Maine Remedial Action Guidelines (RAGs) for Sites Contaminated with Hazardous Substances

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Approved:

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1 Disclaimer

This guidance provides a DEP-accepted approach for determining human health risk and clean-up goals at remediation sites. These guidelines are not rules and are not intended to have the force of law. This guidance does not create or affect any legal rights of any individual, all of which are determined by applicable law. This guidance does not supersede statutes or rules.

2 Introduction and Purpose

2.1 Purpose

Maine law charges the Commissioner of the Department of Environmental Protection (DEP) with abating pollution to protect public health and welfare. This guidance is one approach that may be used to determine which sites pose a risk and therefore warrant abatement, mitigation, and/or remediation; establish target clean-up levels; and clear sites for reuse (close-out sites) once remediation is completed. The purpose of this guidance is to ensure:

1. Protection of public health and welfare at and near remediation sites;
2. Consistency of remediation decisions in Maine; and
3. Certainty for the regulated community.

2.2 Consistency with Superfund Risk Assessment

The Maine Remedial Action Guidelines for Sites Contaminated with Hazardous Substances (RAGs) were developed with toxicological assistance from the Maine Department of Health and Human Services' Center for Disease Control and Prevention (CDC). These guidelines are consistent with EPA's Superfund Program[1], which responds to releases of hazardous substances to the environment. RAGs are based upon EPA's risk assessment guidance, supported by the CDC and DEPs' Guidance for Site Specific Risk Assessment provided in Attachment B: Supplemental Guidance for Conducting Risk Assessments in Maine.

2.3 When to Use RAGs and When to Develop a Site-Specific Risk Assessment

A project lead may choose to use these RAGs to simplify derivation of clean-up goals for sites and to speed-up the decision-making process. Alternatively, the project lead may decide to use the risk assessment procedures in Attachment B to determine whether site action is warranted, determine target clean-up goals, and/or determine if the site can be closed out. The choice of which procedure to use (RAGs or site-specific risk assessment) is generally at the discretion of the project lead on the clean-up, which may be the site owner/operator, Potential Responsible

[1] *United States Comprehensive Environmental Response, Compensation, and Liability Act*, 42 U.S.C. §§ 9601-9675

Party, DEP, EPA, Department of Defense, or other party. The exception to this is if DEP determines, in consultation with CDC, that a media/scenario/route-of-exposure will likely cause a greater risk due to site-specific circumstances than contemplated when the RAGs were developed. In this case, the DEP will require that the project lead develop a risk assessment using the procedures in Attachment B: Supplemental Guidance for Conducting Site-Specific Risk Assessments in Maine. For example, if a person was only exposed to metals at an agricultural site via plant uptake and subsequent ingestion of the plants, then site specific target clean-up goals would need to be developed for that route of exposure and scenario. Another example is if there are subsistence anglers consuming contaminated fish tissue, then a site-specific risk assessment is required.

3 Applicability

3.1 Applicable Programs & DEP Approval Process

This procedure applies to the DEP programs listed below. In general, DEP reviews an applicant's proposal and reaches agreement on appropriate RAGs for a specific site. Ideally, clean-up should allow for unrestricted site use. DEP determinations that soil clean-up levels will be protective of public health and welfare are made in clean-up decisions in the form of DEP Orders, Administrative Agreements, Consent Agreements, and other legally binding decision documents.

Consult staff in the following programs to determine the administrative procedures for review and approval of site specific clean-up goals. Details on each of these programs are available on the DEP website at: http://www.maine.gov/dep/programs/.

3.1.1 Uncontrolled Hazardous Substance Sites

The project lead may decide to use this procedure to determine clean-up levels at an Uncontrolled Hazardous Substance Site (Uncontrolled Site) under 38 M.R.S. § 1364(5). The Uncontrolled Sites Program (USP) directs the investigation and removal of threats to the public health, safety or welfare that are posed by hazardous substances at sites. Basically, the USP is the State of Maine equivalent to the federal Superfund Program. At DEP lead sites, DEP establishes clean-up goals in formal DEP Decision Documents, after a management review meeting.

3.1.2 Voluntary Response Action Program

Maine's Voluntary Response Action Program (VRAP), under 38 M.R.S. § 343-E, allows applicants to voluntarily investigate and clean-up properties to the satisfaction of the DEP in exchange for protections from future DEP enforcement actions. The project lead may decide to use this guidance to determine clean-up levels for a site in the VRAP.

3.1.3 Brownfields

The project lead may decide to use these procedures to determine clean-up levels at a Brownfields site. The Brownfields program provides grants to assist with the assessment and remediation of "[r]eal property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant", pursuant to the Business Liability Relief and Brownfields Revitalization Act, 42 U.S.C. §§ 9601-9628.

3.1.4 Superfund/CERCLA

At sites subject to clean-up under the federal Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. § 9601 et seq. of 1980, as amended (CERCLA or Superfund), clean-up levels are determined by Applicable or Relevant and Appropriate Requirements (ARARs) and the "Nine Criteria" found in 40 C.F.R. 300.430 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The DEP will recommend that EPA consider using this guidance to establish clean-up goals for sites being investigated and remediated under Superfund in Maine, including Department of Defense sites. Site specific remediation decisions are finalized in a Record of Decision for each site.

3.1.5 RCRA

In Maine, RCRA subtitle C corrective action sites are subject to the Maine Hazardous Waste, Septage and Solid Waste Management Act and associated regulations (06-096, Chapters 850 through 857). These laws generally require releases of hazardous waste and constituents to be removed where practical, but if not, the Remedial Action Guidelines are used to ensure corrective action prevents current and future exposure to contaminants that pose a risk to human health or the environment. Site specific remediation clean-up goals and procedures are established in DEP Orders and Licenses.

3.1.6 Not Applicable to other DEP Programs

DEP does not intend that these guidelines be used by programs that are not listed above.

3.1.7 Relation to Beneficial Reuse of Remediated Debris

Remediated soils or other debris may qualify for a subsequent reuse, such as fill, even though pollutants in the material may exceed normal background concentrations.

3.1.7.1 Hazardous Waste

The beneficial reuse of contaminated material that is classified as a hazardous waste is subject to the hazardous waste laws described in Section 3.1.5 above, and the

project lead should consult with the DEP's RCRA Corrective Action staff (207-287-7688) regarding its reuse requirements.

3.1.7.2 Other Residuals

The beneficial reuse of contaminated material that is not classified as a hazardous waste is subject to the DEP's Solid Waste Program rules. Specifically, if the material is to be beneficially used for Agronomic Utilization, such as for topsoil, fertilizer, soil amendment, or for any other plant growth purpose, then the reuse is subject to the solid waste rules at *Agronomic Utilization of Residuals*, 06-096 C.M.R. ch. 419. If the material is to be used for any another purpose, such as construction fill or a building material, then that activity would be subject to the solid waste rules at *Beneficial Use of Solid Wastes*, 06-096 C.M.R. ch. 418. These rules generally have exemptions to allow the storage and reuse of materials on the site of generation, if DEP is the project lead. See the rules and discuss with the DEP's solid waste staff (aka materials management staff) (207-287-7688) any intended storage or reuse of materials from a remediation project to determine if it is an exempt activity or if a license under Chapter 418 or Chapter 419 is needed.

3.2 Applicable Pollutants and Contaminants

3.2.1 Applicable to Hazardous Substances

This procedure is applicable to determining clean-up levels for media contaminated by hazardous substances, including waste oil.

3.2.2 Applicable to Mixtures

The procedure is applicable to clean-up levels for media contaminated by a mixture of hazardous substances and petroleum.

3.2.3 Not Applicable to Petroleum Only

This procedure does not apply to media that are contaminated with only petroleum. For media that are contaminated with petroleum but not hazardous substances, refer to DEP's Remediation Guidelines for Petroleum Contaminated Sites in Maine[2]. For purposes of this section, petroleum includes gasoline, aviation fuels, methyl tertiary butyl ether (MTBE), kerosene, #2 heating oil, other heating oils including heavy oils, diesel fuel, or other comparable petroleum hydrocarbons, and gasoline-ethanol blends with 15% ethanol or less. Petroleum does not include waste oil.

[2] Petroleum clean-up guidance is available on DEP's website at: http://www.maine.gov/dep/spills/petroleum/

3.3 Applicable Media, Scenarios and Routes-of-Exposure

This guidance is specifically developed for sites or operable units with the media, scenarios and routes-of-exposure that the DEP and Maine CDC identified as the most likely to create the greatest risk at contaminated sites, as summarized in Table 1 beginning on page 12. This procedure does not apply to establishing clean-up guidelines for public drinking water supplies, surface water, or any other media/scenarios/routes-of-exposure that are not included in Table 1. Further, if DEP determines that other media/scenarios/routes-of-exposure may create a greater risk under site-specific circumstances, DEP will require a risk assessment following the procedures in Attachment B, rather than using these RAGs.

Attachment A: Technical Support Document for Maine 2018 Remedial Action Guidelines contains additional information, including the references to the formulas and factors used to develop RAGs for each media/scenario/route-of-exposure.

3.4 Not Applicable to Ecological Risk

This procedure applies to soil clean-up guidelines protective of human health impacts only. This guidance is not applicable to ecological impacts. If DEP believes that hazardous substances in media pose significant risk to ecological receptors, it may require that the project lead conduct an ecological assessment before the RAGs are applied at the site. DEP generally requires an ecological assessment if evidence indicates that a current or future potential exists for exposure of ecological receptors to contaminants from the site. Evidence includes visible physical evidence (sheens or neat product, etc.) or analytical data that contaminants from the site are impacting surface water, sediment, wetlands, or biota. Evidence also includes runoff or other exposure pathways that will likely result in ecological impacts. Evidence may also include data suggesting potential adverse impacts to terrestrial biota, such as contaminants that can bioaccumulate and that are within the top two (2) feet of soil. Additional guidance on assessing ecological risk at contaminated sites is available at: http://www.epa.gov/risk/superfund-risk-assessment-ecological-risk-topics.

3.5 Not Applicable to Selection of COPCs for Full Risk Assessment

The RAGs should not be used in selecting Contaminants of Potential Concern (COPCs) for a risk assessment. Rather, COPCs should be developed in accordance with Attachment B. This is because RAGs are set at an Incremental Lifetime Cancer Risk (ILCR) of 10^{-5} or a Hazard Quotient (HQ) of 1. Risk-based concentrations for use in selecting COPCs should reflect an ILCR of 10^{-6} and non-carcinogenic HQ of 0.1. The use of risk-based concentrations at the lower target risk and hazard levels is consistent with Superfund guidance, aimed at ensuring that contaminants that could possibly contribute significantly to risk and hazard are included in the quantitative assessment. Because the intent of the COPCs selection process is to generate a conservative list of contaminants requiring quantitative

evaluation, recommended screening criteria are conservative so as not to omit contaminants that may contribute significantly toward cumulative site risk.

3.6 Not Applicable to Radionuclides

Radionuclides are not addressed in the RAGs. Contact the CDC's Maine Radiation Control Program for protocols in assessing and mitigating risk from radionuclides.

Table 1: Media, Scenario and Routes-of-Exposure included in the Remedial Action Guidelines

Media	Scenario	Route of Exposure	Description
Soil (including hydric)	Residential	Ingestion	Incidental exposure while working/playing outside including dust from dirt tracked indoors
		Skin Contact	Incidental exposure while working/playing outside including dust from dirt tracked indoors
		Inhalation	Incidental exposure while working/playing outside including dust from dirt tracked indoors
	Recreational / Park User	Ingestion	Incidental exposure while working/playing outside
		Skin Contact	Incidental exposure while working/playing outside
		Inhalation	Incidental exposure while working/playing outside
	Commercial Worker	Ingestion	Incidental exposure while working outside
		Skin Contact	Incidental exposure while working outside
		Inhalation	Incidental exposure while working outside
	Construction / Excavation Worker	Ingestion	Incidental exposure while working outside
		Skin Contact	Incidental exposure while working outside
		Inhalation	Incidental exposure while working outside, including to trench air
Groundwater	Residential	Ingestion	Use as drinking water
		Skin Contact	Exposure during showering or bathing
		Inhalation	Incidental exposure during showering
	Construction / Excavation Worker	Ingestion	Incidental exposure while working outside
		Skin Contact	Incidental exposure while working outside
		Inhalation	Incidental exposure while working outside
Sediment	Recreational / Park User	Ingestion	Incidental exposure while wading
		Skin Contact	Incidental exposure while wading
		Inhalation	Incidental exposure while wading
[Reserved -Ambient Air]	Residential	Inhalation	Exposure while living outdoors
Indoor Air	Residential	Inhalation	Exposure while living indoors
	Commercial Worker	Inhalation	Exposure while working indoors
Fish Tissue	Recreational Angler*	Ingestion	Secondary source in diet
* For Subsistence Angler exposure pathway, a Site-Specific Risk Assessment is required because ingestion rates will vary between sites.			

4 Risk protocols Used to Develop the RAGs

4.1 RSL Calculator for Superfund Risk Assessments

Maine CDC and DEP developed these RAGs using EPA's "Regional Screening Levels for Chemical Contaminants at Superfund Sites" ("Regional Screening Levels" or "RSLs") risk calculator.[3] The RSL calculator uses the risk assessment protocols that have been developed under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), more commonly called the Superfund Program. The RAGs are therefore based on Reasonable Maximum Exposure (RME) scenarios, which are common situations that result in the highest exposure that is reasonably anticipated to occur at a site. The RSL calculator allows the user to select exposure factors. Some of the major inputs to the RSL calculator were:

4.1.1 Target Risk Level for RAGs

The goal for site clean-up and closure is to reduce risk posed by contaminants to acceptable levels. Consistent with the Site-Specific Risk Assessment Guidance, provided in Attachment B, sites are closed out when the cumulative (combined) effects of contaminants at the site do not pose a risk that is greater than a Hazard Index (HI) of 1 by target organ, and an Incremental Lifetime Cancer Risk (ILCR) of greater than $1x10^{-5}$. This goal is presumed to have been met when each contaminant is below its respective media guideline presented in Table 3 through Table 6.

