land. It is the responsibility of the proponent to ensure that the director and any affected party are kept informed about the substance release as new information becomes available. If a remediation program cannot be completed within two years after a person responsible becomes aware of, or ought to have become aware of the release, the person responsible must immediately complete a remedial action plan and submit it in accordance with the requirements of the guidelines to the director. The person is also responsible for submitting any additional information that the director requires.

In addition, the proponent must:

- ensure that all acts, regulations, procedures, and other regulatory guidance in Alberta are followed during the work
- ensure that all appropriate documents are submitted to the regulator(s), all affected third parties, and that the information is accurate, consistent, and complete
- ensure that the site’s environmental conditions are suitable for its intended use and it meets all legal conditions and requirements

2.2. Role of environmental professionals

The professional provides guidance to the proponent to ensure that all relevant regulatory requirements in provincial and municipal governments for contamination management, remedial measures and reclamation are adhered to. The environmental professional must be a member in good standing with one of the following: Alberta Institute of Agrologists (AIA), Alberta Society of Professional Biologists (ASPB), Association of Professional Engineers and Geoscientists of Alberta (APEGA), Association of the Chemical Profession of Alberta (ACPA), Association of Alberta Forest Management Professionals (AAFMP), or the Association of Science and Engineering Professional Technologists of Alberta (ASET). The professional must maintain professional competency as outlined in Professional Responsibilities in Completion and Assurance of Reclamation and Remediation Work in Alberta - Joint Practice Standard (Alberta Institute of Agrologists et al., 2012), have a minimum of five years of relevant experience based on the Competencies for Reclamation and Remediation Advisory Committee's Recommendations Report

(AENV, 2006) and carry adequate insurance throughout the duration of the assessment, including but not limited to general liability and errors and omission insurance.

2.3. Role of the department

The role of the department is to ensure Alberta's established environmental outcomes are protective of human health and the environment. The department develops new and improves existing provincial standards, guidelines and other regulatory tools to provide assurance of the environmental outcomes related to management of contaminated sites. The department works closely with the AER to ensure that these policies will meet the intended outcomes for all industry sectors.

The department also promotes assessment, proper management of risks and productive use of contaminated sites. This may be achieved through programs such as remediation certification, reclamation certification, professional sign-off for site assessment reports and brownfield strategies.

The department and the AER provide access to environmental information that is under their jurisdictions regarding contaminated or potentially contaminated sites.

The department engages with professional members, agencies, other government departments, industry and the general public for implementation of policies and regulations related to remediation and management of contaminated or potentially contaminated sites.

2.4. Role of the Alberta Energy Regulator

The Alberta Energy Regulator (AER) is the single regulator of energy development activities in Alberta across the life cycle from initial application to operation to closure. The AER operationalizes the department's policies, including policies for contaminated site assessment, risk management and remediation.

Regulatory oversight of energy activity contaminated sites is conducted using the AER's directives and the department's policies. Further information is available in AER Manual 021: Contamination Management (AER, 2021) and Directives. The AER reviews remediation certificate applications and reclamation certificate applications for energy activities and issues a certificate if the area meets the department's policies.

The AER's compliance assurance program and supporting processes use education, prevention and enforcement activities to facilitate efficient and effective compliance with legislation, AER's directives and the department's policies.

The AER provides feedback on and input into the department's policies from an operational perspective.

3.0 Principles of contaminant management

The EPEA requires remedial measures to be implemented whenever a release is causing, has caused or may cause an adverse effect. The implementation of remedial measures involves key elements of Alberta's framework for the management of contaminated sites: source control, environmental site assessment, risk assessment, and contaminant management including remediation.

3.1. Source control

A source of contamination is anything that adds contaminant mass to the environment. Source control is a necessary action in support of pollution prevention, a key outcome of Alberta's policy on contaminated site management. Failure to control sources allows contaminants to spread, increasing risk and remediation costs, and potentially limiting future land use if remediation to the Tier 1 or Tier 2 Guidelines is not possible. If there is evidence of soil or groundwater contamination, the source, if it is still present, must be identified and removed or controlled. Source control is not considered complete unless it can be demonstrated that contaminant migration has either stabilized or decreased in all environmental media and that the degree of contamination at any point is unlikely to worsen over time.

To ensure consistency with pollution prevention, the Tier 1 Guidelines are not "pollute-up-to" levels. The department requires responsible environmental practices and does not accept the action of polluting up to a limit. If an ESA detects cumulative release of substances to the environment, mitigative measures must be taken, including at a minimum source control, even when a contaminant concentration is below an applicable soil or groundwater quality standard. Sources must not be left uncontrolled until cumulative releases result in an exceedance of a remediation guideline value in the Tier 1 or Tier 2 Guidelines.

Contaminants can be introduced from a variety of sources. Leaking pipelines and storage tanks are common sources of contamination. Contaminated soil and groundwater may be a source of contamination to other areas of a site if the contaminants are mobile. Soil or groundwater with naturally elevated substance concentrations may become a source of contamination if they are redistributed and cause the receiving soil or water to exceed the Tier 1 or Tier 2 Guidelines.

There is differentiation between sources that are remediated to an acceptable land use endpoint and those that are managed by exposure barriers and administrative controls. Where complete source removal is not feasible, the source must be removed to the greatest extent possible and treatment, control and/or management measures must be implemented to address the residual source. Where this option is employed, the source is managed through exposure control and the site will not be eligible for a remediation certificate or Tier 2 compliance letter.

Control or management measures must prevent the contaminant from spreading to adjacent areas. If source control measures are required, they must operate until the contaminant concentration meets the Tier 1 or 2 Guidelines. Source control must be supported by a monitoring program that demonstrates its efficacy.

