ATLANTIC RBCA
ENVIRONMENTAL QUALITY STANDARDS

RATIONALE AND GUIDANCE DOCUMENT

July 2021, updated July 2022

Acknowledgements

The Rationale Document supercedes the Nova Scotia Environment (NSE) April 2014 ENVIRONMENTAL QUALITY STANDARDS FOR CONTAMINATED SITES - RATIONALE AND GUIDANCE DOCUMENT and provides an updated set of Environmental Quality Standards (EQS) intended for application throughout all four Atlantic Provinces.

The Rationale Document was prepared by Mr. Rob Willis (Dillon Consulting Limited) and Mr. John Henderson (Stantec Consulting Ltd.) under contract to Atlantic Partners in Risk Based Corrective Action (RBCA) Implementation (Atlantic PIRI).

Summary of Changes to Atlantic RBCA Environmental Quality Standards Rationale and Guidance Document (and associated tables) (from July 2021 version to July 2022 version)

Location in document	Change made	Rationale
Cover page and footer on all subsequent pages of Atlantic RBCA EQS Rationale and Guidance Document; Footer on Appendix A flysheet	Date change from "July 2021" to "July 2021, updated July 2022"	Consistent with approach used previously when updating guidance documents.
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Human Health-Based Tier I Environmental Quality Standards (EQS) for Groundwater - All Land Uses; Potable Groundwater Condition (µg/L)"*	Included OG value for Al; AO values for Fe, ZN, NA, Cl, MTBE (all land uses) Removed footnote #3 (re-numbered #4 to #3) For Strontium, replaced residential/parkland fine/coarse "NGR" cells with 2400 (consistent with PSS tables) Changed footnote date to July 2022	Consistent with approach used in original Nova Scotia Environment EQS/PSS process. Transcription error in original version.
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Human Health-Based Tier I Environmental Quality Standards (EQS) for Groundwater - All Land Uses; Non-potable Groundwater Condition (µg/L)"*	Removed footnote #3 (re-numbered #4 to #3) Changed footnote date to July 2022	Change made to reflect update to OG/AO values (above)
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Tables (4 tables): *"Human Health Tier II Pathway Specific Standards for Groundwater – Agricultural, Residential/Parkland, Commercial, Industrial"*	Removed last sentence of footnote #3 Changed footnote date to July 2022	Change made to reflect update to OG/AO values (above)
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Ecological Tier I Environmental Quality Standards for Groundwater*"	For Aldrin, replaced reference to ISL with EQS (two cells) Changed footnote date to July 2022	Typo in original version (improper acronym reference).

Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Ecological Tier I Environmental Quality Standards for Surface Water"*	For Aldrin, replaced reference to ISL with EQS (one cell) Changed footnote date to July 2022	Typo in original version (improper acronym reference).
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Ecological Tier I Environmental Quality Standards for Sediment"*	Removed Total TPH row. Clarification added to footnote; Modified TPH is dependant on sediment OC); consult with source document (Atlantic RBCA V4 User Guidance – Appendix 2)	Change made to clarify application of Modified TPH adjusted for sediment OC.
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Ecological Tier I Environmental Quality Standards for Soil"*	Changed gas/fuel/lube parameters to F1/F2/F3 and added F4 row (with associated values) Changed footnote date to July 2022	Consistency with Atlantic RBCA V4 User Guidance – Appendix 2; Ecological Screening Protocol for Impacted Sites in Atlantic Canada
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Ecological Tier II Pathway Specific Standards for Soil - Agricultural"*	Changed gas/fuel/lube parameters to F1/F2/F3 and added F4 row (with associated values) Changed footnote date to July 2022	Consistency with Atlantic RBCA V4 User Guidance – Appendix 2; Ecological Screening Protocol for Impacted Sites in Atlantic Canada
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Ecological Tier II Pathway Specific Standards for Soil – Residential/Parkland"*	Changed gas/fuel/lube parameters to F1/F2/F3 and added F4 row (with associated values) Changed footnote date to July 2022	Consistency with Atlantic RBCA V4 User Guidance – Appendix 2; Ecological Screening Protocol for Impacted Sites in Atlantic Canada
Atlantic RBCA EQS Rationale and Guidance Document Appendix A Table: "*Ecological Tier II Pathway Specific Standards for Soil – Commercial/Industrial"*	Changed gas/fuel/lube parameters to F1/F2/F3 and added F4 row (with associated values) Changed footnote date to July 2022	Consistency with Atlantic RBCA V4 User Guidance – Appendix 2; Ecological Screening Protocol for Impacted Sites in Atlantic Canada

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Human Health Tier II Pathway Specific Standards for Soil - Industrial

Human Health Tier II Pathway Specific Standards for Groundwater - Agricultural
Human Health Tier II Pathway Specific Standards for Groundwater – Residential/Parkland
Human Health Tier II Pathway Specific Standards for Groundwater - Commercial
Human Health Tier II Pathway Specific Standards for Groundwater - Industrial

Ecological

Ecological Tier I Environmental Quality Standards for Sediment
Ecological Tier I Environmental Quality Standards for Soil
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Ecological Tier II Pathway Specific Standards for Soil – Residential/Parkland
Ecological Tier II Pathway Specific Standards for Soil - Commercial/Industrial

Ecological Tier II Pathway Specific Standards for Surface Water/Groundwater

LIST OF ABBREVIATIONS AND ACRONYMS

AEP	Alberta Environment and Parks
ASTM	American Society for Testing and Materials
Atlantic PIRI	Atlantic Partnership in RBCA Implementation
BCMOECCS	British Columbia Ministry of Environment and Climate Change Strategies
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CASRN	Chemical Abstracts Service Registry Number
CCME	Canadian Council of Ministers of the Environment
CoC	Contaminant of Concern
CSQG	Canadian Soil Quality Guideline
CSR	Contaminated Sites Regulation
EqP	Equilibrium Partitioning
EQS	Environmental Quality Standard
ESL	Ecological Screening Level
HC	Health Canada
MOECC	Ontario Ministry of Environment and Climate Change
NOAA	National Oceanic and Atmospheric Administration
NSSAM	Numerical Standards and Site Assessment Methodologies Working Group
NSE	Nova Scotia Environment
OMOE	Ontario Ministry of the Environment
PEL	Probable Effect Level
PAH	Polycyclic Aromatic Hydrocarbon
PFAS	Per- and Polyfluoroalkyl Substances
PHC	Petroleum Hydrocarbons
PSS	Pathway-specific Standard
PSSL	Pathway-specific Screening Level
RBCA	Risk-Based Corrective Action
RBSL	Risk-Based Screening Level
RDL	Reportable Detection Limit
RSL	Regional Screening Level
SQG	Soil Quality Guideline
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound(s)

1.0 INTRODUCTION

Each of the four Atlantic Provinces (Nova Scotia, Prince Edward Island, New Brunswick and Newfoundland and Labrador) administer impacted sites assessment programs in accordance with applicable legislation, regulations and other regulatory instruments (including various protocols, policies and guidance documentation) that pertain to and/or describe the application and use of numerical standards within provincial impacted site assessment programs.

This document provides the reference information and rationale that was used to develop Tier I Environmental Quality Standards (EQS) and Tier II Pathway-Specific Standards (PSS) for the Atlantic Provinces.

The Atlantic RBCA Tier I EQS and Tier II PSS may be adopted in Ministerial Protocols and other relevant guidance and regulatory instruments developed by the four Atlantic Provinces. These Protocols and guidance describe the intended use and application of Atlantic RBCA EQS and PSS within the respective Atlantic Provinces. In general, the Atlantic RBCA EQS and PSS are the regulatory numerical standards used for the identification, assessment and remediation of impacted sites located within Nova Scotia, Prince Edward Island, New Brunswick and Newfoundland and Labrador.

It must be recognized that the Rationale Document presented herein is a supporting document to the respective impacted sites regulations, policies, protocols and other guidance within the four Atlantic Provinces and should be read in conjunction with these relevant regulatory instruments and tools. Any wording, information, or requirements contained in the relevant provincial impacted sites regulations, and other relevant regulatory instruments and tools, takes precedence over the information presented herein.