4.1.2 Chronic or Subchronic Exposure

Chronic exposure refers to an individual being impacted by contamination for a long-time, typically a lifetime, while subchronic exposure refers an individual being impacted to contamination for a shorter duration, typically between 2 weeks and 7 years. RAGs for the Residential, Park User and Commercial Worker Scenarios are based on chronic exposure to contamination. That is, the RAG is set at a level where exposure of a RME individual over a lifetime will not exceed the target risk levels described in Section 4.1.1 above. On the other hand, because a construction worker is expected to be exposed to site contamination for a year or less, the Construction Worker RAGs are based on subchronic exposure.

4.1.3 Additional Pathways

Maine CDC and DEP had to supplement the RSL risk calculator for some scenarios that were not included in the RSLs, such as exposure of construction workers to groundwater. When supplementing the RSLs, we

[3] EPA Regional Screening Levels (RSLs) webpage: https://www.epa.gov/risk/regional-screening-levels-rsls, downloaded April 23, 2018.

used default exposure factors and risk assessment formulas consistent with those used in the RSL calculator.

4.1.4 Complete Details on Derivation of RAGs

The toxicity of each contaminant will vary due to a variety of factors including the contaminant's chemical and physical properties, the route (eating, breathing or skin contact), duration, and intensity of exposure, and the sensitivity of the exposed people. The formulas and factors used to derive each RAG are referenced in Attachment A: Technical Support Document for Maine 2018 Remedial Action Guidelines.

4.2 Definitions Used in The RAGs

4.2.1 Background Contaminants

"Background Contaminants" means those contaminants that are not due to the release of contaminants at the Hazardous Substance Site. The background contaminants may be naturally occurring in the environment (e.g., arsenic) or man-made (e.g., DDT). Note Hazardous Substance Site activity may chemically transform or release naturally occurring substances into other environmental media. These additional concentrations of the naturally occurring substance that are released from the Hazardous Substance Site activity are not representative of natural background concentrations. For example, biological degradation of buried organic materials (such as tannery wastes) at a site can deprive the subsurface of oxygen, causing changes to subsurface chemical conditions that favor elements (like arsenic) to become more soluble in groundwater. In this case, the increase in arsenic in groundwater may be considered a site-related contaminant and a consideration in remediation of the site, even though it came from the parent rock, rather than the site waste.

4.2.2 Background Locations

"Background Locations" means areas with relevant media (e.g. soil, groundwater, air) that are similar to the Hazardous Substance Site (i.e., media with similar physical characteristics), that have been influenced to the same degree by regional deposition, runoff, or other contaminant inputs, but where contaminants released at the Hazardous Substance Site have not come to be located. Some chemicals may be present in background locations because of both natural and man-made conditions (such as naturally occurring arsenic and arsenic from pesticide applications or mining operations).

4.2.3 Contaminant

"Contaminant" means chemicals that are hazardous substance, as defined in Maine's Uncontrolled Sites Law[4], which references the Superfund definition of hazardous substances.

4.2.4 Contaminant or Chemical of Potential Concern (COPC)

A "Chemical of Potential Concern" or "Contaminant of Potential Concern" (COPC) means a contaminant that has been released at a site and further risk evaluation is warranted.

4.2.5 Contaminant or Chemical of Concern (COC)

A "Chemical of Concern" or "Contaminant of Concern" (COC) means a contaminant that has been released at a site and risk evaluation indicates that mitigation or remediation is necessary to prevent exposure to the contaminant.

4.2.6 Environmental Covenant; Covenant

"Environmental covenant" or "covenant" means a servitude arising under an environmental response project and documented in a recordable instrument (usually a deed) that imposes activity and use limitations on a parcel of land. "Environmental covenant" does not include a municipal ordinance, a voluntary or other remedial action plan or action plan condition, or an administrative or judicial order, even if it imposes activity or use limitations.[5]

4.2.7 Environmental Media Management Plan

An "Environmental Media Management Plan (EMMP)" describes property owner obligations and procedures to ensure owners, contractors, employees, or other persons engaged in site disturbance activities appropriately manage impacted groundwater, soil, or air to prevent human health and environmental impacts.

4.2.8 Exposure Pathway / Complete Exposure Pathway

"Exposure Pathway" means the route a contaminant takes from its source (where it began) to its end point, and how people can come into contact or otherwise are exposed to the contaminant. An exposure pathway has five parts: a source of contamination (such as a leaking tank), an environmental medium and transport mechanism (such as movement through groundwater), a point of exposure (such as a private well), a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). An exposure pathway

[4] *Maine's Uncontrolled Hazardous Substance Sites* law, 38 M.R.S. §§ 1361–1371.
[5] 38 Maine Revised Statutes (MRS) § 3002(4).

is termed a completed exposure pathway only when all five parts are present.[6]

4.2.9 Exposure Point

"Exposure Point" means a location of potential contact between a person and a hazardous substance.

4.2.10 Exposure Point Concentration

"Exposure Point Concentration (EPC)" means the concentration of contaminant that an individual would be exposed to in the relevant medium at the exposure point. Calculation of an appropriate EPC for site specific risk assessment is described in Attachment B.

4.2.11 Hazard Quotient

The "Hazard Quotient (HQ)" is a calculation used to determine whether an adverse health risk, other than cancer, might occur to an individual exposed to a given contaminate at a site. Specifically, the HQ applies to non-carcinogenic effects and is the ratio of estimated site-specific exposure to a single chemical from a site over a specified period (exposure level) to the estimated daily exposure level at which no adverse health effects are likely to occur (toxicity guideline).

4.2.12 Hazard Index

The "Hazard Index (HI)" is the sum of the Hazard Quotients and is used to calculate whether an adverse health risk, other than cancer, might occur to an individual exposed to contaminants at a site. Specifically, the HI applies to non-carcinogenic effects and means the sum of hazard quotients for substances that affect the same target organ or organ system. The Hazard Index is estimated as the Average Daily Dose or Average Daily Exposure for the exposure period divided by the Reference Dose or Reference Concentration, respectively. The Hazard Index is also described as a weighted sum of the exposure measures for the mixture component chemicals. The "weight" factor according to dose addition should be a measure of the relative toxic strength, sometimes called "potency."

4.2.13 Hazardous Substance

"Hazardous Substances" are chemicals that might pose a health risk if individuals are exposed to them above a specific dose. For purposes of this guidance, Hazardous Substance has the same meaning as defined under the *Maine Uncontrolled Hazardous Substance Sites Act*, 38 M.R.S. § 1362(1), which defines "Hazardous Substances" as:

[6] Adopted from the Agency for Toxic Substances and Disease Registry (ATSDR) Glossary of Terms: https://www.atsdr.cdc.gov/glossary.html.

1. Any substance identified by the Board of Environmental Protection under Section 1319-O;
2. Any substance identified by the Board of Environmental Protection under Section 1319;
3. Any substance designated pursuant to the United States Comprehensive Environmental Response, Compensation and Liability Act of 1980, Public Law 96-510, Sections 101 and 102 (Superfund);
4. Any toxic pollutant listed under the United States Federal Water Pollution Control Act, Section 307(a);
5. Any hazardous air pollutant listed under the United States Clean Air Act, Section 112;
6. Any imminently hazardous chemical substance or mixture with respect to which the Administrator of the United States Environmental Protection Agency has taken action pursuant to the United States Toxic Substances Control Act, Section 7; and
7. Waste oil as defined in Section 1303-C.

4.2.14 Hazardous Substance Site

"Hazardous Substance Site" or "site" means any site where hazardous substances have come to be located, and are subject to any of the following DEP programs: Brownfields, Federal Defense Facilities, Resource Conservation and Recovery Act (RCRA) subtitle C, Uncontrolled Hazardous Substance, Voluntary Response Action Program (VRAP), or Superfund.

4.2.15 Incremental Lifetime Cancer Risk

The "Incremental Lifetime Cancer Risk (ILCR)" is the method used to calculate the increased, upper-bound risk of cancer that might occur to an individual exposed to contaminants at a site, with the exposure averaged over a lifetime. Specifically, ILCR means the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a contaminant.

4.2.16 Neat Material

"Neat material" means liquid or solid hazardous substances which occur in a pure or nearly pure form and which may or may not be in a container. Neat material is distinct from dissolved contamination.

4.2.17 Project Lead

The "project lead" is the agency, group, or person that is the primary leader for remedial activities at the site and generally hires the contractor

that undertakes the remediation. The project lead may be the site owner/operator or other Potential Responsible Party, a state or federal agency, a developer, or other person.

4.2.18 Public Water

"Public water", or "public drinking water supply" means any well or other source of drinking water that furnishes water for human consumption for 15 service connections, regularly serves an average of at least 25 individuals daily at least 60 days out of the year, or supplies bottled water for sale.

4.2.19 Sediment

For the purposes of this document only, sediment is defined as any granular material and/or fine organic material that is located beneath water for most the year. Materials that are located under water but are frequently exposed (e.g. tidal areas) are considered soils for purposes of this guidance.

4.2.20 Urban Fill

"Urban fill" means soil mixed with other materials used to modify site elevation to facilitate property development and that is unrelated to a specific property activity. Urban fill is a soil matrix that includes such material as brick, cement, wood, wood ash, coal, coal ash, boiler ash, clinkers, other ash, asphalt, glass, plastic, metal, demolition debris, roadside ditch materials. Certain urban areas of Maine, such as the Bayside area of Portland, have large quantities of Urban Fill present. Many properties in Maine have smaller quantities of Urban Fill present, including developed properties in rural areas of the state. To distinguish urban fill from site related contaminants, soil descriptions should include the components of fill materials that are present and the Conceptual Site Model should include the extent or approximate extent of the materials both vertically and horizontally.

5 Responsibilities

5.1 Project Leads

The primary leader for remedial activities at a hazardous substance site should develop media specific clean-up goals for DEP's consideration that are consistent with this guidance or the site-specific risk assessment guidance provided in Attachment B.

5.2 BRWM Staff

DEP program staff should encourage adherence to this guidance to facilitate site clean-up. Staff should alert their supervisors when alternative approaches are proposed for a site.

5.3 BRWM Unit Supervisors

Unit supervisors should ensure that remediation decisions are consistent within their units. Unit supervisors must receive pre-approval from the Division or Bureau Director before recommending any clean-up approvals that vary from this guidance.

5.4 BRWM Division Directors

Division Directors are responsible for ensuring that the staff in their division are trained in how to use this procedure and that soil clean-up guidelines are consistently applied within the Division's programs and between other divisions to which this procedure is applicable. Division Directors will consult with each other on variances to this guidance in their respective programs, generally through a project specific management review meeting.

6 Where RAGs Fit in the Site Assessment and Remediation Process

6.1 Introduction

Establishing contaminant specific RAGs is one part of the site investigation and remediation process. The focus of this guidance is on development and application of RAGs. To provide context, however, this Section provides a brief overview of the site assessment and remediation steps that must come before employing the RAGs. This overview is not a primer on those processes. Guidance for site assessment and remediation is available on the DEP website at: http://www.maine.gov/dep/spills/publications/guidance/index.html, including links to DEP Maine DEP Sampling & Data Validation SOPs**.** Further, the legal requirements for the handling, storage, treatment, and disposal of contaminated materials at Hazardous Substance Sites is not described in this guidance.

6.2 Emergency Removal

Before employing RAGs, acute hazards posing imminent risk to public health or welfare should be subject to emergency removal. Before implementing RAGs, the following minimum actions should be taken at sites:

1. Imminent threats to public health or safety (including the threat of explosions) must be removed;
2. Hazardous substances stored in unmarked containers, containers of questionable integrity, inappropriate containers, or containers that are otherwise in violation of hazardous materials or hazardous waste laws must be removed; and
3. Neat materials not properly stored and hot spots must be recovered and removed. In keeping with this policy, the RAG values for contaminants in

Table 3 through Table 6 were capped at saturation points for individual contaminants whenever available. When saturation points were not available, DEP used the RSL default ceiling limit of 10% or 100,000 mg/kg.

Emergency removal units often leave residual contamination at the site, which would be subject to this guidance. Note that when contamination can be readily identified, recovered and removed for less cost than investigating the site, then the contamination should simply be removed, per DEP approvals.

6.3 Conceptual Site Model Development

Prior to using the RAGs, the project lead will need to develop a conceptual site model (CSM) for DEP approval, using guidance such as ASTM E1689 - 95 (2014), Standard Guide for Developing Conceptual Site Models for Contaminated Sites, as updated[7]. This Guideline defines a CSM as "a written or pictorial representation of an environmental system and the biological, physical and chemical processes that determine the transport of contaminants from sources through environmental media to environmental receptors within the system."

The CSM is a dynamic tool that directs the project lead's investigation[8] and risk mitigation decisions at the site. The CSM should be developed as early in the assessment process as possible (it does not require site specific hydrogeologic or laboratory data) and updated as new information becomes available. For instance, the CSM will be used to focus site investigation work plans (Scope of Work, Site Specific Quality Assurance Project Plans, etc.) on the collection of data needed to support a site-specific, risk-based decision. The data obtained may change the understanding of the site's risk, and if so, the CSM should be revised accordingly, and then be used to assess risk mitigation options.