3.2. Environmental site assessment

An ESA is implemented to determine whether soil or groundwater contains contaminants exceeding the Tier 1 or Tier 2 Guidelines. The ESA process may be conducted in phases, but the overall process must be thorough enough to characterize site conditions, identify and delineate all areas of potential environmental concern (APEC) prior to being considered complete. Additional ESA information can be found in the department's Environmental Site Assessment Standard (AEP, 2016a, as amended).

Environmental site assessments must be extensive enough to review the site information, summarize the site conditions, and complete a conceptual site model. The ESA report must summarize the relevant site information from a risk perspective, identify issues that may pose unacceptable risks, and facilitate the evaluation of the exposure scenarios. This would include an evaluation of all COPCs, APECs, human and ecological receptors, and exposure routes including preferential pathways.

As part of the ESA, complete delineation must be accomplished. All risk assessments must include complete delineation, including risk assessments that compare against the Tier 1 Guidelines. Where delineation is not complete, the regulator will assume that the risk assessment is not accurate.

Delineation provides information needed to support appropriate decisions about contaminant remediation and management. Delineation programs must be extensive enough in both horizontal and vertical directions to enable the proper assessment of all applicable exposure pathways and receptors. Where this includes risk to the groundwater pathway, delineation will include characterization of the surficial and bedrock geology unit contributing to lateral or vertical groundwater flow to a depth consistent with the scale of the hydrogeological assessment required. Delineation is considered complete when measured concentrations are consistently less than the Tier 1 or Alberta Tier 2 Guidelines developed using the pathway exclusion approach.

In some instances, aspects of remediation, source control or exposure control may be undertaken simultaneously with delineation. For instance, this might occur when there is an immediate risk to human health, or the environment and remediation and exposure control must be initiated simultaneously with delineation, or for simple excavations where compliance with the Tier 1 Guidelines is shown by a sufficient number of post-excavation confirmatory samples from the excavation base and side walls. This work, however, cannot be assumed to complete requirements for delineation and risk assessment until contaminant delineation has been completed. For instance, where post-excavation samples fail to comply with the Tier 1 Guidelines after excavation is complete, full delineation of the remaining contamination must be undertaken and used to develop further contaminant management (remediation or exposure control actions).

Where contaminant concentrations in soil or groundwater exceed the risk-based endpoints at the property boundary, delineation will only be considered complete if it is adequate to assess concentrations to the edge of the contaminated area past the property boundary.

3.3. Risk assessment

Risk assessment evaluates information on the potential toxic effects of contaminating substances on biological systems (receptors) in contact with contaminated soil, air, water and food through various exposure routes (pathways). Risk assessment must answer the following key questions:

- What contaminating substances present on the site may be a cause for concern?
- How can humans or other receptors in the environment (for example, plants and animals) become exposed to those substances, and what is the likelihood that exposure will occur?
- If exposure occurs, what is the likelihood that the substances will produce harmful effects?

Alberta Tier 1 and Tier 2 Guidelines form the basis of risk assessment policy for substance releases and contaminated-sites management under Part 5 of the EPEA in Alberta. Where a substance has been released that causes an exceedance of the Tier 1 Guidelines in soil or groundwater, it may cause adverse effect, unless otherwise demonstrated through the Tier 2 process in a manner acceptable to the Director. Sections 2.3 and 2.4 of the Remediation Regulation state that:

- A substance release to soil or groundwater must be remediated to meet the requirements of the Alberta Tier 1 Soil and Groundwater Remediation Guidelines, including all applicable numerical soil and groundwater standards applicable to the land use set out in the Alberta Tier 1 Soil and Groundwater Remediation Guidelines.
- A person may remediate an area of land or site in accordance with the Alberta Tier 2 Soil and Groundwater Guidelines if:
    - (a) the Alberta Tier 2 Soil and Groundwater Guidelines meet the equivalent protection of environment and human health as outlined in the Alberta Tier 1 Soil and Groundwater Remediation Guidelines to the satisfaction of the director; and
    - (b) the area of land or site is remediated to the satisfaction of the director.

This does not preclude other requirements or approval conditions that may be in place or requirements for source control as outlined in this framework, regardless of the concentration relative to the Tier 1 guidelines.

When a particular substance is not listed in the Tier 1 guidelines, the proponent will need to develop a site-specific remediation objective using the same procedures outlined in the Tier 1 and Tier 2 guidelines. The first step in this process will be establishing acceptable exposure endpoints for receptors.

The Tier 1 and Tier 2 guidelines are considered the primary source of information in Alberta. When the information is unavailable from these guidelines, the person will need to reference the Guidance for Selecting Toxicity Reference Values for Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines (AEP, 2017b, as amended).

3.4. Contaminant management

3.4.1. Duty to take remedial measures

As discussed in Section 1.3.1, whenever a release causes, has caused, or may cause adverse effect, appropriate remedial measures must be taken. Alberta's Remediation Regulation further clarifies the Duty to Take Remedial Measures, as outlined in the EPEA. The requirement to take remedial measures is triggered under Alberta's Remediation Regulations when the person responsible becomes aware of, or ought to have become aware of the release of a substance into the environment.

Remediation objectives are specified in the Tier 1 Guidelines and Tier 2 guidelines. The Environmental Site Assessment Standard (AEP, 2016a, as amended) outlines the procedures to be used for delineating the volume of soil or groundwater containing contaminant concentrations that exceed the Tier 1 or Tier 2 guidelines and reporting requirements for site assessments. When delineation is complete, a plan must be developed to remediate or otherwise manage the contaminants in a manner that is consistent with the framework outlined here. As indicated under Section 3.2 there are some instances, aspects of remediation, source control or exposure control may be undertaken concurrently with delineation. Using dilution to reduce contaminant concentrations is not an acceptable form of management, unless authorized by the appropriate regulatory authority under an operating approval, code of practice or directive.