1.1 BACKGROUND AND HISTORY OF ATLANTIC REGION NUMERICAL STANDARDS

In 2009, NSE formed a Numerical Standards and Site Assessment Methodologies Working Group (NSSAM Working Group), which included several scientific experts, to advise NSE on the process of identifying and adopting numerical environmental quality standards to support impacted site regulations. The NSSAM Working Group completed significant research related to sources of existing environmental quality standards, relevant environmental media, and typical receptors/exposure pathways. Following the work and advice of the NSSAM working group, NSE commissioned a report in 2011 which formed a portion of the rationale and background for the 2014 NSE Rationale and Guidance document. Selected technical updates, text and policy direction were incorporated into the 2011 document by NSE, which culminated in the release of the 2014 NSE Rationale and Guidance document in April of 2014.

In 2017, the four Atlantic Provinces expressed interest in harmonizing the environmental quality standards used at impacted sites located within Atlantic Canada. This harmonization effort was led and coordinated by the Atlantic Partners in Risk-Based Corrective Action (RBCA) Implementation (Atlantic PIRI), on behalf of the four Atlantic Provinces.

As an initial step in the harmonization effort, Atlantic PIRI retained contractors who were involved with the original NSE EQS process, to review and update the current set of NSE EQS and PSS. This involved changes and updates to the 2014 NSE EQS and PSS (to ensure that the adopted Atlantic EQS and PSS values reflect more recent regulatory guideline values developed by the source agencies and departments), as well as to the 2014 NSE Rationale Document. The revision and update effort focused on the same environmental media, exposure pathways, receptor types, land use categories, groundwater use conditions and soil texture categories that were originally addressed in the 2014 NSE EQS and Rationale Document.

It is expected that the four Atlantic Provinces will independently determine how and when to apply and implement the EQS and PSS within their individual provincial impacted site management processes, programs, and policy frameworks. At the discretion of the individual Atlantic Provinces, this may include modifications to the Tier I EQS and Tier II PSS described herein.

1.2 OBJECTIVES

The objectives of this Rationale Document are as follows:

- To document the basis and rationale for the adoption of Atlantic RBCA EQS and PSS for application to impacted sites in the four Atlantic Provinces.

- To provide site professionals and others with an understanding of the hierarchy of jurisdictional sources used for Atlantic RBCA EQS and PSS adoption and to provide the regulatory sources of the adopted Tier I EQS and Tier II PSS values.

2.0 Development of Atlantic RBCA Environmental Quality Standards (EQS) and Pathway-Specific Standards (PSS)

The development of numerical Atlantic RBCA EQS and PSS for the identification, assessment, and remediation of impacted sites in Atlantic Canada is based on several important factors.

These factors include:

- The relevant or applicable environmental media at the site.
- The potential contaminants of concern (CoC) present in site media.
- The site land use classification and site use patterns.
- Site soil texture classification.
- Operable exposure pathways at the site.
- Human and ecological receptors present at the site.
- Site groundwater use conditions (potable versus non-potable).

A brief discussion of these factors follows.

2.1 APPLICABLE ENVIRONMENTAL MEDIA

The numerical Atlantic RBCA EQS and PSS have been developed for all relevant environmental media which are typically evaluated at impacted sites in Atlantic Canada.

These media are:

- Soil.
- Groundwater.
- Surface Water (freshwater and marine).
- Sediment (freshwater and marine).

2.2 POTENTIAL CONTAMINANTS OF CONCERN

A master list of potential contaminants of concern (CoC's), for all media of interest, was developed in consultation with representatives from each of the provincial regulatory agencies which administer and oversee impacted sites programs (i.e., Nova Scotia Environment, New Brunswick Department of Environment and Local Government, Prince Edward Island Department of Communities, Land and Environment, and Newfoundland and Labrador Department of Municipal Affairs and Environment), and with representatives of Atlantic PIRI. Atlantic region analytical laboratories were also consulted to verify that: i) they have the appropriate analytical capabilities, equipment and certifications for the parameters on the master list; and, ii) they can achieve appropriate RDLs for the listed parameters in the relevant media, such that the RDLs are below the selected EQS and PSS values. Analytical laboratory consultation also determined whether there is a need to revise or consider revising certain analytical groupings or packages. The resulting master list of CoC's is based on collective experience at impacted sites in Atlantic Canada and considers environmental quality guideline availability from both Canadian and U.S. jurisdictions.

The master list forms the basis for the compilation of EQS and PSS for use at impacted sites within the context of this Rationale Document, and in support of applicable impacted sites regulations and other regulatory instruments within the four Atlantic Provinces. This list of CoC's is not intended to be used as an analytical screening tool for potential triggers under applicable regulations. Rather, each site and situation warrant a specific evaluation and assessment to determine which, if any, of the potential CoC's may be present in site media.

The master list of CoC's is provided in **Table 2-1**, along with corresponding Chemical Abstracts Service Registry Numbers (CASRN), where available and applicable. The CASRN for each substance listed in **Table 2-1** is simply an identification number published by the Chemical Abstracts Service, a division of the American Chemical Society.

The individual Atlantic Provinces have the option to modify the master list of COC's, as deemed necessary and appropriate within their respective jurisdictions.

For consistency, the complete master list of CoC's is presented for the compiled Tier I EQS and Tier II PSS tables provided in **Appendix A**. These tables or similar tables may also be posted to websites that provide impacted sites program guidance and documentation for the four Atlantic Provinces. For some chemicals, exposure pathways or receptors indicated in the Tier I EQS or Tier II PSS tables, there may be no EQS or PSS value available. In such cases, the absence of an applicable guideline is indicated in the tables.

Table 2-1 Master List of Potential Contaminants of Concern

Master List of Potential Contaminants of Concern (CoC's)	
Inorganics	**CASRN**
Aluminum	7429-90-5
Antimony	7440-36-0
Arsenic	7440-38-2
Barium	7440-39-3
Beryllium	7440-41-7
Boron (total)	7440-42-8
Boron (hot water soluble)	7440-42-8
Cadmium	7440-43-9
Chromium (hexavalent)	18540-29-9
Chromium (total)	7440-47-3
Cobalt	7440-48-4
Copper	7440-50-8
Cyanide	57-12-5
Iron	7439-89-6
Lead	7439-92-1
Manganese	7439-96-5
Mercury (total)	7439-97-6
Methylmercury	22967-92-6
Molybdenum	7439-98-7
Nickel	7440-01-0
Selenium	7782-49-2
Silver	7440-22-4
Sodium	7440-23-5
Strontium	7440-24-6
Thallium	7440-28-0
Tin	7440-31-5
Uranium	7440-61-1
Vanadium	7440-62-2
Zinc	7440-66-6
Petroleum Hydrocarbons (PHC)	**CASRN**
Benzene	71-43-2
Toluene	108-88-3
Ethylbenzene	100-41-4
Xylenes	Various
Modified Total Petroleum Hydrocarbons (Gasoline)	Various
Modified Total Petroleum Hydrocarbons (Fuel Oil)	Various
Modified Total Petroleum Hydrocarbons (Lube Oil)	Various
Methyl Tertiary Butyl Ether (MTBE)	1634-04-4
Polycyclic Aromatic Hydrocarbons (PAH)	**CASRN**
Naphthalene	91-20-3

Master List of Potential Contaminants of Concern (CoC's)	
1 – Methylnaphthalene	90-12-0
2 – Methylnaphthalene	91-57-6
Acenaphthene	83-32-9
Acenaphthylene	208-96-8
Anthracene	120-12-7
Fluoranthene	120-12-7
Fluorene	206-44-0
Phenanthrene	86-73-7
Pyrene	129-00-0
Benzo[a]pyrene (BaP) Total Potency Equivalents (Human Health – Carcinogenicity)	Various
Benz[a]anthracene	56-55-3
Benzo[a]pyrene	50-32-8
Benzo[b,j,k]fluoranthene isomers	205-99-2; 205-82-3; 207-08-9
Benzo[g,h,i]perylene	191-24-2
Chrysene	218-01-9
Dibenz[a.h]anthracene	53-70-3
Indeno[1,2,3-c,d]pyrene	193-39-5
Volatile Organic Compounds (VOC)	**CASRN**
Bromodichloromethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
Carbon Tetrachloride (Tetrachloromethane)	56-23-5
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
Dibromochloromethane	124-48-1
1,2-Dichlorobenzene	95-50-1
1,3-Dichlorobenzene	541-73-1
1,4-Dichlorobenzene	106-46-7
1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethylene	75-35-4
cis-1,2-Dichloroethylene	156-59-2
trans-1,2-Dichloroethylene	156-60-5
1,2-Dichloropropane	78-87-5
1,3-Dichloropropene	10061-01-5
Ethylene Dibromide	106-93-4
Methylene Chloride (Dichloromethane)	75-09-2
Styrene	100-42-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene	127-18-4