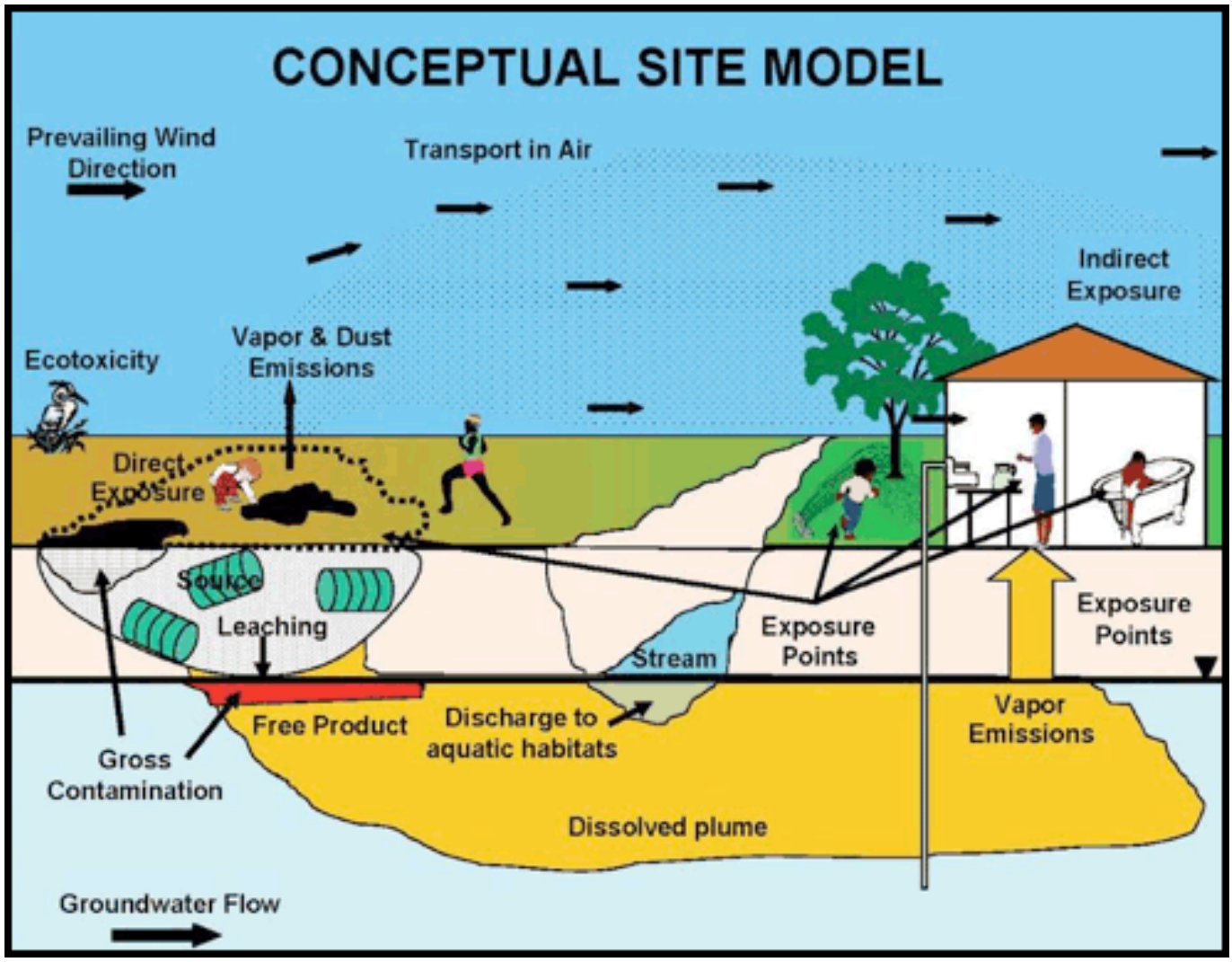
Per the ASTM Guideline[9], developing a CSM includes the following steps (in any order):

1. Identification of potential contaminants;
2. Identification and characterization of the source(s) of contaminants;
3. Delineation of potential migration pathways through environmental media, such as ground water, surface water, soils, sediment, biota, and air;
4. Establishment of background areas of contaminants for each contaminated medium;

[7] ASTM E1689 - 95(2014), Standard Guide for Developing Conceptual Site Models for Contaminated Sites is available at: https://www.astm.org/Standards/E1689.htm
[8] ASTM E1903-11, Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process is a good reference for applying a CSM to an environmental site assessment and is available at: https://www.astm.org/Standards/E1903.htm.
[9] ASTM E1689 - 95(2014), Standard Guide for Developing Conceptual Site Models for Contaminated Sites is available at: https://www.astm.org/Standards/E1689.htm.

5. Identification and characterization of potential environmental receptors (human and ecological); and
6. Determination of the limits of the study area or system boundaries.

Figure 1: Example of a Conceptual Site Model with Multiple Pathways[10]



The CSM narrative should concisely (one to three pages) focus on the site's contaminant source, migration pathway, and potential receptors. The narrative summarizes site information and should include a description of:

1. The site;
2. Potential sources (containers, disposal units) and other areas of concern, primary release mechanisms (leaking containers, spills,

[10] Interstate Technology Regulatory Council (ITRC), Incremental Sampling Methodology Guidance, downloaded 6/21/2018 from: https://www.itrcweb.org/ism-1/3_1_2_Conceptual_Site_Models.html

disposal areas) and secondary sources (high concentrations in soil and/or groundwater);

3. A list of site related contaminants, their distribution, and background conditions;
4. A discussion of actual or potential migration pathways, including fate and transport mechanisms and the hydrogeologic setting within the flow field); and
5. Potential ecological and/or human receptors.

The narrative is typically supported by several figures and perhaps a table, depending on site complexity. The CSM can be a stand-alone document or part of another site document, but detailed description of hydrogeology, properties of contaminants, contaminant distribution, and so forth should be included in other documents or Sections, rather than the CSM. Its language should be understandable by both investigators and future property owners.

6.4 Sampling

6.4.1 Detection Levels & Data Quality Objectives

It is important to consider the site's clean-up goals when establishing the Data Quality Objectives[11] (DQOs) for a site sampling plan. For most sites, detection below the RAG levels should be possible if the appropriate sampling and testing procedures are used. The Practical Quantification Limit (PQL) for a given sample will depend on a combination of factors including matrix interferences, analytical method, instrument sensitivity and lab precision. Under some site-specific circumstances, however, a given RAG may be below the level that can be accurately measured using current sampling and analytical protocols. Contact DEP (207-287-7688) for further guidance in these cases, or for additional help in establishing site DQOs.

6.4.2 Assessing Vapor Intrusion

Vapor intrusion (VI) is the volatilization of hazardous substances from contaminated soil or groundwater into buildings. Because VI potential is dictated by numerous factors, contaminant levels in soil or groundwater are not a reliable indicator of VI potential. Therefore, DEP was not able to develop soil or groundwater guidelines that are protective of the vapor intrusion pathway. Rather DEP considers measurement of contaminants in soil vapor and indoor air to be the best representation of VI potential and risk. Sub-slab concentrations should be multiplied by an attenuation factor

[11] Data quality objectives, or DQOs, are a description of the data that must be obtained during a site investigation to support decisions regarding the site, such as the potential risk posed by the site, and how to address those potential risks. DQOs are based on the end use of the data. For more information, see http://www.epa.gov/fedfac/guidance-systematic-planning-using-data-quality-objectives-process (EPA QA/G-4), EPA/240/B-06/001, February 2006.

of 0.03, and then compared to Table 4: Maine Remedial Action Guidelines for the Indoor Air Exposure Pathway, by Exposure Scenario. For additional information on VI, see DEP's Supplemental Guidance for Vapor Intrusion of Chlorinated Solvents and Other Persistent Chemicals.[12]

6.4.3 The Chromium RAGs and Sampling for Chromium

To use the soil RAGs for chromium, the exposure point concentration must be expressed as hexavalent (Chromium (+6), CAS 18540-29-9) and trivalent chromium (Chromium (+3), CAS 16065-83-1), rather than total chromium. This is because the toxicity of chromium varies with its valence state. Hexavalent Chromium is much more toxic than trivalent chromium.

6.4.4 Soil Sampling Depths

The plow layer, or upper two feet, are considered accessible surface soils in Maine for risk assessment purposes. Soils between 2 and 15 feet are considered potentially accessible. Potentially accessible soils should be considered accessible for risk assessment purposes until an environmental covenant and EMMP are in place to prevent excavation of foundations or other construction from inadvertently bringing this soil to the surface. Soils below 15 feet are generally considered inaccessible for risk assessment purposes in Maine.

6.5 Exposure Point Concentrations

RAGs are compared to the Exposure Point Concentration (EPC) for each medium at the site. The EPC is the concentration of a contaminant in a specific medium at an exposure point, such as a well or soil in a residential yard. Unless otherwise approved by DEP, the EPC should be set at the 95th upper confidence interval of the mean. If this value exceeds the maximum value in the dataset or there is insufficient data to run a statistical analysis, please refer to Attachment B: Supplemental Guidance for Conducting Risk Assessments in Maine. In the case of Multi-Incremental Sampling (i.e., establishing grid-based Decision Units and compositing soil samples within a Decision Unit), if the Decision Unit represents the EPC, then the composite result is directly compared to the RAG. If an EPC is represented by multiple Decision Units, then the 95th upper confidence interval of the mean of the Decision Unit samples applies as described above. Further guidance on establishing EPC is provided in Attachment B: Supplemental Guidance for Conducting Site-Specific Risk Assessments in Maine.

6.5.1 Handling Chemical Isomers of xylene, 1,2 dichloroethylene and cis-1,2-dichloroethylene

The following parameters should be addressed as follows:

[12] available at: http://www.maine.gov/dep/spills/publications/guidance/index.html

- The xylene isomers summed and are evaluated with the RAG for total xylenes.
- There are RAGs for cis and trans 1,2 dichloroethylene, if 1,2 dichloroethylene is reported, the RAG for cis-1,2-dichloroethylene is used.
- There is a RAG for 1,3-dichloropropane, if cis and trans 1,3-dichloropropane are reported they should be summed and compared to the RAG for 1,3-dichloropropane.

6.5.2 Handling Pesticide Classes

These chemicals are totaled for each pesticide class and compared to the parent compound's RAG.

- Total DDT. The terms "DDT", "DDE", and "DDD" are used to refer to the sum of isomer concentrations of p,p'-DDT and o,p'-DDT, p,p'-DDE and o,p'-DDE, and p,p'-DDD and o,p'-DDD, respectively. "DDTs" refers to any or all of the six compounds identified above, as well as the metabolites and degradation products of these six compounds. "Total DDT" refers to the sum of the concentrations of p,p'-DDT, o,p'-DDT, p,p'-DDE, o,p'-DDE, p,p'-DDD, and o,p'-DDD.
- Total Endosulfan is the sum of α- and β-isomers, endosulfan diol, endosulfan ether, endosulfan sulfate, and endosulfan lactone.
- Total Chlordane is the sum of cis and trans-chlordane, heptachlor, heptachlor epoxide, oxychlordane and cis-nonachlor, trans-nonachlor.
- Total Endrin is the sum of endrin, endrin aldehyde, endrin ketone, heptachlorobicycloheptene, hexachloronorbornadiene, and isodrin.

7 Determine Target Clean-up Levels Using RAGs

7.1 Introduction

Once the procedures in Sections 6 are completed, subject to Section 2.3, use either this guidance to determine whether remedial action is necessary. When remedial action is indicated, establish target clean-up levels. The RAGs in Table 3 through Table 6 present the target clean-up guidelines by medium and exposure scenario for hazardous substances commonly encountered at sites in Maine. Contaminants are listed by CAS number and a common name to ensure the correct identification. To determine site specific RAGs, use the process detailed in the Sections below.

1. Exclude background contaminants that were not released by site activities in accordance with Section 7.2);
2. Based on the Site's CSM, determine which media are contaminated and the applicable scenario, and then select the appropriate table (see Table 2: Media to RAG Table Cross-walk);
3. Determine the appropriate land use scenario for the site, considering current and potential future land uses. The descriptions of the scenarios are found in Section 7.3, and the criteria for exclusion of scenarios in Section 7.4;
4. Determine the lowest applicable value in the column of the table that you are using;
5. Plan and undertake the clean-up, if necessary;
6. Following remedial action, confirmation sampling needs to show that the target clean-up goals have been met and the site may be closed-out, or if further action is needed.

The following Sections discuss in more detail the above process for selecting the appropriate RAG for a given site.

7.2 Assess Risk Contribution from Background Contaminants

In some cases, background (see definitions in Section 4.2) concentrations of contaminants may exceed acceptable clean-up guidelines for soil. The DEP allows the project lead to increase a clean-up level from the risk-based RAG to account for background concentrations.

7.2.1 Background Concentrations Policy

DEP will not require a clean-up of site soil to be more stringent than the local background concentration. Therefore:

1. When the concentration of the substance in the background location exceeds a RAG, then the concentration of the substance in background location will be the clean-up level at the site.
2. When the concentration of the substance in the background location is less than a RAG, then the RAG becomes the clean-up level.

7.2.2 Determining Background Concentrations

The methodology used to establish background contamination levels at a site should be reviewed and approved by DEP. Generally, DEP accepts four methods of determining background concentrations:

1. Site Specific Samples - The most accurate approach is to use representative sample results from the site or similar nearby areas to determine applicable background concentrations. If samples are collected to establish background concentrations, DEP should review and approve the sampling and analytical plan and any statistical methods[13] used in identifying the background level;
2. Typical Background Values presented in Table 4 includes typical Maine background levels in soil. These may be used if there is not better, representative, site-specific background data available;
3. Literature Values - A review and report on published literature or data from similar sites may be appropriate. These may be used if there is no representative, site-specific background data available; or
4. Other - Other scientifically based methods for establishing background may be approved by the DEP, when there is no representative, site-specific background data available.

7.2.3 Arsenic Background Concentrations vs. Man-made Sources

Maine soil often contains naturally occurring arsenic above the risk-based RAG. Further, degradation of contaminants or remedial activities at a site may release arsenic from parent materials. If arsenic is identified in on-site soil above the arsenic RAG, determine if it is released by site activities, naturally occurring, or both. Arsenic introduced through site activities must be reduced to the greater of the RAG or background concentrations.