If the substance release cannot be remediated within a two-year period after a person reasonable becomes aware of, or ought to have become aware of the release to the Alberta Tier 1 or Alberta Tier 2 objectives, the Remediation Regulation requires submission of a remedial action plan. If the remedial action plan is reviewed by the director and additional action or information is required, the plan must be updated in accordance the director's requirements.

Further information on remedial action plans is provided in the Remedial Action Plan Guide (AEP, 2021), for EPA regulated activities and Manual 021: Contaminant Management (AER, 2021), for AER regulated activities.

3.4.2. Remediation versus exposure control

The department distinguishes between sites that are remediated to an acceptable land use endpoint and those that are risk managed using physical, engineered, institutional and/or administrative controls. Sites managed using exposure control are not eligible for regulatory closure due to the ongoing need to manage site risk.

Exposure control requires regulatory and stakeholder consultation, regulatory acceptance of the exposure control plan and effective and accountable action by those responsible for maintaining the management program in the future. Requirements for acceptable risk management plans are described further in Alberta's Exposure Control Guide (AEP, 2016b, as amended) and Alberta's Risk Management Plan Guide (AEP, 2017a, as amended).

Exposure control may also be used as an interim measure while a site is being remediated with the goal of meeting an acceptable remedial endpoint. Once the area meets the applicable guidelines defined in Alberta's Tier 1 or Tier 2 guidelines, it is no longer considered under exposure control and will be eligible for a remediation certificate.

Exposure control will not be considered by the department for new construction on a contaminated site with residential-only or agricultural-only land use unless authorized by the director. The department recognizes the need to consider exposure control for existing residential infrastructure that has been impacted by a contaminated site.

3.4.3. Contravention of the *Environmental Protection and Enhancement Act*

Contaminant management cannot contravene any provisions in the EPEA. When adverse effects are evident, contaminants must be managed to alleviate adverse effects regardless of whether a site meets the Tier 1 or Tier 2 guidelines. Disposal of wastes or contaminated materials from remediated sites will need to be done in a manner consistent with the Act and regulations. The department's representatives are available to participate in the risk management process to ensure that all department regulatory requirements are met.

3.5. Considerations other than risk

3.5.1. Off-site contamination and impairment of property

If contamination has migrated or may migrate off the proponent's property, the proponent is required under the act to report to any affected party and take action to prevent adverse effect. In treating off-site impacts, the proponent must achieve an acceptable solution that involves input from all parties. If the proponent(s) does not have care and control of an affected property, an exposure control decision must involve input from the affected stakeholders to ensure that the plan is viable and restrictions on the land are acceptable to the impacted party. An affected third party could include owners, lessees, and tenants of a neighbouring parcel, roadway, easement, or utility corridor that is likely or actually contaminated by the migration of a substance. This could include municipalities and/or the provincial government.

In cases when the affected party will not participate in the process, the proponent must apply remediation objectives for the appropriate land use based on options outlined in the Tier 1 or Tier 2 guidelines to address adverse effect issues on the affected off-site property. More information on this issue can be found in the Exposure Control Guide (AEP, 2016a, as amended).

3.5.2. Safety, odours and nuisance

Offensive odours, safety issues and nuisance conditions are regulated under the EPEA and other provincial legislation but are not strictly related to human health or ecological effects. These issues require resolution independent of the level of human and ecological health risk on a contaminated site.

4.0 Alberta's Risk Management Framework

This section introduces the guiding principles that underlie the department's policy for risk management on contaminated sites.

In Alberta, three risk-management options are provided for contaminated sites:

- Tier 1 - generic remediation guidelines
- Tier 2 - site-specific remediation guidelines based on the modification of the Tier 1 guidelines
- Exposure Control - risk management through exposure barriers or administrative controls (may be based on site-specific risk assessment)

Regardless of the option chosen, the target level of human health and ecological protection afforded by Tier 1, Tier 2, or exposure control must be the same.

Regulatory closure is available for sites that are managed to achieve the Tier 1 and the Tier 2 remediation guidelines where no conditions are imposed on future use of the site within a given land use. Figure 3 provides an overview of the Tier 1 and Tier 2 guidelines. More information is available in the Tier 1 Guidelines and Tier 2 Guidelines.

The objective of Alberta Tier 1, Tier 2 guidelines and Exposure Control Guide is to deliver the same degree of human health and ecological protection, regardless of which option is used. Human health and ecological protection objectives must be maintained at all management levels (Alberta Tier 1, Tier 2, and Exposure Control). The same protocols are used to develop both Tier 1 and Tier 2 guidelines. The two options differ in the amount of site-specific information used to develop the guidelines.

Changes to the Tier 1 or Tier 2 guidelines that require ongoing risk management controls are exposure control. For more information see Exposure Control Guide (AEP, 2016b, as amended) and Risk Management Plan Guide (AEP, 2017a, as amended).

The Tier 1 Guidelines are simple tabular values that require minimal site information for their use. Assumptions about soil and groundwater characteristics have been set generically so they can be reasonably applied to most soil or groundwater conditions in Alberta. This will make these guidelines protective for most sites in Alberta; however, some site information is needed to ensure that site conditions are adequately represented by the assumptions used to develop the Tier 1 Guidelines. Where assumptions used in developing Tier 1 Guidelines are not conservative enough, assumptions will need to be modified and the guidelines re-assessed under the Tier 2 approach.

Applying the Tier 2 Guidelines require more information about the site than for the Tier 1 Guidelines. This additional information allows the assessor to develop guidelines that are tailored to the characteristics of the site. When a site has characteristics that make it more sensitive than the Tier 1 assumptions, the resulting Tier 2 values may be more restrictive than Tier 1 values. Sites that are less sensitive may have Tier 2 values that are less restrictive than Tier 1 values, while delivering the same level of human and ecological health protection because they are tailored to that specific site.