Master List of Potential Contaminants of Concern (CoC's)	
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethylene	79-01-6
Vinyl Chloride	75-01-4
Pesticides	**CASRN**
Aldicarb	116-06-3
Aldrin	309-00-2
Atrazine	1912-24-9
Azinphos-methyl	86-50-0
Bendiocarb	22781-23-3
Bromoxynil	1689-84-5
Carbaryl	63-25-2
Carbofuran	1563-66-2
Chlorothalonil	1897-45-6
Chlorpyrifos	2921-88-2
Cyanazine	21725-46-2
2,4-D	94-75-7
DDT	50-29-3
Diazinon	333-41-5
Dicamba	1918-00-9
Dichlorfop-methyl	51338-27-3
Dieldrin	60-57-1
Dimethoate	60-51-5
Dinoseb	88-85-7
Diquat	85-00-7
Diuron	330-54-1
Endosulfan	115-29-7
Endrin	72-20-8
Glyphosate	1071-83-6
Heptachlor	76-44-8
Lindane	58-89-9
Linuron	330-55-2
Malathion	121-75-5
MCPA	94-74-6
Methoxychlor	72-43-5
Metolachlor	51218-45-2
Metribuzin	21087-64-9
Paraquat	4685-14-7
Parathion	56-38-2
Phorate	298-02-2
Picloram	1918-02-1
Simazine	122-34-9
Tebuthiuron	34014-18-1
Terbufos	13071-79-9

Master List of Potential Contaminants of Concern (CoC's)	
Toxaphene	8001-35-2
Triallate	2303-17-5
Trifluralin	1582-09-8
Per- and Polyfluoroalkyl Substances (PFAS)	**CASRN**
Perfluorooctane sulfonate (PFOS)	45298-90-6
Perfluorooctanoic acid (PFOA)	335-67-1
Perfluorobutanoate (PFBA)	375-22-4
Perfluorobutanesulfonate (PFBS)	45187-15-3
Perfluorohexanesulfonate (PFHxS)	108427-53-8
Perfluoropentanoate (PFPeA)	2706-90-3
Perfluorohexanoate (PFHxA)	307-24-4
Perfluoroheptanoate (PFHpA)	20109-59-5
Perfluorononanoate (PFNA)	375-95-1
Other Parameters	**CASRN**
Polychlorinated Biphenyls (Total PCB)	Various
Dioxins and Furans (TEQ)	Various
Pentachlorophenol (PCP)	87-86-5
Organotins – Tributyltin	688-73-3
Ethylene Glycol	107-21-1
Propylene Glycol	57-55-6
Phenol	108-95-2
Chloride	16887-00-6

Notes: CASRN is a Registered Trademark of the American Chemical Society.
"*Various*" indicates that a CASRN is not applicable as the parameter is a variable mixture of individual substances.

2.3 LAND USE CLASSIFICATIONS

The exposure frequency, duration, and intensity for human and ecological receptors at an impacted site are related to the nature of the land use, the activities inherent to that land use and the ease of access to site media (CCME, 2006). Therefore, land use is an important factor in the assessment and remediation of impacted sites.

The Canadian Council of Ministers of the Environment (CCME) uses four land use categories in the development of generic Canadian Soil Quality Guidelines (CSQG).

The four CCME land use categories are as follows:

- Agricultural.
- Residential/Parkland.
- Commercial.
- Industrial.

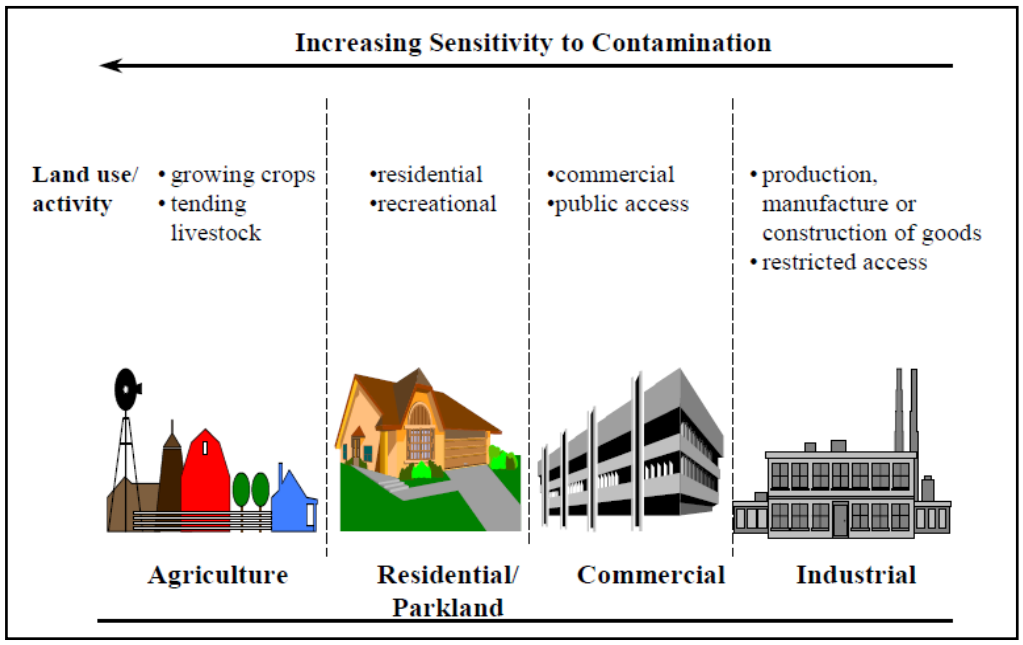
These four land use classifications are adopted herein with respect to the development of Tier I EQS and Tier II PSS. In general, when applying the Tier I EQS and/or Tier II PSS, the land use category that is most

consistent with, or applicable to, the current site land use and activities (and/or future land use where applicable) must be considered.

It should be noted that not all environmental media, receptors or exposure pathways of interest are necessarily included within each of the specific land use categories. This reflects regulatory guideline derivation approaches and history within the source jurisdictions, as well as practical considerations regarding the operability or significance of certain exposure pathways, and/or presence of certain receptors.

Potential sensitivity to contamination increases among ecological and human receptors as a function of the land use/activities, as shown in **Figure 2-1** below.

Figure 2-1 Sensitivity to Contamination by Land Use/Activity (from CCME, 2006)



The CCME definition for each land use category incorporates generic conditions and places boundaries on the receptors and exposure pathways considered in the derivation of guideline values for a given land use. Details of the receptor characteristics and exposure assumptions for each land use category are provided in CCME (2006).

The four CCME land use categories are briefly described below.

2.3.1 Agricultural

The primary land use/activity is growing crops or tending livestock. This category also includes agricultural lands that provide habitat for resident and transitory wildlife and native flora. Agricultural land encompasses a wide range of activities including dairy, livestock and/or crop production. Most farms include a homestead; therefore, the possible presence of an on-site residence (like those for residential/parkland sites specified below) is also considered. Agricultural lands are generally accessible by the farmer and family members, including children, who represent the more sensitive human receptor category.

2.3.2 Residential/Parkland

The primary land use/activity for this classification is residential occupancy or recreational activity. This category assumes parkland can be a buffer between areas of human residency and includes campgrounds, but does not include undeveloped wildlands, such as national or provincial parks.

The generic residential property assumed for this land use category is a typical detached single-family home with a backyard, where young children, particularly toddlers, are presumed to play outdoors. Recreational parks where children play, and where other family activities may also occur, are included in this land use category. In addition, long term care institutional facilities may also be considered as residential land use depending on the site-specific circumstances.

2.3.3 Commercial

The primary land use/activity is commercial (e.g., shopping malls and offices). Commercial land use properties span a wide variety of activities with varying degrees of access for human and ecological receptors. For the purposes of deriving environmental quality guidelines, it is commonly assumed that a generic commercial property may contain a day care facility; however, this land-use category may also include schools, hospitals, and religious facilities. Operations where food is grown would generally be excluded from this category.

2.3.4 Industrial

The primary land uses/activities involve the production, storage or distribution of goods. Industrial properties may span a wide variety of activities but generally do not permit direct public access. Typically, only workers would be present. Thus, children would not be expected to access industrial properties to any significant extent. Access to industrial properties is often limited for ecological receptors as well, due primarily to the lack of habitat or impaired habitat at industrial sites.