7.2.4 Background Concentration of Polycyclic Aromatic Hydrocarbons

Table 4 also lists Maine background concentrations for polycyclic aromatic hydrocarbons (PAHs) in soil in Rural Developed areas, Urban Developed areas, and Urban Fill. PAHs are often elevated in developed areas from historic PAH source materials that are mixed with soil, such as coal, coal or wood ash, degraded asphalt and driveway sealants, other road wear materials, and Polycyclic Organic Matter (POM) from combustion sources that is deposited from air. In 2011-2012 DEP contracted a study of

[13] For sample sets large enough to do statistical analysis, DEP recommends calculating the 90% Upper Prediction Limit (UPL) using the most recent PRO-UCL software. Follow the software's recommendations regarding the use of parametric or non-parametric tests and the handling of non-detected concentrations. Consult with DEP when determining which sample results, if any, should be considered outliers. A report on the datasets and statistical methods used to establish background for the RAGs is available at: http://www.maine.gov/dep/ftp/RAGS-Background-Documents/Metals-and-PAH-Background-Study-2012/. Similar statistical approaches should be used with site specific data to compare the site-specific dataset to the Maine background dataset.

typical background concentrations of PAHs in Maine[14] and found that concentrations are different in Urban Developed areas as compared to Rural Developed, as compared to Urban Fill. The division between rural and urban datasets was based on the Department of Transportation's (DOT's) definition of urban compact zone. The difference between rural and urban areas is based on DOT's breakdowns, which are shown on Google Earth maps at: http://www.maine.gov/dep/gis/datamaps/statewide_layers/state_urban_compact_areas.kmz.

A soil cover or other barrier, and an EMMP are usually appropriate for managing potential exposure risks to the Urban Fill material. Urban Fill material includes components in the soil matrix that are unrelated to a specific property activity or past property use. The fill material has been placed over an area to modify the elevation of the land surface for the development of the property or properties. Urban Fill components in the soil matrix may include a variety of identifiable materials including brick, cement, wood, wood ash, coal, coal ash, ash, boiler ash, clunkers, asphalt, glass, plastic, metal, inert demolition debris, and roadside ditch materials. Certain urban areas of Maine, such as the Bayside Area of Portland, have large quantities of Urban Fill present. Many properties in Maine have smaller quantities of Urban Fill present, including developed properties in rural areas of the state. Soil descriptions should include the components of fill materials present and the Conceptual Site Model should include the extent or approximate extent of the materials both vertically and horizontally.

The PAH background concentrations in Table 4 should not be used at sites that are undeveloped. In these instances, site specific background samples should be collected.

7.2.5 Addressing Risk Due to Background

Even though the DEP does not require remediation of media with background contaminants that exceed RAGs, these background contaminants may pose a risk to public health. In these cases, DEP recommends that the site land use and exposures be limited to meet an alternative RAG for the contaminant if feasible. For example, arsenic or PAH levels may pose a risk if a site is used as residential property, but not pose a risk if the site is used as a commercial property. When a property owner determines that remediation or site use restriction are not practical, then the property owner should ensure that potentially affected parties, such as buyers, are at least notified of the health risk from the background contaminant.

[14] AMEC, Summary Report for Evaluation of Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) and Metals in Background Soils in Maine, Prepared for the Maine Department of Environmental Protection (17 SHS, Augusta, ME 04333-0017) November 16, 2012.

7.3 Application of Exposure Pathways and Scenarios

The DEP prefers that clean-up levels allow for unrestricted site use, so whenever practicable, clean-up levels must be set at the lowest level of a contaminant for all the exposure scenarios in the RAG tables (see Table 2: Media to RAG Table Cross-walk). Likewise, land use may change in the future and scenarios protective of all potential future uses should be selected. When DEP finds that it is not practical to meet the lowest clean-up values (usually the Residential Scenario), DEP may approve clean-up to the target for other scenarios, provided an Environmental Covenant (Section 7.4.2) is in place to restrict site uses that would result in the RAG being exceeded. For instance, for the soil exposure pathway, the Outdoor Commercial Worker, Construction/Excavation Worker, and Recreational/Park User are common alternative land uses to residential use, so RAGs have been developed for these scenarios. Based on the Site's CSM along with the current and future site use, determine the appropriate scenario for the site. Establish Exposure Point Concentrations under that scenario and then compare to the RAGs in the appropriate column of the table.

Table 2: Media to RAG Table Cross-walk

Contaminated Media	Use Table
Soil (including hydric) and Sediment	Table 3
Indoor Air*	Table 4
Groundwater	Table 5
Fish Tissue – Recreational Angler	
* Revised Ambient Air Guidelines are under development.	

The following is a general description of the exposure scenarios that are included in the exposure pathway tables. These descriptions are intended to aid the RAGs user in applying the correct exposure scenario for a given site. If there is a significant exposure pathway or exposure scenario that is not covered in the RAGs, but is applicable to the site (e.g., the only exposure to site contaminants would be through eating cattle that graze extensively on plants that have up taken contaminants at the site), then the site-specific risk assessment guidance provided in Attachment B should be used to assess risk and clean-up goals at the site, rather than these RAGs. Likewise, if the project lead believes any of the assumptions used in developing the RAGs is overly conservative relative to site conditions, then alternative remedial goals should be developed using procedures described in Attachment B unless otherwise specified below. All the factors used to develop the RAGs are available in Attachment A.

7.3.1 Leaching to Groundwater Exposure Scenario

Soil RAGs, which are protective of human health by the contact/ingestion route, do not necessarily prevent continued degradation of groundwater resources. Leaching of contaminants from soil may increase concentrations in groundwater and the contamination plume may spread. Therefore, DEP also developed RAGs to prevent the transfer of contaminants from soil to an aquifer, such that the contaminants would not exceed the Residential Groundwater RAGs.

Since technically all groundwater in Maine is classified as GW-A, which must be of drinking water quality, the DEP requires that whenever practical, contaminated soil and/or groundwater be remediated to meet the Residential Groundwater RAG (see Section 7.4.3). The Leaching to Groundwater RAGs in Table 3 are concentrations of contaminants in soil that when leached out are not expected to increase concentrations of the contaminant in groundwater above the Residential Groundwater RAG. DEP had previously modeled dilution and attenuation assuming a source area 15 feet deep, and contaminants migrating to a well 50 feet away. The RSL calculators use a model of leaching which does not consider distance or degradation, but instead allows a single Dilution Attenuation Factor (DAF) to modify expected groundwater concentrations at an exposure point such as a well. Based on the modeling performed in support of earlier RAGs, DEP has selected a DAF of 55 (See Attachment A for further details).

In situations where a drinking water source will be used within 50 feet of the contaminated area, or the depth to the water table or bedrock is less than 15 feet, DEP reserves the right to require that a more stringent, site-specific clean-up level be developed for review and approval by the DEP. On the other hand, the project lead may choose to use site-specific modeling to generate site-specific soil clean-up targets that are less stringent but still will not cause the Groundwater RAG to be exceeded. For more modeling details, see the Technical Support for these RAGs provided in Attachment A. Likewise, the project lead may propose test procedures to use EPA's Leaching Environmental Assessment Framework (LEAF)[15] to show that Groundwater RAGs will not be exceeded, or hydrogeological studies to demonstrate that a historic spill has not contaminated groundwater at the site and is unlikely to do so. Any alternative approach must be reviewed and approved by the DEP (see Section 3.1) before being implemented.

[15] EPA webpage, "'How-to' Guide for the Leaching Environmental Assessment Framework" (downloaded August 27, 2018 from: https://www.epa.gov/hw-sw846/how-guide-leaching-environmental-assessment-framework), October 2017.

7.3.2 Residential Exposure Scenarios

Soils, indoor air and groundwater cleaned to the RAGs for the Residential Exposure Scenario are protective of all residential uses of sites, and exposures at daycares, eldercare and medical treatment facilities. When developing these RAGs, DEP and CDC assumed continuous exposure to children and adults over a twenty-six (26) year period as the population passes through childhood and into adulthood.

7.3.2.1 Soil

Exposures to soil by incidental ingestion, dermal contact, and inhalation of contaminants in both fugitive dust and ambient air are assumed to occur with a high frequency and high intensity when the ground is not frozen or snow covered, as children and adults play and work in a residential yard and engage in activities that disturb and displace soil (e.g., lawn mowing, gardening, and bike riding). This pathway also assumes exposure to dust stemming from dirt tracked into the house during times of the year when the ground is not frozen or snow covered. Using Maine specific climate data, Maine has determined that soil is accessible 256 days per year. Please see Attachment A for details of soil exposure frequency.

7.3.2.2 Indoor Air

Exposure to contaminants in indoor air is through breathing, or inhalation of contaminants from indoor or vapor intrusion sources.

7.3.2.3 Groundwater

Exposure to contaminants in groundwater is through drinking the water from a well drawing from the contaminant source, adsorption of contaminants through skin (dermal contact) and breathing of contaminants that evaporate from the water while showering. Previous editions of the RAGs used Maine's Maximum Exposure Guidelines (MEGs), which are based on exposure to water through ingestion only, and included a Relative Source Contribution (RSC) factor to account for other routes of exposure (inhalation and dermal exposure to water) and exposure pathways (e.g. contaminants in soil and/or diet). For the RAGs Residential Exposure to Groundwater Scenario, DEP used the media "Tap Water" in the RSL calculator. This RSL model generates a risk-based screening level that accounts for ingestion, dermal, and inhalation exposures to the groundwater. Therefore, the Relative Source Contribution (RSC) factor that is used in the MEGs is not included in the 2018 RAGs. See Attachment A for further information.

7.3.3 Park User / Recreational Exposure Scenario

7.3.3.1 Soil

Soil cleaned to the RAGs for the Park User Scenario is protective of recreational activities at a park, recreational area or other open space. The Park User Scenario is like the Residential Scenario in that it assumes exposure to children and adults over 26 years. However, the frequency of exposure of recreational activities at a park or other open space is reasonably anticipated to be less than that occurring in a residential yard. Using professional judgment, the RAGs assume that a Park User is exposed to soil 90 days per year (3 days per week, for 30 weeks from April through October). Soil exposure time (3 hours per day) is the mean time spent outdoors at a park/golf course for the Northeast Region as presented in Table 16-20 of the EPA Exposure Factors Handbook.[16]

Soil exposures are assumed to occur by incidental ingestion, dermal contact, and inhalation of contaminants in fugitive dust and ambient air when the ground is not frozen or snow covered.

7.3.3.2 Sediment

Likewise, the sediment pathway assumes exposure to children and adults over a 26-year period via incidental ingestion and dermal contact while wading, with increased frequency during warmer times of the year. Using professional judgment, the RAGs assume that a recreator is exposed to sediment 78 days per year (3 days per week, for 26 weeks from May through October). Sediment exposure time, 3.7 hours per day, is the mean time spent outdoors at a pool/river/lake for the Northeast Region as presented in Table 16-20 of the EPA Exposure Factors Handbook.[17]

Note, if the CSM suggests that contaminants are leaching from sediments to surface water in concentrations that might pose a risk, then a site-specific risk assessment should be conducted to evaluate the actual risk from surface water exposure.

7.3.4 Commercial Worker Exposure Scenarios

Note that the RAGs are superseded by any applicable OSHA standards, which are promulgated, as detailed in Section 7.3.6 on page 33. Exceedance of RAGs should trigger an evaluation of whether OSHA

[16] Exposure Factors Handbook: 2011 Edition. https://www.epa.gov/sites/production/files/2015-09/documents/techoverview_efh-complete.pdf
[17] Exposure Factors Handbook: 2011 Edition. https://www.epa.gov/sites/production/files/2015-09/documents/techoverview_efh-complete.pdf.

standards apply. If OSHA standards are not applicable, the RAGS should be used to assess the threat posed by the contaminant.

7.3.4.1 Soil

Soils cleaned to the RAGs for the Outdoor Commercial Worker Exposure Scenario are protective of all indoor and outdoor commercial uses of sites, including full-time industrial and maintenance workers whose jobs require that they be outdoors for a portion of the workday such as groundskeepers, loading dock workers, parking lot attendants, and mechanics. This scenario can also be used to conservatively evaluate indoor workers who may be routinely exposed to soil briefly during work breaks and outdoor lunches. These RAGs assume exposures to soil by incidental ingestion, dermal contact, and inhalation of contaminants in fugitive dust and ambient air occur over 25 years for the work days of the year when the ground is not frozen or snow covered. Using Maine specific climate data adjusted for the work week, the RAGs assume a soil exposure frequency of 183 days per year. Contact with soil is assumed to be of lower intensity than assumed for an excavation or construction work scenario since these workers are unlikely to be displacing soil (i.e., digging).

7.3.4.2 Indoor Air

Indoor air that meets the Commercial Indoor Air Guideline is protective of workers at commercial establishments who may be exposed to contaminant from vapor intrusion (VI) or indoor sources. The RAGs are based on chronic exposure default factors of 8 hours per day for 250 days per year for 25 years of exposure.

7.3.5 Excavation or Construction Worker

Note that the RAGs are superseded by any applicable OSHA standards, which are promulgated, as detailed in Section 7.3.6. Exceedance of RAGs should trigger an evaluation of whether OSHA standards apply. If OSHA standards are not applicable, the RAGs should be used to assess the threat posed by the contaminant.

7.3.5.1 Soil

Soils cleaned to the RAGs for the Excavation or Construction Worker Scenario are protective of exposures to soil during high intensity soil disturbance activities such as digging, grading, and back-filling for a construction project lasting up to one year. This scenario can be used to conservatively evaluate a utility worker or landscaper whose exposure may be as intense as an excavation or construction worker, but is expected to be of a lesser duration than a year. Exposures to soil by incidental ingestion, dermal contact

and inhalation of contaminants on fugitive dust and in ambient air are assumed to occur at a greater intensity than that assumed for the Outdoor Commercial Worker due to the degree of soil disturbance and displacement anticipated.

7.3.5.2 Groundwater

Groundwater that meets or is less than the RAGs for the excavation or construction worker scenario are protective of exposures to groundwater during high intensity groundwater disturbance activities such as digging, grading, and back-filling for a construction project lasting up to a year. This scenario can be used to conservatively evaluate a utility worker or landscaper whose exposure may be as intense as an excavation or construction worker, but is expected to be of a lesser duration than a year. Using professional judgment, the RAGs assume that a construction worker is exposed to water in a trench 1 day per week for 4 hours per event. Exposures to groundwater by incidental ingestion, dermal contact and inhalation of contaminants that volatilize into ambient air were included in the RAG development.