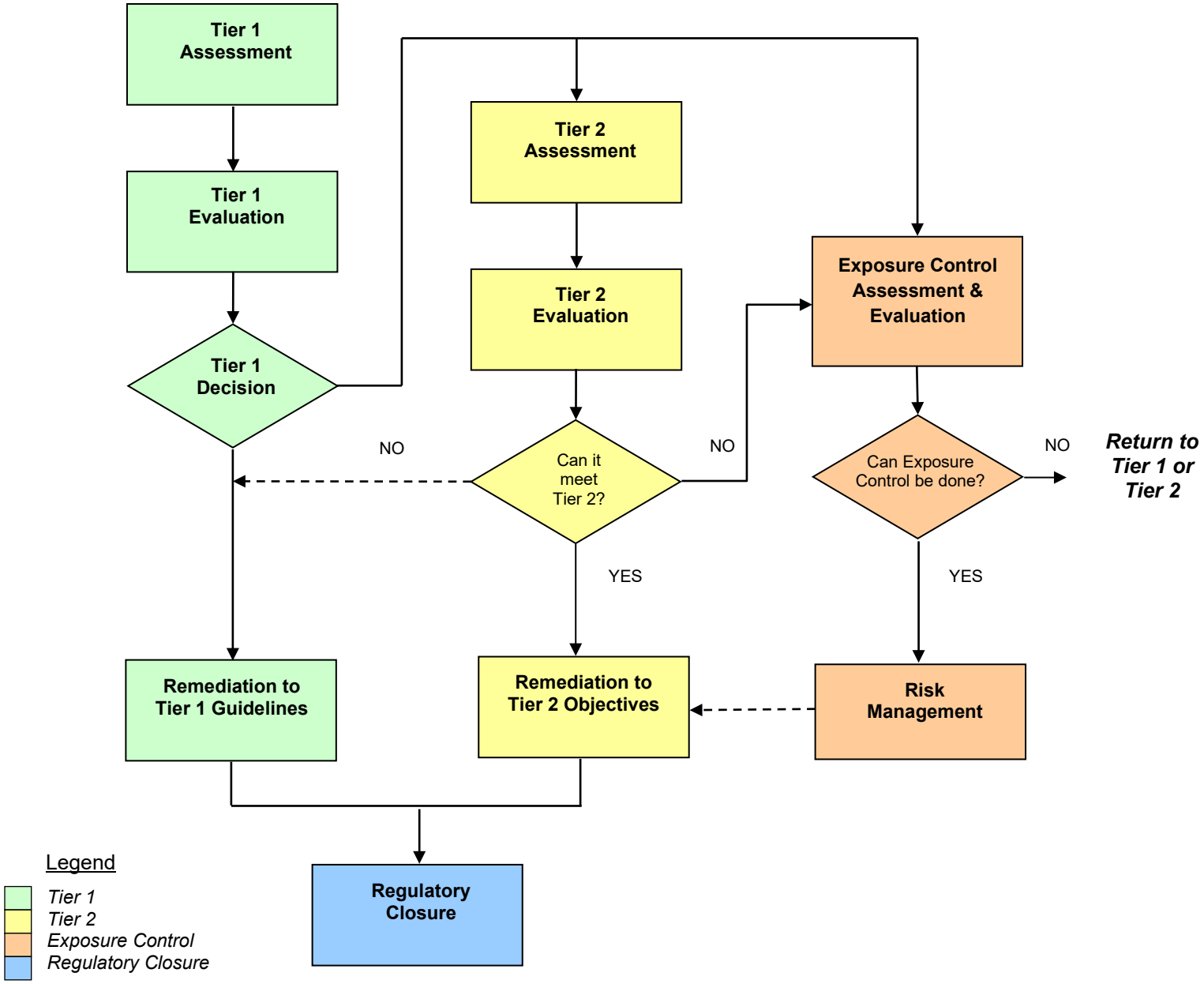

FIGURE 3: IMPLEMENTATION OF TIER 1, TIER 2, AND EXPOSURE CONTROL GUIDELINES

4.1. Alberta Tier 1 - generic remediation guidelines

Generic guidelines are based on identification of the receptors to be protected under various land uses, the applicable exposure pathways, and a corresponding set of parameters that allow reasonably conservative predictions of risk at sites throughout Alberta. Whenever possible, the derivation of risk-based Tier 1 Guidelines uses models that incorporate toxicity information, receptor characteristics, and fate and transport mechanisms.

Some contaminants have been evaluated for only a limited number of exposure pathways. If ESAs identify the presence of other influential exposure pathways related to these substances, Tier 2 Guidelines may need to be developed for these pathways.

Tier 1 Guidelines are expected to be applicable to most contaminated sites in Alberta, although site managers may choose a Tier 2 approach to incorporate more site information in the development of remediation guidelines. Even at sites that eventually apply a Tier 2 or Exposure Control approach, Alberta Tier 1 Guidelines must be used for an initial screening as the first step in a phased ESA.

There may be some situations when site conditions result in a more sensitive scenario than is captured by the conservative generic scenarios in Tier 1, or where conditions violate one or more assumptions essential to the validity of the modelling used in the Tier 1 derivation. In these cases, a Tier 2 approach will be required. Where the Tier 2 approach is required, it can be restricted to the specific pathway/receptor relationships that are in question. Where the resulting guideline is more restrictive than Tier 1, it must be implemented for the site in question. Where the resulting guideline is less restrictive, the person may apply the Tier 1 Guidelines. More information on these situations is provided in the Tier 1 Guidelines.

4.2. Alberta Tier 2 – modified remediation guidelines

There may be circumstances when site-specific conditions modify potential human and ecological exposure, relative to the generic conditions used to derive the Tier 1 Guidelines, such that the generic guidelines are unnecessarily conservative. Alternatively, site-specific conditions may increase risks to a level that render a Tier 1 approach unacceptable. Accordingly, guidance is provided on methods under which the Tier 1 Guidelines can be adjusted to a particular site, including a discussion of parameters for which generic values could be replaced by site-specific values. Some site conditions may not fit the assumptions of the Tier 1 or Tier 2 models and will require a mandatory site-specific risk assessment.