2.3.5 Natural or Wildlands Areas

For undeveloped, wild lands or natural area land uses, there is no CCME land use category currently. Thus, each province may establish policy or guidance as to which of the existing CCME land use categories best applies for the protection of undeveloped, wild, or natural land uses within their jurisdiction. Precedents within Canada exist for setting environmental quality guidelines for natural areas. For example, Alberta Environment and Parks (AEP, 2019) has established a natural areas land use category. AEP (2019) defines natural areas as those being away from human habitation and activities, where the primary concern is protection of ecological receptors. Human exposure pathways are not typically considered for natural areas unless the natural area of interest is underlain by a potable groundwater supply that may be used as a drinking water

source. In Alberta, parameter guideline values are typically adopted from the residential/parkland land use category, but there are some exceptions based on potentially operable exposure pathways within a natural area. For example, if natural areas may be used for livestock grazing, AEP (2019) requires consideration of livestock soil ingestion and the protection of groundwater for livestock water-related exposure pathways.

2.4 SOIL TEXTURE CLASSIFICATION

For some types of land use and some chemical parameters, regulatory agencies have developed separate soil and/or groundwater quality guidelines based on coarse-grained or fine-grained soil texture. Soil texture should be considered when conducting site assessments, in accordance with applicable impacted site regulations and protocols. Generally, EQS and PSS for coarse grained soil are lower values than EQS and PSS for fine-grained soil, though not always. The selection of EQS or PSS for fine grained soil should be supported with data from a sieve analysis from an appropriate soil horizon that is believed to be impacted and is the focus of site assessment activities. The coarse and fine soil texture categories are defined according to ASTM (2011) as follows.

2.4.1 Fine-grained Soil

A fine-grained soil is defined as material having greater than 50% (by dry weight) of particles equal to or less than 75 microns (200 mesh) in diameter.

2.4.2 Coarse-grained Soil

A coarse-grained soil is defined as material having greater than 50% (by dry weight) of particles greater than 75 microns (200 mesh) in diameter.

2.5 EXPOSURE PATHWAYS

CCME (and other regulatory agencies) provide environmental quality guidelines which consider the common range of potential exposure pathways that are operable at most impacted sites.

The exposure pathways considered for the purpose of EQS and PSS development are summarized below (**Tables 2-2 and 2-3**). Should other relevant exposure pathways be deemed operable at a given site that are not captured by the exposure pathways addressed herein, a more detailed Tier II or Tier III site-specific evaluation may be warranted. This may involve the use of numerical guidelines for specific pathways that have been derived by jurisdictions other than those considered herein (Tier II), the development of site-specific guidelines for a given pathway (Tier II or III), or the use of site-specific risk assessment approaches (Tier II or III). More information on Tier II PSS and a discussion of Tier II and III site-specific approaches is provided in **Section 6.2**.

2.5.1 Human Exposure Pathways

Table 2-2 presents the human exposure pathways that were considered in the selection of EQS and PSS.

Table 2-2 Applicable Human Exposure Pathways

Media	Exposure Pathways
Soil	• Direct Contact (ingestion and/or dermal contact) • Vapour Migration from Soil to Indoor Air (inhalation of soil vapour in indoor air) • Dust Inhalation (inhalation of soil or dust particles in outdoor/indoor air) • Soil Leaching for Protection of Potable Groundwater (groundwater ingestion, as may be applicable) • Off-site Migration (for commercial and industrial sites only)
Sediment	• May be evaluated in a similar manner as soil under certain conditions (See **Section 3.3.1**)
Surface Water	• Ingestion (as drinking water or from incidental water ingestion, as may be applicable)
Groundwater	• Ingestion as Drinking Water (as may be applicable) • Vapour Migration to Indoor Air (inhalation of vapours in indoor air)

2.5.2 Ecological Exposure Pathways

Table 2-3 presents the ecological exposure pathways (along with the target ecological receptor groups for each pathway) that were considered in the selection of EQS and PSS.

Table 2-3 Applicable Ecological Exposure Pathways

Media	Exposure Pathway (Receptor Group)
Soil	• Direct Soil Contact (plants and soil invertebrates) • Soil and Food Ingestion (livestock and/or wildlife)
Sediment	• Direct Contact with Sediments (freshwater and marine benthic aquatic life)[a]
Surface Water	• Direct Contact with Surface Water (freshwater and marine pelagic aquatic life)[b]
Groundwater	• Migration of Groundwater Contaminants to Surface Water (freshwater and marine pelagic aquatic life)[c]

Notes:

a) Includes direct contact of gills and other respiratory surfaces with sediments; ingestion of sediment (including sediment pore water ingestion); ingestion of aquatic prey species and other food items (e.g., detritus, plants, phytoplankton, zooplankton, macroinvertebrate fauna, and fish); and root contact with sediment for aquatic plants.
b) Includes direct contact of gills and other respiratory surfaces with water; ingestion of water; ingestion of aquatic prey species and other food items (e.g., detritus, plants, phytoplankton, zooplankton, macroinvertebrate fauna, and fish); and foliar contact with water for aquatic plants.
c) Includes migration to a freshwater or marine surface water body such that aquatic organisms may become exposed to what was originally a groundwater contaminant.

2.5.3 Human and Ecological Receptors

The human and ecological receptors that were considered in the selection of the EQS and PSS are generally the same default receptor types used by CCME and the other consulted jurisdictions.

2.5.4 Groundwater Use Conditions

The selection of both EQS and PSS for soil and groundwater considers whether a groundwater resource is potable (i.e., used for drinking water or other domestic purposes) or is non-potable. Thus, soil and groundwater EQS and PSS have been determined for both potable and non-potable groundwater use conditions. The Atlantic Provinces may develop specific guidance for the purposes of regulating groundwater use at impacted sites.

2.6 GENERAL HIERARCHY OF IMPACTED SITES GUIDELINES SOURCE JURISDICTIONS

During the numerical environmental quality standards process that led to the NSE EQS, PSS and Rationale Document in 2014, it was determined that a range of appropriate guidelines are available from CCME and other Canadian and international jurisdictions, and that *de novo* derivation or development of specific provincial standards was not warranted. This is considered to remain the case at present. Consequently, all EQS and PSS values are adopted values that have been derived by CCME and other regulatory authorities in Canadian or international jurisdictions.

General preference was given to CCME environmental quality guidelines where they exist. For petroleum hydrocarbon and chlorinated VOC EQS and PSS values, preference was given to the criteria developed by the Atlantic Partnership in Risk Based Corrective Action (Atlantic PIRI). In the absence of CCME or PIRI guidelines for a given CoC, guidelines or other types of benchmarks from other Canadian or international regulatory authorities were identified and adopted, if deemed appropriate and scientifically defensible. The general hierarchy used to select EQS and PSS is outlined below:

General Hierarchy:

1. Atlantic RBCA Version 4.0 (Atlantic PIRI, 2021) RBSLs, PSSLs and ESLs (for BTEX, PHCs, and selected chlorinated VOCs).

2. Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines (http://ceqg-rcqe.ccme.ca/en/index.html)[1].
3. Federal Environmental Quality Guidelines (e.g., https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/federal-environmental-quality-guidelines.html).
4. As necessary, other Canadian jurisdictions (i.e., Alberta, British Columbia, Ontario) in specified orders of preference.
5. As necessary, United States Environmental Protection Agency (USEPA).
6. As necessary, select other U.S. and international jurisdictions.

If an environmental quality guideline for a particular CoC, pathway or receptor type was not available from the initial preferred jurisdiction, the next preferred jurisdiction(s) in the hierarchy was (were) then consulted until an appropriate environmental quality guideline could be identified and adopted (if the guideline value was deemed scientifically defensible). There were some deviations from the above hierarchy if the available guideline values from a source higher in the hierarchy were considered inappropriate or of weaker scientific basis relative to guidelines available from the other jurisdictions that were considered. For some CoC's however, no known regulatory authority has established environmental quality guidelines for certain environmental media, pathways, or receptor types. Thus, there are some CoC's which lack EQS or PSS currently.

Review of the environmental quality guidelines derived by these jurisdictions in previous numerical EQS development efforts has demonstrated that all are adequately conservative and protective of human and/or environmental health and are thereby considered appropriate and sufficiently defensible values for use as EQS and PSS at impacted sites located within the four Atlantic Provinces. Furthermore, the use of guidelines from these jurisdictions is well established common practice by impacted sites professionals across Atlantic Canada.