7.3.6 Role of OSHA Standards for Commercial and Excavation or Construction Worker Exposure Scenarios

Commercial guidelines in this document are superseded by OSHA regulations when the exposure stems from the commercial facilities' own operations and the employer is required by OSHA regulations to train its employees in awareness and protection from the contaminants of concern for a given exposure pathway. OSHA standards and guidelines pertaining to air quality will need to be followed when undertaking trenching activities, when the construction/excavation worker soil RAGs are exceeded at a site. Air monitoring should be undertaken during construction activities in areas where groundwater exceeds the Construction Worker RAG levels in Table 5, and appropriate action taken when air concentrations exceed OSHA standards. When the Construction Worker Scenario for groundwater is exceeded at a site, it indicates that procedures should be put into place to warn construction workers to follow OSHA standards, including appropriate monitoring, during construction activities.

7.3.7 Other Scenarios

There are other potential exposure scenarios. Generally, they will not pose a greater risk than the scenarios presented. However, under unusual circumstances the DEP may determine that other scenarios may be important or the default exposure factors may not be protective at a limited number of sites. These exposure scenarios and exposure factors should be considered on a site-specific basis using the CSM, as illustrated in Figure 1, and a site-specific risk assessment should be conducted using the

protocols in the site-specific risk assessment guidance provided in Attachment B.

7.3.8 Accessibility of Soil Affects Exposure Scenarios

The soil depth or a covering may make the soil at a site inaccessible to a person so that the exposure route is not complete. However, future site activities may disturb the soil such that formerly inaccessible deep soils are raised to the land surface, or become accessible if pavement or a building is removed. A list of DEP approved cover systems is provided below. Contaminated soil is considered inaccessible, and therefore the pathway is not complete, when the contaminated soil is either:

1. "Isolated" because it is located at a depth greater than 15 feet below the surface; for buildings having earthen floors, the floor is considered the soil surface;
2. Completely covered by intact pavement or concrete, an EMMP controls digging activities and ensures inspection and maintenance of the cap, and a DEP approved environmental covenant is recorded with the deed;
3. Covered with a high visibility geotextile fabric or plastic marker layer (e.g., orange snow fencing), then at least 6 inches of clean soil, and then at least 6 inches of loam, which supports a healthy vegetative cover; a DEP approved environmental covenant and an EMMP controls digging activities and ensures inspections and maintenance of the cap; or
4. Covered with at least 2 feet of clean fill, and a DEP approved environmental covenant and an EMMP controls digging activities and ensures inspections and maintenance of the cap.

7.3.9 Source Control RAGs at Vapor Intrusion Sites

If soil clean-up is necessary to prevent VI risk instead of diverting the vapors themselves, then the project lead must develop site-specific remediation goals in consultation with the DEP to meet the applicable indoor air targets shown in Table 4.

7.4 Exclusion of Pathways

7.4.1 General Exclusions

The DEP may approve excluding certain RAG scenarios or exposure pathways at a given site through the procedures developed by the programs identified in Section 3.1. Using those program specific procedures, the DEP will determine which exposure scenarios and/or exposure pathways are applicable to the site, based on current and future

land use, environmental covenants, and other program requirements. Exposure scenarios and routes-of-exposure may be excluded if DEP determines that clean-up to a more stringent guideline is not practical and if current and all future exposures are precluded by site use restrictions meeting the standards in the *Uniform Environmental Covenants Act,* 38 M.R.S. §§ 3001-3013 (UECA). The deed restrictions and environmental covenants must be approved of by the DEP. UECA templates can be found on the DEP website (http://www.maine.gov/dep/spills/publications/guidance/index.html).

7.4.2 Use of Institutional Controls / Environmental Covenants

DEP's primary objective is to have sites restored so that unrestricted use will not cause excessive risk to site users. However, this is not always practical and sometimes site use restrictions (i.e., institutional controls) are necessary to protect public health. As an example, environmental covenants can be used to prohibit drinking onsite water and residential uses, so that the remedial action goal for soil would be the lesser of the RAGs for the Park User, Outdoor Commercial Worker, and Excavation or Construction Worker Scenarios. The environmental covenant must be adequate to prevent residential exposure given the soil clean-up levels, and may include such elements as preventing any future residential development, restricting soil excavation, and/or restricting groundwater withdrawal.

Covenants usually include the following minimal elements:

1. Notice provisions must provide adequate notification of the environmental covenant(s) to future owners of the property and/or operators at the site. The notice must include the condition(s) imposed by the environmental covenants and clearly define the party responsible for maintaining the environmental covenant;
2. All required oversight and maintenance of any environmental covenant must be enforceable; and
3. Environmental covenants must remain protective for the life of the selected remedy.

Environmental covenants where a single authority has control over the land use and/or groundwater is preferred. This can mean property ownership, and control of the facilities needed to use the land or groundwater.

7.4.3 Exclusion of the Residential Groundwater RAGs

Subject to applicable law, the DEP will allow exclusions to obtaining the groundwater guidelines in Table 5 and/or the Leaching to Groundwater RAGs in Table 3 when the project lead demonstrates that the groundwater

contamination will not have any present or future adverse impact on human health, or water supplies.

Exclusion of the groundwater pathway is appropriate under any of the following circumstances:

1. The site geology will prevent contaminant migration to or in groundwater;
2. The area is served by Public Water and all the following are true:
    a. No potential or existing Public or Private water supply sources are located in the contaminant source or potential groundwater plume areas;
    b. Groundwater is non-potable due to the presence of prior contamination; and
    c. Institutional Controls approved by the DEP will prevent current and future exposure to contaminated groundwater.
3. It is not technically and/or economically feasible to clean up discharges, and passive or active measures (including alternative water supplies and permanent, enforceable institutional controls) permanently mitigate or eliminate current and future exposure; or
4. There is a high probability that contaminants will degrade prior to reaching the point of exposure, and a funded contingency plan is in place to remediate the site if area conditions change or new information suggests an imminent exposure potential.

The following are examples of situations where the DEP is not likely to approve exclusion of the groundwater pathway:

1. Environmental Covenants do not prevent exposure to the contaminated groundwater;
2. There is off-site migration of contamination and area residences or businesses utilize the surrounding aquifer;
3. The area of the contaminant source and potential groundwater contamination plume is not served by Public Water;
4. The area of the contaminant source and potential groundwater contamination plume are over or up gradient of a mapped sand and gravel aquifer or high yield bedrock aquifer or a recharge zone for either one;

5. The area of the contaminant source and potential groundwater contamination plume are within any wellhead or source protection area;
6. Where discharge of contaminated groundwater to the ground surface or surface water causes a violation of surface water quality standards or otherwise adversely impacts human health or ecological resources;
7. The area of the contaminant source and potential groundwater contamination plume are within a sole source aquifer; or
8. The contaminated plume is expanding, not under control, and migrating from the source area.

7.5 Technical Impracticability Waivers

DEP's goal is to restore contaminated aquifers to drinking water quality whenever possible, and to prevent the spread of further contamination in aquifers. However, in some instances, it is not economically feasible using current technology to restore aquifers to the Groundwater RAGs found in Table 5. The DEP will make remediation decisions that encourage the development of new remediation technologies, but also recognizes the need to use limited funds wisely. Consistent with EPA's Technical Impracticability (TI) Waiver policies[18], before issuing a TI Waiver DEP will first ensure that the following baseline actions are complete:

1. Source control has been completed. That is, localized high concentrations of contaminants in soil and/or groundwater have been treated to levels that will significantly reduce a continuing pollutant load to the aquifer; and
2. Current and future users of the aquifer are not at risk. This may require: an understanding of whether contamination is still spreading in the aquifer, providing alternative water supplies, provisions to mitigate VI risks, and in some cases operation of active plume containment systems to prevent the spread of contamination. Environmental covenants may be used to help prevent exposure, but alone do not justify a TI waiver.

In addition to the completion of baseline actions, the factors that DEP will consider before granting a TI waiver are:

1. The results of a focused feasibility study of potential treatment options, including cost and the chances of further significant reductions in contamination or of attaining the RAGs levels; and

[18] USEPA OSWER Directive 9283.1-33, "Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration (http://www.epa.gov/superfund/contaminant-media-and-site-type-specific-consultation-directives) June 26, 2009.

2. The resource and people at risk.

DEP has concurred with formal TI waivers at the following sites:

1. Two at the former Loring Air Force Base in Limestone;
2. The F. O'Connor Superfund site in Augusta;
3. The McKin Superfund site in Gray; and
4. The Hows Corner Superfund site in Plymouth.

At TI waiver sites, DEP usually requires a Technology review every 5 years to determine if a new technology is now feasible to remediate contaminated groundwater.

7.6 Variances from Default Exposure Factors

In formulating the RAGs, the guidelines were derived using conservative default exposure factors because all potential pathways were not considered, or in the case of dermal contact, cannot be quantified for some contaminants. To employ less conservative exposure assumptions, the site must be adequately characterized and a full risk assessment conducted using the procedures in the site-specific risk assessment guidance provided in Attachment B.

The default exposure factors used to establish the RAGs are available in Attachment A. In general, DEP has utilized EPA default exposure factors whenever possible, to promote regional consistency. However, in some cases exposure factors more suitable to Maine were substituted, such as the use of a lower exposure frequency for the outside worker to account for the winter months in Maine when the ground is frozen or snow covered. This provides more realistic target levels that are a bit higher than national standards that are, by default, estimated to be protective of areas where the ground is accessible throughout the year. Since this is not the case in Maine, higher target levels are appropriate and protective of Maine residents and workers.

7.7 Other Applicable, or Relevant and Appropriate Requirements

As discussed in section 3.1, some of the DEP programs implementing the RAGs will have promulgated standards or other guidance that may dictate more stringent clean-up goals than those established in this document. For instance, under Superfund, promulgated standards such as Maximum Contaminant Levels will become the point-of-departure for establishing remedial goals for groundwater at a site, and RAGs along with other guidance such as Drinking Water Health Advisories (HAs) must be considered. Additionally, the intended future use of the site may also dictate other clean-up goals than those in this document. For example, if the site goal is to remediating groundwater for use as a public water supply, then the Department of Health and Human Services (DHHS) Drinking

Water Program will need to be involved in establishing remedial goals: In addition to meeting RAGs, the groundwater will likely need to also meet MCLs and HA.

8 Technical Help & Technical Basis of the RAGs

8.1 Technical Assistance

For Technical Assistance, contact your DEP project manager, the DEP program reviewing your proposal (see Section 3 on page 7), or the Remediation Division at 207-287-7688.

8.2 References to Technical Basis

The RAGs were derived based on the protocols in the Technical Basis for the Maine RAG provided in Attachment A. Attachment A provides additional information on the calculation methods, factors, assumptions and data that were used to develop the RAG values.

9 RAGs Tables

Table 3: Maine Remedial Action Guidelines for the Soil Exposure Pathway, by Exposure Scenario

NOTE: Microsoft Excel™ versions of Tables 3-6 can be found on the DEP website at: http://www.maine.gov/dep/spills/publications/guidance/index.html

CAS Number	Chemical	Soil RAG (milligram per kilogram, mg/kg)						Maine Background 90% UPL* (mg/kg)			
		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
83-32-9	Acenaphthene	300	4,900	62,000	14,000	16,000	48,000	-	0.1	0.2	3.5
208-96-8	Acenaphthylene	290	4,900	45,000	14,000	16,000	48,000	-	0.32	0.39	1.4
67-64-1	Acetone	160	52,000	100,000	81,000	100,000	98,000	-	-	-	-
75-05-8	Acetonitrile	1.4	1,200	5,100	28,000	100,000	4,600	-	-	-	-
98-86-2	Acetophenone	32	11,000	100,000	30,000	35,000	100,000	-	-	-	-
107-02-8	Acrolein	0.00046	0.21	0.9	4.7	180	0.58	-	-	-	-
107-13-1	Acrylonitrile	0.0063	3.7	17	34	58	14	-	-	-	-
15972-60-8	Alachlor	0.48	130	560	380	440	2,600	-	-	-	-
309-00-2	Aldrin	0.083	0.54	2.5	1.6	1.8	14	-	-	-	-
107-05-1	Allyl Chloride	0.037	2.5	10	56	1500	14	-	-	-	-
7429-90-5	Aluminum	1,700,000	100,000	100,000	100,000	100,000	27,000	-	-	-	-
62-53-3	Aniline	2.5	610	5,500	1,700	2,000	1,700	-	-	-	-
120-12-7	Anthracene	3200	25,000	100,000	70,000	81,000	100,000	-	0.29	0.4	6.7
7440-36-0	Antimony (metallic)	19	43	640	120	140	140	0.71	-	-	-
12674-11-2	Aroclor 1016	7.4	5.6	70	16	18	16	-	-	-	-
7440-38-2	Arsenic, Inorganic	0.83	9.3	41	26	30	54	16	-	-	-