Options that can be applied at Tier 2 level are:

1. Modifying the Tier 1 Guidelines based on exclusion of exposure pathways and receptors that may not be operable at the site.
2. Adjusting the Tier 1 Guidelines using site-specific values for certain parameters determined as part of a more detailed ESA. The same models and approaches are used as for the development of the Tier 1 Guidelines and a limited range of parameter adjustments to these models is allowed based on site-specific conditions.
3. Site-specific risk assessment (SSRA).

More information on these options is provided in the Tier 2 Guidelines.

4.3. Exposure Control – risk management

Risk management relies on ongoing exposure control to mitigate risks to human health and the environment. This option is used for sites that require restrictions to the typical activities considered under a given land use or require ongoing management. This can be accomplished by providing exposure barriers such as physical or chemical barriers to exposure and/or by implementing administrative controls on a property. These options require long-term care and control by one or more responsible parties.

While this option is available for management of risks at contaminated sites, it renders the site ineligible for closure that is available under Tier 1 and Tier 2 approaches.

The use of the exposure-control guidelines is described in the Exposure Control Guide (AEP, 2016b, as amended) and the Risk Management Plan Guide (AEP, 2017a, as amended).

4.4. Using Tier 1 or Tier 2 soil and groundwater remediation objectives

4.4.1. Source control and pollution prevention

The goal of the Tier 1 or Tier 2 guidelines is to provide either generic or site-specific numerical targets for remediation of contaminated soil and groundwater. As previously discussed, these soil and groundwater remediation guidelines are not “pollute-up-to” levels. Sources must not be left uncontrolled regardless of contaminant concentration. Source control is a crucial component of proactive pollution prevention. For further information, see the Tier 1 Guidelines.

4.4.2. Background soil and groundwater quality

4.4.2.1. Definition of background

For applying the Tier 1 or Tier 2 guidelines, the background concentration of a substance in soil or groundwater is defined as:

- The natural concentration of that substance in the absence of any input from anthropogenic activities or sources; or
- The background concentration in the surrounding area because of generalized non-point anthropogenic sources.

In some situations, the background concentration of a substance can be a significant proportion of, or even exceed the Tier 1 Guidelines. In cases when the background concentration is demonstrated to be greater than the Tier 1 Guidelines, the remediation level may be set to background concentration. For more information, see the Tier 1 Guidelines.

The definition for background cannot be used to eliminate point source emissions, anthropogenic activities that cause redistribution of soil or water sources with elevated substance concentrations, or non-point anthropogenic sources that result from activities at the site in question. Care should be taken to distinguish between apparent background concentrations that are the result of diffuse anthropogenic sources and true, natural background conditions. In comparing against background, emphasis should always be placed on ensuring that anthropogenic sources are not identified as natural background.

For example, surface soils in urban areas that have variable levels of polycyclic aromatic hydrocarbons (PAHs) because of generalized automobile emissions can be considered as background based on the definition; however, additional PAH contamination may result from industrial activities at the site in question and the latter cannot be considered part of the urban background. Similarly, some sites may have elevated electrical conductivities in the surface soil or groundwater due to natural conditions at the site that would be considered background. However, if material with elevated conductivity is brought to the surface from deeper sediments or groundwater due to anthropogenic activities, this must be assessed as a COPC.

4.4.2.2. Selecting background sample locations

For soil, background concentrations of COPCs will vary with parent material, depth, hydrologic regime and biological activity. These factors lead to spatial variations in background concentrations that may or may not be predictable. For groundwater, background conditions will be specific to the groundwater zone being considered and can vary both spatially and temporally. These factors will need to be accounted for in assessing background conditions. Sites chosen for background determination need to closely match the site in question with respect to:

- geographical characteristics (e.g., location, topography, geological deposits, size/area, etc.)

- physical characteristics, chemical characteristics, hydrology
- sampling depths and time

It is often necessary to sample outside the site in question due to the difficulty in obtaining a pristine sample within site boundaries. In urban areas, preference must be given to undeveloped land that has not received imported fill, naturally-wooded areas, parks or large residential lots where there is limited influence from human activity. Background sampling locations for groundwater must be located upgradient of the contaminated area in question. Background sites must not be located next to or within the general vicinity of contaminant point sources. The history of the reference site and adjacent land, including current and previous activities, must be considered and documented.

4.4.3. Land use

Potential adverse effect provisions seek to preserve, recover and protect options for future land use and function. Consequently, Alberta's regulatory framework requires that remediation and risk management decisions on contaminated sites consider not only current, but future land and water use.

The Tier 1 Guidelines are calculated for five types of land use: natural areas, agricultural, residential/parkland, commercial, and industrial. For further guidance on the definition of the individual land uses, see the Tier 1 Guidelines (AEP, 2022a, as amended). The most sensitive land use must be applied to the entire property, regardless of the location of the contamination because changes in current development, conditions, or activities may occur at some point in the future within the range of allowable uses. The land use selected must provide for independent development options within that land use so that future excavations, buildings, groundwater wells or other typical development and activities for a particular land use are not restricted. The Tier 1 and Tier 2 Guidelines allow for some modification of this rule for sites that are adjacent to a more sensitive land use (see these guidelines for further detail).

The proponent must ensure that the definition of land use is consistent with the land use allowed under the relevant zoning for the selected option. Section 2.3 of the Remediation Regulation (Government of Alberta, 2022b) also requires that the proponent consider potential for changes to more sensitive zoning that are in progress or are reasonably foreseeable.