One change from the 2014 set of NSE EQS is a somewhat greater reliance on guidelines developed by the BCMOECCS. This reflects a recent comprehensive review and update, undertaken by BCMOECCS, of the BC Contaminated Sites Regulation (CSR) and its associated regulatory instruments and guidance, including environmental quality guidelines. Thus, guidelines from BCMOECCS are among the most current at this time. In addition, review of BCMOECCS technical guidance and protocols indicates that BC environmental quality guidelines are risk-based values that are derived using appropriate and standard methodologies that are the same or similar to those utilized by CCME and other Canadian jurisdictions. As such, the BCMOECCS guideline values are considered equally defensible and appropriate to those developed by the other jurisdictions that were consulted. Similar to the other consulted jurisdictions, BCMOECCS provides various types of technical documentation that describe and explain the guidelines that have been derived and adopted within British Columbia.

The consulted jurisdictions generally utilize the same or similar protocols and methodologies when developing environmental quality guidelines. However, it should be recognized that there are often differences in guideline values between two or more jurisdictions (despite the same or similar protocols being used) that reflect differing science policy between the jurisdictions with respect to certain assumptions and/or default parameter values.

[1] This includes Health Canada Guidelines for Canadian Drinking Water Quality.

The assumptions, models and approaches used in the development of the various adopted EQS and PSS are not discussed in detail within this document. Rather, it is recommended that site professionals and other users of the EQS and PSS consult the relevant source jurisdiction documentation to ensure they understand the underlying scientific principles, approaches and assumptions for the derivation of the adopted EQS and PSS values, as well as the appropriate application of the EQS and PSS.

In some cases, the guidelines that were adopted as EQS and PSS were modified to suit specific Atlantic Canada impacted sites policies and practices, or to make the adopted values more consistent with those developed by CCME or Atlantic PIRI. The types of modifications are briefly described in Section 3.0 and Section 4.0, where relevant. Specific modifications for any given chemical parameter in any of the media considered are described in the referenced tables of Appendix A, where relevant. It is noted that individual Atlantic Provinces may further modify the adopted Atlantic RBCA EQS or PSS, depending on specific requirements within their respective jurisdictions.

Another change in the current EQS and PSS tables (and the Rationale Document herein), relative to those presented in the 2014 NSE EQS and Rationale Document, is with respect to methylmercury (MeHg). This parameter has been removed from the human health soil and groundwater PSS tables, and the ecological soil PSS tables, based on MeHg comprising a very low proportion of total mercury (THg) in soil and groundwater. MeHg typically comprises 1% to 3% of the THg present in soil (USEPA MRC, 1997; USEPA, 2001). Thus, the majority of the THg present in soil at any given time is inorganic Hg. Similar proportions of MeHg are expected for sediments, given that MeHg is highly water soluble and will not partition to sediments to any significant extent (USEPA MRC, 1997; USEPA, 2001). Thus, MeHg has also been removed from the ecological sediment PQS table on this basis. Although MeHg in most surface water bodies is typically <10% of THg (CCME, 2003), MeHg has been retained in the ecological surface water and groundwater PQS sheets as a CCME water quality guideline value exists for this parameter. This CCME guideline is protective of freshwater and marine aquatic life but is not protective of MeHg bioaccumulation and biomagnification in aquatic food webs, nor is it protective of predator consumers of fish and other aquatic life that may contain MeHg in their tissues. Groundwater MeHg proportion of THg would be expected to be similar to or less than what is typical in surface water bodies.

2.7 ANALYTICAL DETECTION LIMIT CONSIDERATIONS

For some of the guidelines that were selected from the preferred source jurisdictions, the guideline values for certain chemicals in certain environmental media are below the typically achievable RDLs for those chemicals in those media. This is not an uncommon situation. Typically, regulatory authorities (including the jurisdictions reviewed for the purpose of selecting PSS and EQS values) will note that a particular guideline value is below the currently achievable RDL, and will sometimes provide direction for site professionals with respect to how site assessment activities should proceed in these situations.
This situation occurs for some CVOC parameters in soil (in relation to vapour intrusion-based human health soil quality guidelines), and for several pesticide parameters in surface water, ground water and sediment. For all such instances where this situation is known to occur, the parameters are bolded and asterisked within the PSS and EQS tables.

For sites where there is a potentially operable soil vapour to indoor air pathway in relation to the affected CVOC parameters, soil vapour or subslab vapour testing is required to determine potential indoor air exposures. In any such testing program, the site professional must consult with and abide by the guidance

provided in ARBCA (2021), with respect to CVOCs, and the Atlantic RBCA Guidance for Vapour Intrusion Assessments posted at: www.atlanticrbca.com/technical-documents/.

For sites with potential sediment, surface water or groundwater contamination in relation to the affected pesticide parameters, additional aquatic media assessment and/or consultation with provincial regulators should occur to confirm if there is a potential that such substances could be present at levels that may adversely affect aquatic biota.

Some general considerations that may be helpful when a PSS or EQS value is less than the achievable RDL are as follows:

- Determine if the parameter of interest is present in other site media, particularly site media where exposure may be expected for human and/or ecological receptors (i.e., site media other than the medium for which the EQS or PSS is <RDL).
- Based on site history and site characterization outcomes, determine if the parameter of interest can be reasonably expected to occur in site media.
- Review the physical-chemical and environmental fate and behaviour properties of the parameter of interest to determine if it is reasonable to anticipate the parameter's presence in site media, especially those site media where exposure may be expected to occur for human and/or ecological receptors.

3.0 Guidelines for Protection of Human Health

3.1 INTRODUCTION

This section of the Rationale Document addresses EQS and PSS that are based on human health effects.

3.2 ADJUSTMENT OF TARGET CANCER RISK LEVEL

The Atlantic Provinces and Atlantic PIRI have long incorporated a target cancer risk level of $1E^{-05}$ (1 in 100,000) as a default scientific policy with respect to what is considered an acceptable level of carcinogenic risk. This policy position is consistent with that of Health Canada for federally owned contaminated sites. Health Canada (2010) notes that a cancer risk in the range of 1 in 100,000 to 1 in 1,000,000 is "essentially negligible" for carcinogenic substances present in drinking water, and in environmental media at federally owned contaminated sites. A target cancer risk level of $1E^{-05}$ has been widely accepted by federal and most provincial agencies within their contaminated or impacted sites programs since the early 1990s. Further information on target cancer risk levels may be found in Health Canada (2010).

In cases where the original adopted guidelines from the source jurisdictions were based on a target cancer risk level of $1E^{-06}$ (1 in 1,000,000), such values were adjusted to reflect a target cancer risk level of $1E^{-05}$.

3.3 HUMAN HEALTH-BASED GUIDELINES FOR SOIL

Human receptors can be exposed to contaminated soil through several exposure pathways including ingestion, dermal contact, vapour migration to indoor air and dust inhalation in outdoor air.

The jurisdictional hierarchy for the selection of human health based EQS and PSS for soil was as follows (in preferential order):

1. Atlantic RBCA Version 4.0 (Atlantic PIRI, 2021) RBSLs and PSSLs (for BTEX, PHCs and selected chlorinated VOCs).
2. CCME Canadian Soil Quality Guidelines for the Protection of Human Health (http://ceqg-rcqe.ccme.ca/en/index.html) for all substances in the master list excluding BTEX and petroleum hydrocarbons; the CCME Canadian Soil Quality Guidelines include the Canadian Soil Quality Guidelines for the Protection of Human Health for Polycyclic Aromatic Hydrocarbons (CCME, 2010).
3. Federal Environmental Quality Guidelines (e.g., https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/federal-environmental-quality-guidelines.html.
4. Alberta Environment and Parks Soil and Groundwater Remediation Guidelines (AEP, 2019; https://open.alberta.ca/publications/1926-6243).
5. British Columbia Ministry of Environment and Climate Change Strategies (BCMOECCS) Contaminated Sites Regulation Schedule 3.1, and other applicable guidance and resources related to contaminated sites in BC (http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/guidance-resources; http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/laws-regulations-compliance).
6. Ontario Ministry of the Environment and Climate Change (MOECC) Rationale for Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario (MOECC, 2011).

7. United States Environmental Protection Agency (USEPA) Regional Screening Levels (USEPA, 2019; https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables).