CAS Number	Chemical	Soil RAG (milligram per kilogram, mg/kg)						Maine Background 90% UPL* (mg/kg)			
		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
1912-24-9	Atrazine	0.11	32	140	92	110	770	-	-	-	-
7440-39-3	Barium	8600	21,000	100,000	61,000	70,000	20,000	470	-	-	-
100-52-7	Benzaldehyde	2.3	2,400	11,000	6,800	7,800	62,000	-	-	-	-
71-43-2	Benzene	0.13	17	75	230	570	240	-	-	-	-
56-55-3	Benzo(a)anthracene	5.8	16	280	45	52	1,700	-	0.86	1.6	27
50-32-8	Benzo(a)pyrene	16	1.6	29	4.5	5.2	9.9	-	1.5	1.7	5.2
205-99-2	Benzo(b)fluoranthene	170	16	290	45	52	1,700	-	1.3	2.0	6.8
191-24-2	Benzo(g,h,i)perylene	130,000	2,500	23,000	7,000	8,100	72,000	-	0.57	0.79	16
207-08-9	Benzo(k)fluoranthene	1,600	160	2,900	450	520	17,000	-	0.69	0.76	12
65-85-0	Benzoic Acid	830	100,000	100,000	100,000	100,000	11,000	-	-	-	-
100-51-6	Benzyl Alcohol	26	8,600	100,000	25,000	28,000	77,000	-	-	-	-
100-44-7	Benzyl Chloride	0.054	16	70	120	180	81	-	-	-	-
7440-41-7	Beryllium and compounds	1,100	210	3,200	610	700	110	2.4	-	-	-
92-52-4	Biphenyl, 1,1'-	0.48	71	300	1,600	3,900	400	-	-	-	-
111-44-4	Bis(2-chloroethyl)ether	0.002	3.3	15	21	28	62	-	-	-	-
117-81-7	Bis(2-ethylhexyl)phthalate	730	530	2,200	1,500	1,700	13,000	-	-	-	-
7440-42-8	Boron And Borates Only	700	21,000	100,000	61,000	70,000	43,000	-	-	-	-
108-86-1	Bromobenzene	2.3	380	650	530	2,800	620	-	-	-	-
74-97-5	Bromochloromethane	1.1	220	940	4,000	100,000	330	-	-	-	-
75-27-4	Bromodichloromethane	0.02	4.4	19	83	500	70	-	-	-	-
75-25-2	Bromoform	0.48	280	790	720	4,000	890	-	-	-	-
74-83-9	Bromomethane	0.11	10	45	160	490	120	-	-	-	-
106-94-5	Bromopropane, 1-	3.5	330	970	970	100,000	970	-	-	-	-
106-99-0	Butadiene, 1,3-	0.0055	0.84	3.8	6.2	9.2	1.6	-	-	-	-
85-68-7	Butyl Benzyl Phthalate	130	3,900	17,000	11,000	13,000	99,000	-	-	-	-
104-51-8	Butylbenzene, n-	180	5,400	80,000	15,000	18,000	34,000	-	-	-	-
135-98-8	Butylbenzene, sec-	320	11,000	100,000	30,000	35,000	34,000	-	-	-	-

CAS Number	Chemical	Soil RAG (milligram per kilogram, mg/kg)						Maine Background 90% UPL* (mg/kg)			
		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
DEP2041	C11-C22 Aromatics	340	2,600	33,000	7,300	8,400	74,000	-	-	-	-
DEP2042	C19-C36 Aliphatics	NC	100,000	100,000	410,000	100,000	100,000	-	-	-	-
DEP2038	C5-C8 Aliphatics	92	1,700	11,000	7,500	9,500	430	-	-	-	-
DEP2040	C9-C10 Aromatics	15	660	3,500	4,700	7,000	2,600	-	-	-	-
DEP2039	C9-C12 Aliphatics	5,800	2,500	14,000	17,000	24,000	2,300	-	-	-	-
DEP2043	C9-C18 Aliphatics	26,000	2,500	14,000	17,000	24,000	4,800	-	-	-	-
7440-43-9	Cadmium (Diet)	38	98	1,400	280	320	42	0.26	-	-	-
86-74-8	Carbazole	15	270	110	750	870	6,700	-	-	-	0.53
75-15-0	Carbon Disulfide	13	690	740	720	35,000	720	-	-	-	-
56-23-5	Carbon Tetrachloride	0.097	9.7	43	150	450	160	-	-	-	-
12789-03-6	Chlordane	1.5	24	110	69	80	100	-	-	-	-
115-28-6	Chlorendic acid	15	0.81	35	230	270	2,000	-	-	-	-
75-68-3	Chloro-1,1-difluoroethane, 1-	2,900	1,200	1,200	1,200	100,000	1,200	-	-	-	-
106-47-8	Chloroaniline, p-	0.086	37	160	110	120	130	-	-	-	-
108-90-7	Chlorobenzene	2.9	410	740	680	7,000	740	-	-	-	-
67-66-3	Chloroform	0.034	4.7	21	97	1,000	75	-	-	-	-
74-87-3	Chloromethane	2.7	160	690	1,300	100,000	1,300	-	-	-	-
91-58-7	Chloronaphthalene, Beta-	210	6,500	82,000	19,000	22,000	48,000	-	-	-	-
95-57-8	Chlorophenol, 2-	4.9	540	8,000	1,500	1,800	2,700	-	-	-	-
76-06-2	Chloropicrin	0.014	2.9	12	66	100,000	1.7	-	-	-	-
95-49-8	Chlorotoluene, o-	13	2,100	32,000	6,100	7,000	800	-	-	-	-
106-43-4	Chlorotoluene, p-	13	2,100	32,000	6,100	7,000	68,000	-	-	-	-
16065-83-1	Chromium(III), Insoluble Salts	2,200,000,000	100,000	100,000	100,000	100,000	27,000	-	-	-	-
18540-29-9	Chromium(VI)	0.37	4.2	89	12	14	46	-	-	-	-

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		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
218-01-9	Chrysene	5000	1,600	29,000	4,500	5,200	100,000	-	1	2.3	6.4
7440-48-4	Cobalt	15	32	480	91	110	100	15	-	-	-
7440-50-8	Copper	1600	4,300	64,000	12,000	14,000	3,400	23	-	-	-
108-39-4	Cresol, m-	41	4,300	56,000	12,000	14,000	100,000	-	-	-	-
95-48-7	Cresol, o-	41	4,300	56,000	12,000	14,000	51,000	-	-	-	-
106-44-5	Cresol, p-	82	8,600	100,000	25,000	28,000	5,100	-	-	-	-
59-50-7	Cresol, p-chloro-m-	94	8,600	100,000	25,000	28,000	26,000	-	-	-	-
98-82-8	Cumene	41	260	270	270	35,000	270	-	-	-	-
57-12-5	Cyanide (CN-)	0.81	33	220	160	210	38	-	-	-	-
110-82-7	Cyclohexane	720	120	120	120	100,000	120	-	-	-	-
75-99-0	Dalapon	6.8	2,600	34,000	7,400	8,500	7,700	-	-	-	-
72-54-8	DDD, p,p`- (DDD)	0.82	2.6	34	7.4	8.5	7.7	-	-	-	-
72-55-9	DDE, p,p'-	6	27	130	79	92	100	-	-	-	-
50-29-3	DDT	43	26	120	73	85	160	-	-	-	-
53-70-3	Dibenz(a,h)anthracene	53	1.6	29	4.5	5.2	170	-	0.32	0.23	4.5
132-64-9	Dibenzofuran	8	100	1,400	280	330	1,200	-	-	-	-
96-12-8	Dibromo-3-chloropropane, 1,2-	0.000079	0.078	0.96	1.5	8.6	3.5	-	-	-	-
124-48-1	Dibromochloromethane	0.13	110	530	320	370	3,000	-	-	-	-
106-93-4	Dibromoethane, 1,2-	0.0012	0.54	2.4	6.8	16	8.9	-	-	-	-
74-95-3	Dibromomethane (Methylene Bromide)	0.11	35	150	800	100,000	190	-	-	-	-
84-74-2	Dibutyl Phthalate	130	8,600	100,000	25,000	28,000	100,000	-	-	-	-
110-57-6	Dichloro-2-butene, trans-1,4-	0.00034	0.11	0.48	2.5	100,000	1.8	-	-	-	-
95-50-1	Dichlorobenzene, 1,2-	16	360	380	370	32,000	380	-	-	-	-
541-73-1	Dichlorobenzene, 1,3-	16	290	300	290	32,000	300	-	-	-	-
106-46-7	Dichlorobenzene, 1,4-	0.25	39	170	770	5,800	620	-	-	-	-

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		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
91-94-1	Dichlorobenzidine, 3,3'-	0.45	17	70	47	54	400	-	-	-	-
75-71-8	Dichlorodifluoromethane	17	130	550	830	70,000	730	-	-	-	-
107-06-2	Dichloroethane, 1,2-	0.027	6.9	30	110	340	110	-	-	-	-
75-34-3	Dichloroethane,1,1-	0.43	53	230	980	5,500	850	-	-	-	-
75-35-4	Dichloroethylene, 1,1-	5.6	340	1,200	1,100	18,000	81	-	-	-	-
156-59-2	Dichloroethylene, 1,2-cis-	0.57	200	1,400	480	700	1,400	-	-	-	-
156-60-5	Dichloroethylene, 1,2-trans-	5.1	990	1,800	1,400	7,000	1,200	-	-	-	-
120-83-2	Dichlorophenol, 2,4-	1.2	260	3,400	740	850	5,100	-	-	-	-
78-87-5	Dichloropropane, 1,2-	0.15	23	99	420	840	110	-	-	-	-
142-28-9	Dichloropropane, 1,3-	7.1	2,100	32,000	6,100	7,000	68,000	-	-	-	-
542-75-6	Dichloropropene, 1,3-	0.093	27	120	210	310	120	-	-	-	-
60-57-1	Dieldrin	0.039	0.46	2	1.3	1.5	12	-	-	-	-
84-66-2	Diethyl Phthalate	330	69,000	100,000	100,000	100,000	100,000	-	-	-	-
108-20-3	Diisopropyl Ether	21	2,300	2,300	2,300	100,000	2,000	-	-	-	-
105-67-9	Dimethylphenol, 2,4-	23	1,700	22,000	4,900	5,700	13,000	-	-	-	-
576-26-1	Dimethylphenol, 2,6-	0.7	52	670	150	170	1,500	-	-	-	-
528-29-0	Dinitrobenzene, 1,2-	0.098	8.6	110	25	28	260	-	-	-	-
99-65-0	Dinitrobenzene, 1,3-	0.097	8.6	110	25	28	130	-	-	-	-
100-25-4	Dinitrobenzene, 1,4-	0.097	8.6	110	25	28	260	-	-	-	-
51-28-5	Dinitrophenol, 2,4-	2.4	170	2,200	490	570	5,100	-	-	-	-
121-14-2	Dinitrotoluene, 2,4-	0.18	24	100	68	78	600	-	-	-	-
606-20-2	Dinitrotoluene, 2,6-	0.037	5	21	14	16	130	-	-	-	-
88-85-7	Dinoseb	7.1	86	1,100	250	280	260	-	-	-	-
123-91-1	Dioxane, 1,4-	0.052	74	340	260	310	1,700	-	-	-	-
115-29-7	Endosulfan	76	640	9,600	1,800	2,100	1,700	-	-	-	-
72-20-8	Endrin	5.1	26	340	74	85	510	-	-	-	-
75-00-3	Ethyl Chloride	330	2,100	2,100	2,100	100,000	2,000	-	-	-	-

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		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
60-29-7	Ethyl Ether	48	21,000	100,000	61,000	70,000	8,100	-	-	-	-
100-41-4	Ethylbenzene	0.92	86	380	400	2,800	470	-	-	-	-
206-44-0	Fluoranthene	4900	3,300	41,000	9,300	11,000	24,000	-	2	3.2	10
86-73-7	Fluorene	300	3,300	41,000	9,300	11,000	96,000	-	0.22	0.29	4.4
50-00-0	Formaldehyde	0.048	250	1,100	5,700	70,000	2,500	-	-	-	-
76-44-8	Heptachlor	0.063	1.9	8.7	5.9	6.9	34	-	-	-	-
1024-57-3	Heptachlor Epoxide	0.016	0.97	4.5	2.9	3.4	4.4	-	-	-	-
118-74-1	Hexachlorobenzene	0.068	3	14	15	20	3.4	-	-	-	-
87-68-3	Hexachlorobutadiene	0.15	15	16	16	350	17	-	-	-	-
319-84-6	Hexachlorocyclohexane, Alpha-	0.023	1.2	5	3.4	3.9	29	-	-	-	-
319-85-7	Hexachlorocyclohexane, Beta-	0.081	4.1	17	12	14	100	-	-	-	-
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	0.13	7.8	35	22	26	3	-	-	-	-
67-72-1	Hexachloroethane	0.11	27	120	210	250	450	-	-	-	-
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.15	83	380	240	270	2,200	-	-	-	-
591-78-6	Hexanone, 2-	0.48	290	2,000	1,000	1,800	300	-	-	-	-
193-39-5	Indeno(1,2,3)pyrene	540	16	290	45	52	1,700	-	0.4	0.74	3.3
7439-89-6	Iron	19000	75,000	100,000	100,000	100,000	100,000	-	-	-	-
78-59-1	Isophorone	14	7,800	33,000	22,000	26,000	100,000	-	-	-	-
7439-92-1	Lead	250	140	440	290	290	450	32	-	-	-
121-75-5	Malathion	5.6	1,700	22,000	4,900	5,700	4,900	-	-	-	-
7439-96-5	Manganese (Non-diet)	1600	2,600	38,000	7,300	8,400	280	840	-	-	-
94-74-6	MCPA	0.11	43	560	120	140	130	-	-	-	-
93-65-2	MCPP	0.26	86	1,100	250	280	2,600	-	-	-	-
7487-94-7	Mercuric Chloride	NC	32	480	91	110	490	-	-	-	-

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7439-97-6	Mercury (elemental)	1.8	3.1	3.1	3.1	100,000	3.1	-	-	-	-
72-43-5	Methoxychlor	110	430	5,600	1,200	1,400	1,300	-	-	-	-
79-20-9	Methyl Acetate	230	100,000	100,000	100,000	100,000	740	-	-	-	-
78-93-3	Methyl Ethyl Ketone (2-Butanone)	64	20,000	28,000	25,000	100,000	11,000	-	-	-	-
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	78	3,400	3,400	3,400	100,000	3,300	-	-	-	-
22967-92-6	Methyl Mercury	770	11	160	30	35	100,000	-	-	-	-
80-62-6	Methyl Methacrylate	17	2,300	2,400	2,400	100,000	2,200	-	-	-	-
1634-04-4	Methyl tert-Butyl Ether (MTBE)	1.8	690	3,000	5,600	17,000	8,200	-	-	-	-
88-19-7	Methylbenzene sulfonamide, 2-	2.3	3,500	33,000	9,800	11,000	10,000	-	-	-	-
70-55-3	Methylbenzene sulfonamide, 4-	41	9,900	94,000	28,000	32,000	29,000	-	-	-	-
75-09-2	Methylene Chloride	1.5	490	2,500	1,200	2,100	1,900	-	-	-	-
90-12-0	Methylnaphthalene, 1-	3.3	240	990	680	790	6,000	-	-	-	-
91-57-6	Methylnaphthalene, 2-	10	330	4,100	930	1,100	960	-	0.16	0.089	0.41
7439-98-7	Molybdenum	110	540	8,000	1,500	1,800	1,700	0.98	-	-	-
91-20-3	Naphthalene	0.3	57	250	1,300	5,400	130	-	0.11	0.22	0.822
7440-02-0	Nickel Soluble Salts	1400	2,100	32,000	6,100	7,000	990	39	-	-	-
14797-55-8	Nitrate	NC	100,000	100,000	100,000	100,000	100,000	-	-	-	-
100-01-6	Nitroaniline, 4-	0.87	350	1,600	980	1,100	2,500	-	-	-	-
55-63-0	Nitroglycerin	0.047	8.6	110	25	28	26	-	-	-	-
86-30-6	Nitrosodiphenylamine, N-	37	1,500	6,400	4,300	5,000	37,000	-	-	-	-