Land uses defined in the Tier 1 Guidelines may not correspond exactly to the range of municipal zoning options, but by evaluating the types of receptors and exposure conditions used in calculating the guidelines for each land use scenario, it is possible to identify which land use scenario is protective for a particular municipal zoning requirement. Assessors must determine the full range of uses allowed under the applicable zoning bylaw when determining the appropriate land use for Tier 1 application. Where a municipal zoning decision incorporates more than one land use scenario, the most conservative land use must be applied (refer to the Tier 1 Guidelines for more details).

4.4.4. Relationship between soil, air and water quality

Environmental media are interconnected. Contaminants in soil may leach into pore water or groundwater. Contaminants in groundwater can act as sources for soil contamination. Volatile compounds in soil or groundwater may volatilize and can migrate through the soil into the interior space of buildings. Contaminants in groundwater can be transported laterally with groundwater flow, and potentially enter a surface water body (creek, slough, lake etc.) at the point of groundwater discharge.

The Tier 1 Guidelines are developed to protect indoor air quality, plants and soil invertebrates, human direct contact and water quality for a range of uses. Guidelines to protect a particular water use are calculated based on the corresponding water quality guideline (drinking water, aquatic life, irrigation, or livestock or wildlife watering).

Under the Tier 2 approach, it is possible to use site-specific information to evaluate risk to some receptors. As a minimum, this approach will involve more detailed site-specific assessment information to support the Tier 2 decision. Under the Tier 2 approach, site-specific information is used to assess the risk of the substance interacting more

closely with the receptor of concern. Reference values representing safe levels of exposure (such as drinking water, aquatic life guidelines, toxicity reference values etc.) are not open to modification under the Tier 2 approach.

The Tier 2 approach must consider interactions between different media (soil, vapour and groundwater) if the contaminant has the ability to partition into the media of concern. For organic contaminants, this is often done in the Tier 1 table; however, partitioning between media is not always available at Tier 1. It is often necessary to screen the medium of concern to ensure that contaminant in one medium is not present at or above critical values in the other medium. For instance, metals do not have readily available models to determine their potential to move between soil and groundwater. In this instance, if there is a risk that is identified in one medium, it will be necessary to investigate the other to ensure that the criteria for soil and groundwater are both met in the respective medium of concern.

4.4.5. Relationship to waste policy

The Beneficial Use of Waste (ESRD, 2012) policy states that excavated contaminated soils going for disposal are to be dealt with as wastes. This includes any contaminated soil that is excavated and disposed of in another location, including contaminated soils that will be disposed of in an allowable manner, such as land treatment cells where soil is left in place after treatment, materials that are moved from the original location to other locations, materials that are treated at separate locations, materials used as soil amendments, or materials used in construction or manufacture of other products.

Under this policy, materials intended to be used as products for beneficial purposes must be designed to meet a specific use and are characterized by well-defined physical, chemical, or biological characteristics that meet specific quality criteria (ESRD, 2012). Alberta's approach to the management of wastes, industrial byproducts, composts and other materials is based on the potential to improve soil quality. Wastes that provide no benefits to soil quality must not be applied to land in a manner that causes soil contamination (AENV, 2000; ESRD, 2012). Industrial byproducts, composts and other materials that provide a potential benefit to soil quality may be applied to land according to good agronomic or forestry practices and in accordance with any other regulatory requirements.

Even when benefits can be shown, any potential contaminants in the byproduct must be managed to prevent their buildup in soil (AENV, 2000).

The Tier 1 Guidelines are used to evaluate contaminant concentrations in soil. They must not be used to evaluate concentrations in the byproduct or organic material itself unless the material is to be placed directly on land without being mixed with soil.

4.4.6. Protection of domestic use aquifers

Groundwater for domestic use is a significant current and future resource distributed over large geographic ranges in Alberta. Consequently, there is a need to protect the quality of domestic use aquifers (DUAs).

For specific guidance regarding implementation, determination of the sustained yield or exclusions allowed within this definition, see the Tier 2 Guidelines.

4.5. Conditions and restrictions associated with Alberta Tier 2

4.5.1. General conditions and restrictions

Certain types of site-specific data or assumptions dictate the need for ongoing site management to ensure that the assumptions used to assess human and ecological risks or to develop site-specific objectives remain valid. Ongoing management of a site or of the contaminants present will invoke a land use restriction or condition that will preclude closure; therefore, site-specific adjustments or assumptions that would trigger ongoing management requirements can only be implemented under the exposure control option.

To avoid the need for ongoing management and associated conditions and land use restrictions, Tier 2 adjustments are limited to parameters that are measurable and stable, such as soil properties, geological conditions, hydrogeology and distance to natural surface water bodies.

Tier 2 assessments that involve full site-specific risk assessment using models and assumptions that may differ from those used in the calculation of the Tier 1 Guidelines may be accepted, provided they do not require any form of ongoing risk management. Parameters that are unique to current site use, an existing development, or the location of a receptor, such as the characteristics of a site building or the distance to a water well, may change in the future thereby invalidating the site-specific assumptions. An adjustment of such parameters is not allowed at Tier 2 level. If a particular site use renders some exposure pathways inoperative (e.g., direct human or ecological contact with contaminated soil at a commercial site that is paved or capped) or the frequency of exposure differs from the generic assumptions, preservation of these conditions will require ongoing management; therefore, these adjustments cannot be made at Tier 2 level. Further guidance on parameters and assumptions eligible for adjustment at Tier 2 level is provided in the Tier 2 Guidelines.

4.5.2. Conditions and restrictions associated with site-specific risk assessments

Tier 2 assessments that implement a site-specific risk assessment using models and assumptions that differ from those underlying the Tier 1 Guidelines may be accepted provided they do not require any form of ongoing risk management. Site-specific risk assessments require additional considerations and monitoring that must be reviewed by the department prior to acceptance.