The Atlantic PIRI Risk Based Corrective Action (RBCA) process has been developed by Atlantic Canadian regulatory agencies for use in assessing petroleum hydrocarbons at impacted sites. This process provides Tier I and Tier II soil (and groundwater) screening levels for total petroleum hydrocarbons (TPH) - expressed as modified TPH (mTPH), as well as for benzene, toluene, ethylbenzene and xylene, for common soil (and groundwater) exposure pathways. The RBCA process includes consideration of many assumptions contained within the CCME Canada-Wide Standard for Petroleum Hydrocarbons in soil and is considered an equivalent approach for the assessment of petroleum hydrocarbons. Atlantic PIRI has recently developed (or adopted) Tier I and Tier II soil and groundwater screening levels for several chlorinated VOCs.

With respect to the USEPA Regional Screening Levels, the original USEPA values for non-carcinogens were divided by a factor of 5. This was done because the USEPA utilizes a target hazard quotient of 1.0 in their derivation process, whereas the standard approach within the CCME and other Canadian jurisdictions is to use a default hazard quotient of 0.2 (or 20%) in the development of human health-based soil quality guidelines.

Where it was necessary to apply MOECC (2011) soil standards, S1 values were applied for the agricultural, residential, and commercial land use categories, while S2 values were applied for the industrial land use category. Details on S1, S2 and other types of soil standards used within Ontario contaminated sites programs are provided within MOECC (2011).

3.3.1 Human Exposures to Sediment

At this time, there are no human health-based guidelines that are specifically derived for the assessment of human sediment exposure.

Recent guidance from Health Canada (2017) indicates that sediment concentrations of CoC's may be screened against available human health-based residential/parkland soil quality guidelines for scenarios where only direct contact exposure (i.e., ingestion, dermal contact) with sediments is expected (such as CCME Canadian Soil Quality Guidelines for human health or other regulatory human health-based soil quality guidelines). However, Health Canada cautions that the exposure factors used to develop soil quality guidelines differ from sediment exposure factors, such that soil quality guidelines could either be over-protective or insufficiently protective of human health, depending on the sediment exposure scenario. In such cases, adjustment of the soil quality guidelines or derivation of site-specific guidelines may be warranted, so long as sufficient technical rationale is provided.

The Atlantic Provinces concur with and support the Health Canada (2017) guidance.

It is noted that human health-based soil quality guidelines do not account for bioaccumulation or biomagnification of chemicals in aquatic food items and cannot be used as screening tools for exposure scenarios that involve aquatic food item consumption.

It is also noted that soil quality guidelines developed for pathways other than direct oral and dermal contact are considered inappropriate for, and not applicable to, sediment exposure scenarios.

3.4 HUMAN HEALTH-BASED GUIDELINES FOR SURFACE WATER

Concerns about surface water quality typically focus on the protection of freshwater or marine aquatic life rather than human health. However, Health Canada provides Recreational Water Quality Guidelines (https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-recreational-water-quality-third-edition.html) that may be used as guidance when assessing surface water quality for such human activities as swimming, water sports and other scenarios involving contact with surface water. In addition, in situations where surface water is used as a drinking water source or where there is believed to be a high potential for incidental ingestion of surface water, the Health Canada Guidelines for Canadian Drinking Water Quality are recommended for use. The Atlantic Canada EQS and PSS do not include human health-based guidelines for surface water quality currently, other than the Guidelines for Canadian Drinking Water Quality.

3.5 HUMAN HEALTH-BASED GUIDELINES FOR GROUNDWATER

Human receptors may be exposed to contaminants in groundwater through direct ingestion (as drinking water) and/or through vapour migration from groundwater to indoor air, and subsequent indoor air inhalation. The jurisdictional hierarchy for the selection of human health based EQS and PSS for groundwater was as follows (in preferential order):

1. Atlantic PIRI Version 4.0 (Atlantic PIRI, 2021) RBSLs and PSSLs (for BTEX, PHCs and selected chlorinated VOCs).
2. Health Canada Guidelines for Canadian Drinking Water Quality (https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality.html#tech_doc).
3. Federal Environmental Quality Guidelines (e.g., https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/federal-environmental-quality-guidelines.html).
4. Alberta Environment and Parks Soil and Groundwater Remediation Guidelines (AEP, 2019; https://open.alberta.ca/publications/1926-6243).
5. British Columbia Ministry of Environment and Climate Change Strategies (BCMOECCS) Contaminated Sites Regulation Schedule 3.2, and other applicable guidance and resources related to contaminated sites in BC (http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/guidance-resources; http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/laws-regulations-compliance).
6. Ontario Ministry of the Environment and Climate Change (MOECC) Rationale for Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario (MOECC, 2011).
7. United States Environmental Protection Agency (USEPA) Regional Screening Levels for Tap Water (USEPA, 2019; https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables; and, other USEPA Drinking Water Quality Guidelines provided at: https://www.epa.gov/ground-water-and-drinking-water.

3.5.1 Potable Groundwater Guidelines

Groundwater is an important public resource in Atlantic Canada, where numerous communities rely on groundwater-based drinking water supplies. Groundwater is also used in a wide variety of industrial and commercial activities.

All Atlantic Provinces require that potential impacts to site groundwater be assessed as part of an impacted site characterization process. The classification of local groundwater use (potable versus non-potable) must be confirmed to appropriately apply the relevant Tier I EQS or Tier II PSS values. The individual Atlantic Provinces provide various tools and guidance that can assist a site professional in determining if groundwater at a given site should be considered potable or non-potable. These relevant tools and guidance should be consulted prior to the selection and application of EQS or PSS. Such tools include protocols and guidance that determine the availability of municipal water supplies to a given site, and the location of protected well-fields or source water protection areas relative to a site.

4.0 Guidelines for Protection of Ecological Health

This section of the Rationale Document addresses EQS and PSS that are based on ecological effects.

4.1 ECOLOGICAL HEALTH-BASED GUIDELINES FOR SOIL

The jurisdictional hierarchy for the selection of ecological health based EQS and PSS for soil was as follows (in preferential order):

1. Atlantic PIRI Version 4.0 (Atlantic PIRI, 2021) ESLs (for BTEX, PHCs and selected chlorinated VOCs).
2. CCME Canadian Soil Quality Guidelines for the Protection of Environmental Health (http://ceqg-rcqe.ccme.ca/en/index.html, including: CCME (2008) Canada Wide Standards for Petroleum Hydrocarbons, and, CCME (2010) Canadian Soil Quality Guidelines for the Protection of Environmental Health for Polycyclic Aromatic Hydrocarbons.
3. Federal Environmental Quality Guidelines (https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/federal-environmental-quality-guidelines.html).
4. Alberta Environment and Parks Soil and Groundwater Remediation Guidelines (AEP, 2019; https://open.alberta.ca/publications/1926-6243).
5. British Columbia Ministry of Environment and Climate Change Strategies (BCMOECCS) Contaminated Sites Regulation Schedule 3.1, and other applicable guidance and resources related to contaminated sites in BC (http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/guidance-resources; http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/laws-regulations-compliance).
6. Ontario Ministry of the Environment and Climate Change (MOECC) Rationale for Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario (MOECC, 2011).
7. Other jurisdictions, as necessary.

The noted jurisdictions provide ecological soil quality guidelines for all land uses considered herein, and for both coarse-grained and fine-grained soils, where appropriate.

4.2 ECOLOGICAL HEALTH-BASED GUIDELINES FOR SEDIMENT

The jurisdictional hierarchy for the selection of ecological health based EQS for sediments (freshwater and marine) was as follows (in preferential order). No sediment PSS were selected as all currently adopted sediment quality guidelines are protective of benthic organisms in direct contact with sediments. The adopted sediment quality guidelines do not address other ecological pathways or receptors currently.

1. Atlantic PIRI (2021; 2012) Sediment ESLs (for BTEX and petroleum hydrocarbons).
2. CCME Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (http://ceqg-rcqe.ccme.ca/en/index.html).
3. Federal Environmental Quality Guidelines (https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/federal-environmental-quality-guidelines.html).
4. British Columbia Ministry of Environment and Climate Change Strategies (BCMOECCS) Contaminated Sites Regulation Schedule 3.4 (http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/laws-regulations-compliance); and/or, BCMOECCS Working Sediment Quality Guidelines (https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf).
5. OMOE. 2008. Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario: An Integrated Approach.
6. United States jurisdictions including various sediment quality guidelines developed within USEPA programs and select individual U.S. states.