CAS Number	Chemical	Soil RAG (milligram per kilogram, mg/kg)						Maine Background 90% UPL* (mg/kg)			
		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	70	5,300	78,000	15,000	17,000	17,000	-	-	-	-
117-84-0	Octyl Phthalate, di-N-	3,100	860	11,000	2,500	2,800	26,000	-	-	-	-
56-38-2	Parathion	24	520	6,700	1,500	1,700	110	-	-	-	-
87-86-5	Pentachlorophenol	0.031	14	54	40	46	190	-	-	-	-
78-11-5	Pentaerythritol tetranitrate (PETN)	3.2	170	2,200	490	570	510	-	-	-	-
14797-73-0	Perchlorate and Perchlorate Salts	NC	75	1,100	210	250	240	-	-	-	-
375-73-5	Perfluorobutane sulfonic acid (PFBS)	7.1	1,700	22,000	4,900	5,700	51,000	-	-	-	-
1763-23-1	Perfluorooctane sulfonic acid (PFOS)	0.021	1.7	22	4.9	5.7	5.1	-	-	-	-
335-67-1	Perfluorooctanoic acid (PFOA)	0.0095	1.7	22	4.9	5.7	5.1	-	-	-	-
85-01-8	Phenanthrene	320	2,500	23,000	7,000	8,100	72,000	-	0.83	1.6	6.1
108-95-2	Phenol	180	26,000	100,000	74,000	85,000	100,000	-	-	-	-
298-02-2	Phorate	0.19	17	220	49	57	51	-	-	-	-
88-99-3	Phthalic Acid	790	100,000	100,000	100,000	100,000	94,000	-	-	-	-
1336-36-3	Polychlorinated Biphenyls (high risk)	3.8	3.1	13	9.6	11	74	-	-	-	-
103-65-1	Propyl benzene	67	260	260	260	35,000	260	-	-	-	-
107-98-2	Propylene Glycol Monomethyl Ether	36	44,000	97,000	71,000	100,000	100,000	-	-	-	-
129-00-0	Pyrene	720	2,500	31,000	7,000	8,100	72,000	-	2	2.8	9.5
7782-49-2	Selenium	29	540	8,000	1,500	1,800	1,700	0.61	-	-	-
7440-22-4	Silver	44	540	8,000	1,500	1,800	1,700	-	-	-	-

CAS Number	Chemical	Soil RAG (milligram per kilogram, mg/kg)						Maine Background 90% UPL* (mg/kg)			
		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
7440-24-6	Strontium, Stable	23000	64,000	100,000	100,000	100,000	100,000	-	-	-	-
100-42-5	Styrene	73	830	870	860	70,000	860	-	-	-	-
1746-01-6	TCDD, 2,3,7,8-	0.000033	0.000065	0.0003	0.00019	0.00022	0.0016	-	-	-	-
95-94-3	Tetrachlorobenzene, 1,2,4,5-	0.44	32	480	91	110	10	-	-	-	-
630-20-6	Tetrachloroethane, 1,1,1,2-	0.12	30	130	410	1,200	480	-	-	-	-
79-34-5	Tetrachloroethane, 1,1,2,2-	0.016	8.9	39	88	160	150	-	-	-	-
127-18-4	Tetrachloroethylene	1	120	160	150	2,100	85	-	-	-	-
58-90-2	Tetrachlorophenol, 2,3,4,6-	9.9	2,600	34,000	7,400	8,500	77,000	-	-	-	-
109-99-9	Tetrahydrofuran	41	26,000	100,000	100,000	100,000	20,000	-	-	-	-
479-45-8	Tetryl (Trinitrophenylmethylnitramine)	20	210	3,200	610	700	6,800	-	-	-	-
7440-28-0	Thallium (Soluble Salts)	0.78	1.1	16	3	3.5	14	-	-	-	-
7440-31-5	Tin	170000	64,000	100,000	100,000	100,000	100,000	-	-	-	-
108-88-3	Toluene	42	750	810	790	28,000	820	-	-	-	-
87-61-6	Trichlorobenzene, 1,2,3-	1.2	86	1,300	240	280	2,700	-	-	-	-
120-82-1	Trichlorobenzene, 1,2,4-	0.64	86	380	360	1,100	400	-	-	-	-
71-55-6	Trichloroethane, 1,1,1-	150	640	640	640	100,000	640	-	-	-	-
79-00-5	Trichloroethane, 1,1,2-	0.0074	2.2	9.4	49	550	13	-	-	-	-
79-01-6	Trichloroethylene	0.056	6.1	28	77	180	3.9	-	-	-	-
75-69-4	Trichlorofluoromethane	180	32,000	100,000	91,000	100,000	940	-	-	-	-
95-95-4	Trichlorophenol, 2,4,5-	220	8,600	100,000	25,000	28,000	77,000	-	-	-	-
88-06-2	Trichlorophenol, 2,4,6-	0.64	86	1,100	250	280	260	-	-	-	-
93-76-5	Trichlorophenoxyacetic Acid, 2,4,5-	3.7	860	11,000	2,500	2,800	26,000	-	-	-	-

CAS Number	Chemical	Soil RAG (milligram per kilogram, mg/kg)						Maine Background 90% UPL* (mg/kg)			
		Leaching to Groundwater	**Residential**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
93-72-1	Trichlorophenoxypropionic acid, -2,4,5	3.4	690	9,000	2,000	2,300	2,100	-	-	-	-
96-18-4	Trichloropropane, 1,2,3-	0.00018	0.07	1.5	0.2	0.23	4.3	-	-	-	-
526-73-8	Trimethylbenzene, 1,2,3-	4.4	230	290	270	3,500	290	-	-	-	-
95-63-6	Trimethylbenzene, 1,2,4-	4.4	180	220	200	3,500	220	-	-	-	-
108-67-8	Trimethylbenzene, 1,3,5-	4.8	160	180	170	3,500	180	-	-	-	-
118-96-7	Trinitrotoluene, 2,4,6-	3.1	50	700	140	160	150	-	-	-	-
7440-62-2	Vanadium and Compounds	4800	540	8,000	1,500	1,800	490	100	-	-	-
108-05-4	Vinyl Acetate	4.8	1,400	2,700	2,700	100,000	140	-	-	-	-
593-60-2	Vinyl Bromide	0.028	1.8	7.8	41	100,000	3.7	-	-	-	-
75-01-4	Vinyl Chloride	0.0036	0.64	24	0.71	0.71	63	-	-	-	-
1330-20-7	Xylenes	11	260	260	260	70,000	260	-	-	-	-
7440-66-6	Zinc and Compounds	21000	32,000	100,000	91,000	100,000	100,000	100	-	-	-

Notes:

NC - not calculated

UPL - Upper Prediction Limit

Table 4: Maine Remedial Action Guidelines for the Indoor Air Exposure Pathway, by Exposure Scenario

Note: Multiply sub slab concentrations by an attenuation factor of 0.03 before comparing the results to the appropriate Air RAG in this table (see Section 6.4.2).

		Air RAG (microgram per cubic meter)	
CAS	**Chemical**	**Residential**	**Commercial**
67-64-1	Acetone	32,000	100,000
75-05-8	Acetonitrile	63	260
107-02-8	Acrolein	0.021	0.088
107-13-1	Acrylonitrile	0.41	1.8
309-00-2	Aldrin	0.0057	0.025
107-05-1	Allyl Chloride	1.0	4.4
7429-90-5	Aluminum	5.2	22
62-53-3	Aniline	1.0	4.4
12674-11-2	Aroclor 1016	1.4	6.1
7440-38-2	Arsenic, Inorganic	0.0065	0.029
7440-39-3	Barium	0.52	2.2
71-43-2	Benzene	3.6	16
56-55-3	Benzo(a)anthracene	0.17	2.0
50-32-8	Benzo(a)pyrene	0.0021	0.0088
205-99-2	Benzo(b)fluoranthene	0.17	2.0
207-08-9	Benzo(k)fluoranthene	1.7	20
100-44-7	Benzyl Chloride	0.57	2.5
7440-41-7	Beryllium and compounds	0.012	0.051
92-52-4	Biphenyl, 1,1'-	0.42	1.8
111-44-4	Bis(2-chloroethyl)ether	0.085	0.37
117-81-7	Bis(2-ethylhexyl)phthalate	12	51
7440-42-8	Boron And Borates Only	21	88
108-86-1	Bromobenzene	63	260
74-97-5	Bromochloromethane	42	180
75-27-4	Bromodichloromethane	0.76	3.3
75-25-2	Bromoform	26	110
74-83-9	Bromomethane	5.2	22
106-94-5	Bromopropane, 1-	100	440
106-99-0	Butadiene, 1,3-	0.94	4.1
DEP2041	C11-C22 Aromatics	52	220
DEP2038	C5-C8 Aliphatics	210	880
DEP2040	C9-C10 Aromatics	52	220
DEP2039	C9-C12 Aliphatics	210	880
DEP2043	C9-C18 Aliphatics	210	880
7440-43-9	Cadmium (Diet)	0.010	0.044
75-15-0	Carbon Disulfide	730	3100

		Air RAG (microgram per cubic meter)	
CAS	Chemical	Residential	Commercial
56-23-5	Carbon Tetrachloride	4.7	20
12789-03-6	Chlordane	0.28	1.2
115-28-6	Chlorendic acid	1.1	4.7
75-68-3	Chloro-1,1-difluoroethane, 1-	52,000	100,000
108-90-7	Chlorobenzene	52	220
67-66-3	Chloroform	1.2	5.3
74-87-3	Chloromethane	94	390
76-06-2	Chloropicrin	0.42	1.8
18540-29-9	Chromium(VI)	0.00012	0.0015
218-01-9	Chrysene	17	200
7440-48-4	Cobalt	0.0031	0.014
108-39-4	Cresol, m-	630	2600
95-48-7	Cresol, o-	630	2600
106-44-5	Cresol, p-	630	2600
98-82-8	Cumene	420	1800
57-12-5	Cyanide (CN-)	0.83	3.5
110-82-7	Cyclohexane	6,300	26,000
72-54-8	DDD, p,p`- (DDD)	0.41	1.8
72-55-9	DDE, p,p'-	0.29	1.3
50-29-3	DDT	0.29	1.3
53-70-3	Dibenz(a,h)anthracene	0.017	0.2
96-12-8	Dibromo-3-chloropropane, 1,2-	0.0017	0.02
106-93-4	Dibromoethane, 1,2-	0.047	0.2
74-95-3	Dibromomethane (Methylene Bromide)	4.2	18
110-57-6	Dichloro-2-butene, trans-1,4-	0.0067	0.029
95-50-1	Dichlorobenzene, 1,2-	210	880
106-46-7	Dichlorobenzene, 1,4-	2.6	11
91-94-1	Dichlorobenzidine, 3,3'-	0.083	0.36
75-71-8	Dichlorodifluoromethane	100	440
107-06-2	Dichloroethane, 1,2-	1.1	4.7
75-34-3	Dichloroethane,1,1-	18	77
75-35-4	Dichloroethylene, 1,1-	210	880
156-59-2	Dichloroethylene, 1,2-cis-	830	3500
156-60-5	Dichloroethylene, 1,2-trans-	830	3500
78-87-5	Dichloropropane, 1,2-	4.2	18
542-75-6	Dichloropropene, 1,3-	7.0	31
60-57-1	Dieldrin	0.0061	0.027
108-20-3	Diisopropyl Ether	730	3100
121-14-2	Dinitrotoluene, 2,4-	0.32	1.4
123-91-1	Dioxane, 1,4-	5.6	25
75-00-3	Ethyl Chloride	10,000	44,000
100-41-4	Ethylbenzene	11	49

		Air RAG (microgram per cubic meter)	
CAS	**Chemical**	**Residential**	**Commercial**
50-00-0	Formaldehyde	2.2	9.4
76-44-8	Heptachlor	0.022	0.094
1024-57-3	Heptachlor Epoxide	0.011	0.047
118-74-1	Hexachlorobenzene	0.061	0.27
87-68-3	Hexachlorobutadiene	1.3	5.6
319-84-6	Hexachlorocyclohexane, Alpha-	0.016	0.068
319-85-7	Hexachlorocyclohexane, Beta-	0.053	0.23
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	0.091	0.4
67-72-1	Hexachloroethane	2.6	11
591-78-6	Hexanone, 2-	31	130
193-39-5	Indeno(1,2,3)pyrene	0.17	2.0
78-59-1	Isophorone	2,100	8,800
7439-96-5	Manganese (Non-diet)	0.05	0.22
7487-94-7	Mercuric Chloride	0.31	1.3
7439-97-6	Mercury (elemental)	0.31	1.3
78-93-3	Methyl Ethyl Ketone (2-Butanone)	5,200	22,000
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	3,100	13,000
80-62-6	Methyl Methacrylate	730	3100
1634-04-4	Methyl tert-Butyl Ether (MTBE)	110	470
75-09-2	Methylene Chloride	630	2600
91-20-3	Naphthalene	0.83	3.6
7440-02-0	Nickel Soluble Salts	0.09	0.39
100-01-6	Nitroaniline, 4-	6.3	26
86-30-6	Nitrosodiphenylamine, N-	11	47
87-86-5	Pentachlorophenol	5.5	24
108-95-2	Phenol	210	880
88-99-3	Phthalic Acid	21	88
1336-36-3	Polychlorinated Biphenyls (low risk)	0.049	0.22
103-65-1	Propyl benzene	1,000	4,400
107-98-2	Propylene Glycol Monomethyl Ether	2,100	8,800
7782-49-2	Selenium	21	88
100-42-5	Styrene	1,000	4,400
1746-01-6	TCDD, 2,3,7,8-	0.00000074	0.0000032
630-20-6	Tetrachloroethane, 1,1,1,2-	3.8	17
79-34-5	Tetrachloroethane, 1,1,2,2-	0.48	2.1
127-18-4	Tetrachloroethylene	42	180
109-99-9	Tetrahydrofuran	2,100	8,800
108-88-3	Toluene	5,200	22,000
120-82-1	Trichlorobenzene, 1,2,4-	2.1	8.8
71-55-6	Trichloroethane, 1,1,1-	5,200	22,000
79-00-5	Trichloroethane, 1,1,2-	0.21	0.88