For site-specific risk assessments, the proponent must consider all aspects of the CCME (2006) protocol. Exposure pathways and receptors used in the development of generic guidelines will need to be reconsidered and additional receptors or exposure pathways may need to be added to ensure that the most sensitive and relevant receptors have been identified and appropriately assessed. Certain exposure pathways or receptors are only used by CCME as checks in the development of the guidelines and are not incorporated into the final tables. These checks will need to be re-evaluated to ensure that the risk assessment remains protective. In addition, where there is insufficient information, CCME does not always develop a specific guideline for that pathway. This will need to be reinvestigated during the risk assessment process. For more information, see Supplemental guidance on site-specific risk assessments in Alberta (Government of Alberta, 2022e, as amended).

For site-specific risk assessments, monitoring or additional assessment is required to verify model assumptions and demonstrate the validity of the conclusions. Complex risk assessments that do not require restrictions to the typical activities considered under a given land use and do not require ongoing risk management may be acceptable for closure under the Tier 2 process.

5.0 Derivation of risk-based remediation guidelines in Alberta

5.1. Overview

The department follows the principles outlined in:

- A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006)
- A Protocol for the Derivation of Groundwater Quality Guidelines for Use at Contaminated Sites (CCME, 2015)
- A Protocol for the Derivation of Soil Vapour Quality Guidelines for Human Exposures via Inhalation of Vapours (CCME 2014)

Section 5 of this framework provides more information regarding Alberta specific requirements related to the protocols.

5.2. Summary of considerations for Alberta

The CCME protocols on which Alberta guidelines are based have been developed in consideration of the range of environmental conditions across Canada. Where appropriate, EPA has chosen Alberta specific inputs. Deviations from CCME default inputs for the Tier 1 Guidelines and for the development of Tier 2 Guidelines are as follows:

- For Human Health Endpoints, Tier 1 calculations are based on the adult and toddler models since these were found to be the most sensitive for the purpose of the current Tier 1 Guidelines. Other age classes are used as a check for the Tier 1 Guidelines. For Tier 2, checks must include all permissible age classes for the relevant land use to ensure that the most sensitive endpoints are being considered. This will be particularly relevant for COPCs where developmental effects may impact specific age classes. For more information, Supplemental guidance on site-specific risk assessments in Alberta (Government of Alberta, 2022e, as amended).
- For Human Health, non-threshold effects are to be calculated based on the incremental lifetime risk of 1 in 100,000.
- For Human Health Commercial and Industrial land uses, Alberta uses the same exposure term in calculating both threshold and non-threshold toxicity reference values, as opposed to the use of 1 in the non-threshold calculation. This may also be carried over to Tier 2 calculations.
- For Human Health guidelines for the vapour inhalation pathway, if a tolerable concentration or inhalation unit risk factor cannot be obtained directly from the primary source literature, one is calculated from the tolerable daily intake or oral slope factor assuming the same risk for vapour inhalation and inputs from the adult model. See the Tier 1 Guidelines for more information.
- For calculation of groundwater guidelines, EPA has adopted the following assumptions:
    - For the drinking water pathway, groundwater guidelines are based on a fixed well screen of two metres; therefore, in dilution factor 3, the factor is calculated using a fixed two metre interval for the average thickness of the mixing zone (Zd).
    - For all groundwater pathways, infiltration rates are based on Alberta specific rainfall patterns and set at 0.012 and 0.06 metres/year (m/y) for fine and coarse soil respectively rather than CCME defaults.
    - For calculating the protection of aquatic life and wildlife watering guidelines, a maximum transport time of 500 years is applied to the calculation of dilution factor 4.
- For the calculation of the Tier 1 and Tier 2 Guidelines for soil or groundwater for the vapour inhalation pathway, EPA allows for the calculation of Qsoil based on the Johnson and Ettinger Model. For Tier 2

Guidelines, site-specific modifications are allowed but are restricted to ranges illustrated in Appendix C of the Tier 2 Guidelines.

- For calculation of soil vapour quality guidelines, EPA accepts the calculation of soil vapour guidelines at Tier 2 with the methodology in A Protocol for the Derivation of Soil Vapour Quality Guidelines for Human Exposures via Inhalation of Vapours (CCME 2014); however, please note the following exceptions;
    - A *de minimis* dilution factor of 100 is allowed for the agricultural, residential and commercial/industrial scenario.
    - Calculation of a site-specific dilution factor for contamination deeper than 30 cm below the building foundation is allowed rather than the one metre separation recommended in CCME.
    - See Alberta Tier 1 Guidelines for soil moisture filled and vapour filled porosity defaults.

5.3. Human health protection

5.3.1. Human receptors and exposure pathways

EPA has collated applicable input parameters in the Tier 1 and Tier 2 guidelines. Where available, these are used as inputs in any Alberta Tier 1 or Alberta Tier 2 assessments.

In keeping with CCME (2006), guidelines need to be based on a critical human receptor that represents the most sensitive receptor to the substance and the most critical health effect within the land use scenario. In addition, the entire range of activities associated with the land use must be free of appreciable health risks.

The most sensitive receptor is a function of the receptor characteristics, the degree of potential exposure, the exposure pathway(s) and the COPC. In some instances, it may also be necessary to identify the presence of uniquely sensitive receptors that may not be protected by the generic guidelines. Further guidance is available in CCME (2006).

At Alberta Tier 1 and Tier 2 levels, the general public is assumed to be present on agricultural, residential/parkland, and commercial land. The general public is considered to incorporate all age classes and the most sensitive pathway/receptor combination must be used in establishing the appropriate risk-based guideline. Based on an analysis of the sensitivity Tier 1 Guidelines are generally based on the toddler model. These are checked against other life stages and need to be adjusted appropriately if another life stage is more sensitive to the contaminant of potential concern. In all instances, land use and life stage assumptions should be re-evaluated to ensure the criteria is developed using the most sensitive populations.