Where sediment quality guidelines beyond CCME were considered, preference was given to identifying jurisdictions that use similar approaches to CCME in sediment guideline derivation. For example, most existing regulatory sediment quality guidelines (including those derived by CCME and MOECC) are based on co-occurrence data (i.e., correlations or co-incidence of benthic impacts with measured sediment chemical concentrations). While there are a number of different approaches to deriving co-occurrence-based guidelines, most have a number of similarities such that it is considered appropriate to adopt these types of guidelines without modification, even though different substances have guidelines that were derived using slightly different approaches. There are however, some substances (mostly organics, including petroleum hydrocarbons and chlorinated VOCs) for which existing sediment quality guidelines are not based on co-occurrence approaches. Rather, the most common sediment guideline derivation approach for such substances is equilibrium partitioning (EqP). In brief, the EqP approach assumes that pore water exposure is the major exposure pathway and that benthic organisms have a sensitivity that is like pelagic organisms. The EqP approach involves extrapolating a water quality guideline to a bulk sediment concentration using a chemical-specific Koc (organic carbon partitioning coefficient) and a default or site-specific sediment organic carbon content. Further details on the EqP approach may be found in USEPA (2008) and numerous papers within the scientific literature. The Atlantic RBCA (2021; 2012) BTEX and petroleum hydrocarbon sediment ESLs were developed using an EqP approach.

For co-occurrence-based sediment quality guidelines, only probable effect level (PEL) or similar types of guidelines were considered. It has become well established in the past twenty or more years that low-effect level and/or no-effect level sediment quality guidelines are highly conservative, and their exceedance often does not correlate well with other endpoints that are commonly evaluated in aquatic risk assessments (such as sediment toxicity test results and benthic community assessment metrics). In practice, exceedance of the PEL

(and similar values) is the more realistic indicator of a potential for population-level adverse effects within benthic invertebrate communities. Emphasis on PELs or similar guideline values has become a common practice in many sediment assessment programs conducted across Canada.

The sediment EQS for modified TPH and BTEX are adopted directly from Atlantic RBCA (2021; 2012). Users of the sediment EQS are encouraged to review the original Atlantic PIRI guidance documentation to be sure they understand how to derive site or sample specific sediment EQS based on measured sediment organic carbon content (if/where appropriate), as well as the difference between the "typical" and "other" sediment categories.

4.3 ECOLOGICAL HEALTH-BASED GUIDELINES FOR SURFACE WATER

The jurisdictional hierarchy for the selection of ecological health based EQS for surface water (for the protection of freshwater and marine aquatic life) was as follows (in preferential order). No surface water PSS were selected as all currently adopted ecological surface water quality guidelines are protective of freshwater and marine aquatic life in direct contact with surface water. The adopted surface water quality guidelines do not address other ecological pathways or receptors currently.

1. Atlantic RBCA (2021; 2012) Surface Water ESLs (for BTEX and petroleum hydrocarbons).
2. CCME Canadian Water Quality Guidelines (freshwater and marine) for the Protection of Aquatic Life (http://ceqg-rcqe.ccme.ca/en/index.html).
3. Federal Environmental Quality Guidelines (https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/federal-environmental-quality-guidelines.html).
4. BCMOECCS Approved and Working Water Quality Guidelines as well as Contaminated Sites Regulation Schedule 3.2 (http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines; http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/laws-regulations-compliance).
5. Alberta Environment and Parks (2018) Environmental Quality Guidelines for Alberta Surface Waters (https://open.alberta.ca/publications/9781460138731).
6. OMOE (1999) Provincial Water Quality Objectives.
7. Ministère de l'Environnement du Québec (2019). On-line updates to Critères de qualité de l'eau de surface au Québec (http://www.mddelcc.gouv.qc.ca/eau/criteres_eau/index.asp).
8. United States jurisdictions, including various water quality guidelines developed within USEPA programs and by select individual U.S. states.

Where surface water quality guidelines beyond CCME and Atlantic RBCA were considered, general preference was given to identifying jurisdictions that use similar approaches to CCME in the derivation of surface water quality guidelines.

If it became necessary to consider surface water quality guidelines from U.S. jurisdictions for a particular CoC, there was no established hierarchy for sourcing guideline values from U.S. federal or state regulatory authorities. Rather, efforts focused on selected U.S. federal and state authorities that are known to have developed surface water quality guidelines for numerous chemicals and that regularly revisit and update their guidelines. Where possible, preference was given to U.S. jurisdictions that use similar surface water quality guideline derivation approaches as the major Canadian jurisdictions that surface water EQS were adopted from (i.e., Atlantic RBCA, CCME, BCMOECCS, MOECC).

As mentioned, the ecological health based EQS for surface water are only applicable for freshwater and marine aquatic life protection. While there are other potential ecological surface water exposure pathways, including plant/crop contact from the use of irrigation water, and livestock and/or wildlife ingestion of surface water, guidelines for these pathways have not been adopted as EQS or PSS at this time. Should these potential surface water pathways merit evaluation at an impacted site, it is recommended that existing guidelines from CCME, BCMOECCS, AEP and other jurisdictions (as appropriate) for these pathways be considered.

4.4 ECOLOGICAL HEALTH-BASED GUIDELINES FOR GROUNDWATER

At this time, ecological EQS for groundwater are values that are protective of freshwater or marine aquatic life, under the assumption that there is groundwater discharge from an impacted site to a receiving water body.

Currently, groundwater EQS are determined by applying a 10X attenuation factor to the surface water EQS values (except for petroleum hydrocarbons and BTEX, as described in Atlantic PIRI, 2021; 2012). The use of a 10X factor has regulatory precedent in several U.S. and Canadian jurisdictions, including NSE, MOECC, BCMOECCS and Massachusett's DEP). These jurisdictions consider a default 10X attenuation factor to be a general conservative order of magnitude factor for the dilution and attenuation of contaminant concentrations that occur during groundwater flow and eventual discharge to a receiving water body.

The groundwater EQS are applicable at site monitor well locations greater than or equal to 10 meters from a freshwater or marine receiving water body. For wells located within 10 meters of a water body (freshwater or marine), groundwater EQS should not be used. Rather, surface water EQS should be applied directly.

For petroleum hydrocarbons and BTEX, Atlantic RBCA (2021; 2012) provides distance-gradated (10 meters to 200 meters from a receiving water body) groundwater ESLs that were developed using the Domenico (1987) analytical solute transport model. These values are not adopted as EQS but may be applied at a Tier II level if deemed appropriate by the site professional.

The same considerations previously noted in **Section 4.3** with respect to the potential ecological surface water exposure pathways of plant/crop contact with irrigation water, and livestock and/or wildlife ingestion of surface water, apply to groundwater EQS as well.

5.0 Consideration of Background Environmental Conditions

It is a common finding that various metals and metalloids (including: aluminum, arsenic, cobalt, iron, manganese, nickel, tin, vanadium) present in Atlantic Canada soils, sediments, surface water and groundwater, exhibit naturally elevated concentrations that may exceed Tier I EQSs and/or Tier II PSSs. For substances with naturally occurring ("background") concentrations that exceed Tier I EQSs or Tier II PSSs, achieving delineation or determining the need for further assessment at impacted sites can become a challenge. At many sites, environmental media concentrations of such metals and metalloids are not the result of current or historical site activities, but rather, reflect natural geological enrichment and/or regional scale impacts such as forest/grass fires, atmospheric deposition of industrial air emissions, urbanization.

While it is relatively common in detailed ESAs and in risk assessment studies to include the consideration of background concentrations of metals and metalloids when identifying substances in site media that may pose a concern to human or ecological health, or otherwise require further investigation, the collection of local background environmental media chemistry data is not typically conducted at initial stages of ESAs. Currently, in Atlantic Canada, there are few curated sources of background environmental data that could potentially represent background conditions for impacted sites located within all Atlantic Provinces. Also, the existing datasets are limited nearly entirely to soils. At some impacted sites, these existing datasets may not necessarily be adequate representations of local background environmental media chemistry. Thus, ESAs conducted at some impacted sites may require the collection of local or regional background environmental media chemistry data in order to achieve delineation of site contaminants and/or to inform the identification of those substances that require further evaluation, and those that do not. It is anticipated that this decision would be made by site professionals on a case-by-case, and site-specific basis.

To facilitate the evaluation of background conditions in the assessment of impacted sites, individual Atlantic Provinces, at their discretion, may develop guidance resources that include protocols, recommended datasets or databases, policies, and potentially other regulatory instruments, that relate to the collection and use of background environmental media chemistry data within Atlantic Canada impacted site assessment programs.

6.0 Atlantic RBCA Environmental Quality Standards (EQS) and Pathway-Specific Standards (PSS)

The Atlantic RBCA Environmental Quality Standards (EQS) and Pathway-Specific Standards (PSS) have been developed to enable consistent assessment and management of potential risks posed to human and ecological receptors at Atlantic region impacted sites, under four common land use categories (i.e., agricultural, residential/parkland, commercial, and industrial), and under conditions of potable and non-potable groundwater use, and coarse and fine-grained soil texture.

EQS are considered to be Tier I values that are the lowest of all applicable or potentially applicable PSS for each receptor type (human health and ecological), land use, groundwater classification and soil texture type, and are inherently more conservative than PSS. The PSS are specific to certain exposure pathways (and/or receptor types) and are considered to be Tier II values for which their application requires more site characterization information than is typically required for the application of Tier I EQS.

The use and application of Atlantic RBCA Tier I EQS and Tier II PSS will be determined by the individual Atlantic Provinces using regulations, policy, or other regulatory instruments.

In general, the application of Atlantic RBCA Tier I EQS assumes that all relevant exposure pathways and receptors that may be associated with a particular land use type, are operable and/or present at a site. Should site media CoC concentrations exceed applicable Tier I EQS, they may then be compared to applicable Tier II PSS. At Tier II, operable and inoperable site exposure pathways and/or non-relevant receptors can be identified such that PSS developed for inoperable pathways and/or inappropriate receptors may be excluded, so long as sufficient rationale or justification is provided. If the justification for pathway or receptor exclusion involves management measures to control certain exposure pathways or to restrict access for certain receptor types, site professionals should expect that additional regulatory requirements may apply.

EQS and PSS should always be applied in conjunction with the site professionals' understanding and consideration of applicable legislation, regulations, and other regulatory instruments (including various protocols, policies and guidance documentation) within each of the four Atlantic Provinces.

Most EQS and PSS can be applied directly as "look-up" values; however, the EQS or PSS for some CoC's in some media are able to be adjusted on the basis of site-specific data on such factors/parameters as pH, water hardness, and sediment organic carbon content. Site professionals are expected to understand and consider the conditions under which EQS and PSS may be modified with site-specific data.

For sites which have unique characteristics (such that the typical assumptions regarding exposure pathways, receptors and land use that are inherent to the adopted EQS and PSS values, may not apply), a site-specific risk assessment approach should be considered. A site-specific risk assessment approach, or another means deemed appropriate by the site professional and provincial regulator, should also be considered if site media are impacted by CoC's that do not have EQS or PSS available.

A list of the regulatory sources or reference documentation for the adopted EQS and PSS values (from the consulted jurisdictions, following the hierarchies presented previously) is provided in **Section 7.0**. The PSS tables presented in **Appendix A** indicate the regulatory sources of each of the selected PSS values.

7.0 Primary Regulatory Sources and Reference Documentation for the Selected EQS and PSS Values

The main sources of regulatory guidelines (and related documentation) that were used to identify EQS and PSS for adoption within Atlantic Canada impacted sites programs were as follows.

Atlantic RBCA Version 4.0 (Atlantic PIRI, 2021) RBSLs, PSSLs and ESLs (for BTEX, PHCs, and selected chlorinated VOCs).

Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines (http://ceqg-rcqe.ccme.ca/en/index.html).

Canadian Council of Ministers of the Environment (CCME) Canada-Wide Standard for Petroleum Hydrocarbons in Soil;
https://www.ccme.ca/en/resources/contaminated_site_management/phc_cws_in_soil.html.

Federal Environmental Quality Guidelines (https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/federal-environmental-quality-guidelines.html).

Alberta Environment and Parks Soil and Groundwater Remediation Guidelines (AEP, 2019; https://open.alberta.ca/publications/1926-6243).

British Columbia Contaminated Sites Regulation (Schedules 3.1, 3.2 and 3.4), and other applicable guidance and resources related to contaminated sites in BC (http://www2.gov.bc.ca/gov/content/environment/air-land-

water/site-remediation/guidance-resources; http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/laws-regulations-compliance).

Ontario Ministry of the Environment and Climate Change (MOECC) Rationale for Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario (MOECC, 2011).

United States Environmental Protection Agency (USEPA) Regional Screening Levels (USEPA, 2019); https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables.

Health Canada Guidelines for Canadian Drinking Water Quality; https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality.html#tech_doc.

United States Environmental Protection Agency (USEPA) Drinking Water Quality Guidelines provided at: https://www.epa.gov/ground-water-and-drinking-water.

BCMOECCS Working Sediment Quality Guidelines; https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf.

OMOE. 2008. Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario: An Integrated Approach.

BCMOECCS Approved and Working Water Quality Guidelines; http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines.

Alberta Environment and Parks. 2018. Environmental Quality Guidelines for Alberta Surface Waters. Water Policy Branch, Alberta Environment and Parks. Edmonton, Alberta.

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Ministère de l'Environnement du Québec. 2019. On-line updates to Critères de qualité de l'eau de surface au Québec; http://www.mddelcc.gouv.qc.ca/eau/criteres_eau/index.asp.

8.0 References Cited Within Rationale Document

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Atlantic RBCA, 2021. Atlantic RBCA (Risk-Based Corrective Action) for Impacted Sites in Atlantic Canada. Version 4.0. User Guidance, July 2021 (updated July 2022).

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CCME (Canadian Council of Ministers of the Environment). 2010. Canadian Soil Quality Guidelines for Carcinogenic and Other Polycyclic Aromatic Hydrocarbons (PAHs): Environmental and Human Health Effects - Scientific Criteria Document. PN 1445. (Revised June 2010).

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CCME (Canadian Council of Ministers of the Environment). 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. ISBN-10 1-896997-45-7 PDF; ISBN-13 978-1-896997-45-2 PDF. PN 1332.

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Ministère de l'Environnement du Québec. 2019. On-line updates to Critères de qualité de l'eau de surface au Québec. http://www.mddelcc.gouv.qc.ca/eau/criteres_eau/index.asp.

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USEPA. MRC. 1997. Mercury Study Report to Congress. Volume III: Fate and Transport of Mercury in the Environment. December 1997. Office of Air Quality Planning and Standards, and, Office of Research and Development, U.S. Environmental Protection Agency. EPA-452/R-97-005.

APPENDIX A

Atlantic RBCA Environmental Quality Standards (EQS) and Pathway-Specific Standards (PSS) Tables

1.0 Human Health Tier I Environmental Quality Standards

Human Health Tier I Environmental Quality Standards for Soil – Potable
Human Health Tier I Environmental Quality Standards for Soil – Non-Potable
Human Health Tier I Environmental Quality Standards for Groundwater – Potable
(UPDATED, JULY 2022)
Human Health Tier I Environmental Quality Standards for Groundwater – Non-Potable
(UPDATED, JULY 202

2.0 Human Health Tier II Pathway Specific Standards

Human Health Tier II Pathway Specific Standards for Soil – Agricultural
Human Health Tier II Pathway Specific Standards for Soil – Residential/Parkland
Human Health Tier II Pathway Specific Standards for Soil – Commercial
Human Health Tier II Pathway Specific Standards for Soil – Industrial

Human Health Tier II Pathway Specific Standards for Groundwater – Agricultural
(UPDATED, JULY 2022)
Human Health Tier II Pathway Specific Standards for Groundwater – Residential/Parkland
(UPDATED, JULY 2022)
Human Health Tier II Pathway Specific Standards for Groundwater – Commercial
(UPDATED, JULY 2022)
Human Health Tier II Pathway Specific Standards for Groundwater – Industrial (UPDATED, JULY 2022)

3.0 Ecological Tier I Environmental Quality Standards

Ecological Tier I Environmental Quality Standards for Sediment (UPDATED, JULY 2022)
Ecological Tier I Environmental Quality Standards for Soil (UPDATED, JULY 2022)
Ecological Tier I Environmental Quality Standards for Surface Water
(UPDATED, JULY 2022)
Ecological Tier I Environmental Quality Standards for Groundwater (UPDATED, JULY 2022)

4.0 Ecological Tier II Pathway Specific Standards

Ecological Tier II Pathway Specific Standards for Sediment

Ecological Tier II Pathway Specific Standards for Soil – Agricultural (UPDATED, JULY 2022)
Ecological Tier II Pathway Specific Standards for Soil – Residential/Parkland (UPDATED, JULY 2022)
Ecological Tier II Pathway Specific Standards for Soil – Commercial/Industrial (UPDATED, JULY 2022)
Ecological Tier II Pathway Specific Standards for Surface Water/Groundwater