At industrial sites, only adults are assumed to be present, which precludes the use of the child exposure model parameters. Human exposure is assumed to be inconsequential in natural areas, except where underlying groundwater is a potential source of drinking water. When these definitions differ from the potential uses of a site, the risk assessment must be modified to consider the most sensitive case.

5.3.2. Human health protection endpoints

The human health protection endpoint is the same at all tiers of contaminated site management and is expressed in terms of an allowable exposure level at which the likelihood of a receptor experiencing adverse health effects is essentially negligible. The level of human exposure to a threshold chemical[1] or non-carcinogen must not exceed the

[1]**Threshold chemical:** A contaminant for which there is a dose/concentration below which no adverse effect is expected to occur.

tolerable daily intake[2] specified by the Tier 1 Guidelines, also considering background exposure to the chemical.

Where guidance in Alberta Tier 1 is not available, the proponent must follow the Guidance for Selecting Toxicity Reference Values for Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines (AEP, 2017b). For threshold chemicals, Alberta applies a hazard quotient of 1 to the calculation of the Tier 1 Guidelines. However, in Alberta, a soil or groundwater allocation factor is required. Allocation factors, as noted in the Tier 1 Guidelines must be applied to the calculation of soil and groundwater criteria. Where the allocation factor is uncertain, an allocation factor of 0.2 must be applied in keeping with CCME 2006. For more information on the allocation factor, see the Supplemental guidance on site-specific risk assessments in Alberta (Government of Alberta, 2022e, as amended).

For non-threshold contaminants, an incremental lifetime cancer risk[3] of 1 in 100,000 for carcinogens is required. For commercial and industrial land use, the Tier 1 values are calculated using the appropriate exposure term for the land use rather than assuming an exposure term of 1.

A Hazard Index is required if additive effects are evident for multiple contaminants of potential concern. For the Alberta Tier 1 criteria, considerations are made for PAH and dioxins and furans. Where other non-additive effects may be present, these will need to be considered using a site-specific risk assessment.

While some contaminants can degrade in the environment with time, the rate of the reaction is dependent on several environmental factors that vary based on site-specific conditions. Tier 1 contains accepted half-lives that can be used for generic assessment of COPCs. Where these are available, they can be applied to the site-specific assessment as well. Where they are not available, the person may be able to establish a degradation rate for the site of interest but will be required to produce supporting lines of evidence, including soil and groundwater monitoring information to demonstrate degradation is occurring.

5.3.3. Ecological receptors and exposure pathways

Risk-based remediation guidelines are required to fulfill two main goals from the ecological standpoint:

- protection of ecological receptors expected to be present at a site based on the setting and land use
- preservation of the ecological function of a site and the ecosystem components

Alberta's guidelines for the protection of ecological receptors have been calculated in a manner consistent with A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006). For the groundwater pathways, Alberta allows for a maximum 500-year time for the calculation of groundwater or soil protection for the aquatic life and wildlife watering pathways. Alberta also allows for pathway exclusion for the surface water aquatic life and wildlife watering pathways that are more than 300 metres from the surface water receptor. For more information on these exceptions, see the Tier 1 Guidelines.

A first step in developing risk-based remediation guidelines for ecological protection is to determine which ecological components are potentially at risk from a substance release. Ecological receptors at a contaminated site, within the range of generic land uses considered in the development of the Alberta guidelines, span a range of trophic levels including soil-dependent organisms (plants, soil invertebrates, and crops), soil functions (e.g., nutrient and energy cycling, related microbial activities), and higher-order consumers (terrestrial and avian wildlife, and livestock). In addition, there is the potential for groundwater underlying a site to discharge to a surface water body; therefore, aquatic receptors including invertebrates, fish and waterfowl are considered. Receptors assigned to each land use for

[2]**Tolerable daily intake:** The level/rate of chemical exposure to which a person may be exposed with no expected adverse effects. A tolerable daily intake can only be determined for contaminants with threshold effects (i.e., non-carcinogens).

[3]**Incremental risk:** Risk due to exposure to a chemical in excess of the "background" risk.

the purpose of guideline derivation must include possible effects of contaminated soil, water, sediment and/or food to the most sensitive species.

5.3.4. Ecological protection endpoints

Ecological protection endpoints must be chosen to ensure that the ecological function will sustain activity within a given land use function (CCME, 2006). Ecological protection endpoints are the same at all levels of management, subject in some cases to a reduced requirement for ecological function based on land use.

Protection of ecological receptors is based on ensuring that exposure does not exceed appropriate toxicological benchmarks. At higher trophic levels, these benchmarks are based on designated chronic effects levels derived for specific species at the population level. For plants and soil invertebrates, the benchmarks are determined and applied on an ecosystem basis using species sensitivity distributions. A lower level of ecological function is allowed at commercial and industrial sites. This is addressed by means of a less stringent protection level for plants and soil invertebrates when calculating the Tier 1 Guidelines.

Ecological protection endpoints where available for Tier 1 have been selected in accordance with the Guidance for Selecting Toxicity Reference Values for Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines (AEP, 2017b, as amended). Where Tier 1 Guidelines are not available, use this guide in determining appropriate references for protection endpoints.

5.4. Considerations other than toxicity

For complex risk assessments or where major changes to generic endpoints, models or pathway/receptor relationships are proposed, factors other than toxicity must be considered in the risk assessment.

Contaminants may have adverse effects in addition to producing toxic responses in human and ecological receptors. These may include aesthetic concerns (e.g., offensive odours), explosive hazards or damage to utilities and infrastructure. If there is evidence that a contaminant may cause significant effects beyond toxicity to human and ecological receptors, then this evidence must be evaluated.

Certain contaminants may potentially degrade into more toxic or more mobile contaminants (e.g., degradation of trichloroethylene to vinyl chloride). Since degradation rates are affected by site-specific factors, potential for these types of effects and degradation products must be considered when developing Tier 2 remediation objectives.

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