		Air RAG (microgram per cubic meter)	
CAS	**Chemical**	**Residential**	**Commercial**
79-01-6	Trichloroethylene	2.1	8.8
88-06-2	Trichlorophenol, 2,4,6-	9.1	40
96-18-4	Trichloropropane, 1,2,3-	0.31	1.3
526-73-8	Trimethylbenzene, 1,2,3-	63	260
95-63-6	Trimethylbenzene, 1,2,4-	63	260
108-67-8	Trimethylbenzene, 1,3,5-	63	260
7440-62-2	Vanadium and Compounds	0.10	0.44
108-05-4	Vinyl Acetate	210	880
593-60-2	Vinyl Bromide	0.88	3.8
75-01-4	Vinyl Chloride	1.7	28
1330-20-7	Xylenes	100	440

Table 5: Maine Remedial Action Guidelines for the Groundwater Exposure Pathway, by Exposure Scenario

		Water RAG (ppb)	
CAS	Chemical	Residential	Construction Worker
83-32-9	Acenaphthene	540	74,000
208-96-8	Acenaphthylene	520	71,000
67-64-1	Acetone	14,000	100,000
75-05-8	Acetonitrile	130	4,800
98-86-2	Acetophenone	1,900	100,000
107-02-8	Acrolein	0.042	0.53
107-13-1	Acrylonitrile	0.52	11
15972-60-8	Alachlor	11	16,000
309-00-2	Aldrin	0.0092	2.9
107-05-1	Allyl Chloride	2.1	44
7429-90-5	Aluminum	20,000	100,000
62-53-3	Aniline	130	86,000
120-12-7	Anthracene	1,800	100,000
7440-36-0	Antimony (metallic)	7.8	2,100
12674-11-2	Aroclor 1016	1.4	500
7440-38-2	Arsenic, Inorganic	0.52	5,800
1912-24-9	Atrazine	3	11,000
7440-39-3	Barium	3,800	100,000
100-52-7	Benzaldehyde	190	100,000
71-43-2	Benzene	4.6	350
56-55-3	Benzo(a)anthracene	0.3	470
50-32-8	Benzo(a)pyrene	0.25	11,000
205-99-2	Benzo(b)fluoranthene	2.5	100,000
191-24-2	Benzo(g,h,i)perylene	600	100,000
207-08-9	Benzo(k)fluoranthene	25	100,000
65-85-0	Benzoic Acid	75,000	100,000
100-51-6	Benzyl Alcohol	2,000	100,000
100-44-7	Benzyl Chloride	0.89	26
7440-41-7	Beryllium and compounds	25	1,400
92-52-4	Biphenyl, 1,1'-	0.83	29
111-44-4	Bis(2-chloroethyl)ether	0.14	54
117-81-7	Bis(2-ethylhexyl)phthalate	56	100,000
7440-42-8	Boron And Borates Only	4,000	100,000
108-86-1	Bromobenzene	62	1,200
74-97-5	Bromochloromethane	83	600
75-27-4	Bromodichloromethane	1.3	130
75-25-2	Bromoform	33	5,500
74-83-9	Bromomethane	7.6	490
106-94-5	Bromopropane, 1-	210	2,800

		Water RAG (ppb)	
CAS	Chemical	Residential	Construction Worker
106-99-0	Butadiene, 1,3-	0.18	7.4
85-68-7	Butyl Benzyl Phthalate	160	100,000
104-51-8	Butylbenzene, n-	1,000	100,000
135-98-8	Butylbenzene, sec-	2,000	100,000
DEP2041	C11-C22 Aromatics	600	100,000
DEP2042	C19-C36 Aliphatics	40,000	100,000
DEP2038	C5-C8 Aliphatics	180	960
DEP2040	C9-C10 Aromatics	71	2,700
DEP2039	C9-C12 Aliphatics	350	3,700
DEP2043	C9-C18 Aliphatics	350	3,900
7440-43-9	Cadmium (Water)	9.2	940
86-74-8	Carbazole	15	13,000
75-15-0	Carbon Disulfide	810	3,100
56-23-5	Carbon Tetrachloride	4.6	700
12789-03-6	Chlordane	0.2	3.7
115-28-6	Chlorendic acid	8.4	100,000
75-68-3	Chloro-1,1-difluoroethane, 1-	100,000	100,000
106-47-8	Chloroaniline, p-	3.7	2,700
108-90-7	Chlorobenzene	78	2,600
67-66-3	Chloroform	2.2	170
74-87-3	Chloromethane	190	11,000
91-58-7	Chloronaphthalene, Beta-	750	81,000
95-57-8	Chlorophenol, 2-	91	29,000
76-06-2	Chloropicrin	0.83	2.6
95-49-8	Chlorotoluene, o-	240	3,300
106-43-4	Chlorotoluene, p-	250	100,000
16065-83-1	Chromium(III), Insoluble Salts	23,000	100,000
18540-29-9	Chromium(VI)	0.35	690
218-01-9	Chrysene	250	100,000
7440-48-4	Cobalt	6	81,000
7440-50-8	Copper	800	100,000
108-39-4	Cresol, m-	930	100,000
95-48-7	Cresol, o-	930	100,000
106-44-5	Cresol, p-	1,900	79,000
59-50-7	Cresol, p-chloro-m-	1,500	100,000
98-82-8	Cumene	450	500
57-12-5	Cyanide (CN-)	1.5	3.6
110-82-7	Cyclohexane	13,000	83,000
75-99-0	Dalapon	600	100,000
72-54-8	DDD, p,p`- (DDD)	0.063	1.7
72-55-9	DDE, p,p'-	0.46	140
50-29-3	DDT	2.3	19,000

		Water RAG (ppb)	
CAS	Chemical	Residential	Construction Worker
53-70-3	Dibenz(a,h)anthracene	0.25	26,000
132-64-9	Dibenzofuran	7.9	1,200
96-12-8	Dibromo-3-chloropropane, 1,2-	0.0033	1.2
124-48-1	Dibromochloromethane	8.7	53,000
106-93-4	Dibromoethane, 1,2-	0.075	8.7
74-95-3	Dibromomethane (Methylene Bromide)	8.3	280
84-74-2	Dibutyl Phthalate	900	100,000
110-57-6	Dichloro-2-butene, trans-1,4-	0.013	1
95-50-1	Dichlorobenzene, 1,2-	300	12,000
541-73-1	Dichlorobenzene, 1,3-	300	6,200
106-46-7	Dichlorobenzene, 1,4-	4.8	400
91-94-1	Dichlorobenzidine, 3,3'-	1.3	2,000
75-71-8	Dichlorodifluoromethane	200	5,400
107-06-2	Dichloroethane, 1,2-	1.7	140
75-34-3	Dichloroethane,1,1-	28	2,200
75-35-4	Dichloroethylene, 1,1-	290	390
156-59-2	Dichloroethylene, 1,2-cis-	35	3,700
156-60-5	Dichloroethylene, 1,2-trans-	300	3,900
120-83-2	Dichlorophenol, 2,4-	46	27,000
78-87-5	Dichloropropane, 1,2-	8.3	180
142-28-9	Dichloropropane, 1,3-	370	100,000
542-75-6	Dichloropropene, 1,3-	4.7	200
60-57-1	Dieldrin	0.018	13
84-66-2	Diethyl Phthalate	15,000	100,000
108-20-3	Diisopropyl Ether	1,500	3,700
105-67-9	Dimethylphenol, 2,4-	360	100,000
576-26-1	Dimethylphenol, 2,6-	11	15,000
528-29-0	Dinitrobenzene, 1,2-	1.9	8,900
99-65-0	Dinitrobenzene, 1,3-	2	5,500
100-25-4	Dinitrobenzene, 1,4-	2	11,000
51-28-5	Dinitrophenol, 2,4-	39	100,000
121-14-2	Dinitrotoluene, 2,4-	2.4	15,000
606-20-2	Dinitrotoluene, 2,6-	0.49	2,700
88-85-7	Dinoseb	15	1,200
123-91-1	Dioxane, 1,4-	4.6	8,600
115-29-7	Endosulfan	100	12,000
72-20-8	Endrin	2.3	580
75-00-3	Ethyl Chloride	21,000	16,000
60-29-7	Ethyl Ether	3,900	14,000
100-41-4	Ethylbenzene	15	1,400
206-44-0	Fluoranthene	800	100,000
86-73-7	Fluorene	290	100,000

		Water RAG (ppb)	
CAS	Chemical	Residential	Construction Worker
50-00-0	Formaldehyde	4.3	22,000
76-44-8	Heptachlor	0.014	3.9
1024-57-3	Heptachlor Epoxide	0.014	5.5
118-74-1	Hexachlorobenzene	0.098	13
87-68-3	Hexachlorobutadiene	1.4	230
319-84-6	Hexachlorocyclohexane, Alpha-	0.073	80
319-85-7	Hexachlorocyclohexane, Beta-	0.25	280
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	0.42	7.2
67-72-1	Hexachloroethane	3.3	470
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	7	100,000
591-78-6	Hexanone, 2-	38	240
193-39-5	Indeno(1,2,3)pyrene	2.5	100,000
7439-89-6	Iron	14,000	100,000
78-59-1	Isophorone	780	100,000
7439-92-1	Lead	5.0	-
121-75-5	Malathion	390	100,000
7439-96-5	Manganese (Non-diet)	430	37,000
94-74-6	MCPA	7.5	680
93-65-2	MCPP	16	16,000
7487-94-7	Mercuric Chloride	5.7	5,200
7439-97-6	Mercury (elemental)	0.63	2.1
72-43-5	Methoxychlor	37	1,400
79-20-9	Methyl Acetate	20,000	670
78-93-3	Methyl Ethyl Ketone (2-Butanone)	5,600	9,000
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	6,300	5,800
22967-92-6	Methyl Mercury	2	100,000
80-62-6	Methyl Methacrylate	1,400	4,200
1634-04-4	Methyl tert-Butyl Ether (MTBE)	140	13,000
88-19-7	Methylbenzene sulfonamide, 2-	800	100,000
70-55-3	Methylbenzene sulfonamide, 4-	2,300	100,000
75-09-2	Methylene Chloride	110	4,900
90-12-0	Methylnaphthalene, 1-	11	8,800
91-57-6	Methylnaphthalene, 2-	36	1,500
7439-98-7	Molybdenum	100	96,000
91-20-3	Naphthalene	1.7	19
7440-02-0	Nickel Soluble Salts	390	100,000
14797-55-8	Nitrate	32,000	100,000
14797-65-0	Nitrite	2,000	100,000
100-01-6	Nitroaniline, 4-	38	100,000
55-63-0	Nitroglycerin	2	1,300
86-30-6	Nitrosodiphenylamine, N-	120	100,000

		Water RAG (ppb)	
CAS	**Chemical**	**Residential**	**Construction Worker**
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	1,000	100,000
117-84-0	Octyl Phthalate, di-N-	200	100,000
56-38-2	Parathion	86	10,000
87-86-5	Pentachlorophenol	0.41	140
78-11-5	Pentaerythritol tetranitrate (PETN)	39	18,000
14797-73-0	Perchlorate and Perchlorate Salts	14	14,000
375-73-5	Perfluorobutane sulfonic acid (PFBS)	400	100,000
1763-23-1	Perfluorooctane sulfonic acid (PFOS)[19]	0.40	750
335-67-1	Perfluorooctanoic acid (PFOA)[19]	0.40	750
85-01-8	Phenanthrene	180	58,000
108-95-2	Phenol	5,800	100,000
298-02-2	Phorate	3.0	280
88-99-3	Phthalic Acid	40,000	100,000
1336-36-3	Polychlorinated Biphenyls	0.079	#N/A
103-65-1	Propyl benzene	660	4,900
107-98-2	Propylene Glycol Monomethyl Ether	3,200	100,000
129-00-0	Pyrene	120	36,000
7782-49-2	Selenium	100	96,000
7440-22-4	Silver	94	12,000
7440-24-6	Strontium, Stable	12,000	100,000
100-42-5	Styrene	1,200	15,000
1746-01-6	TCDD, 2,3,7,8-	0.0000012	0.00033
95-94-3	Tetrachlorobenzene, 1,2,4,5-	1.7	5.6
630-20-6	Tetrachloroethane, 1,1,1,2-	5.7	620
79-34-5	Tetrachloroethane, 1,1,2,2-	0.76	90
127-18-4	Tetrachloroethylene	41	260
58-90-2	Tetrachlorophenol, 2,3,4,6-	240	93,000
109-99-9	Tetrahydrofuran	3,400	16,000
479-45-8	Tetryl (Trinitrophenylmethylnitramine)	40	100,000
7440-28-0	Thallium (Soluble Salts)	0.20	770
7440-31-5	Tin	12,000	100,000
108-88-3	Toluene	1,100	24,000
87-61-6	Trichlorobenzene, 1,2,3-	7.0	2,900

[19] In 2016, EPA established a lifetime health advisory of .070 µg/l (parts per billion) for the combined concentration of PFOA and PFOS. The RAGs for PFOA and PFOS in this table are risk-based values based on current science; however, EPA is developing further information on these contaminants. At this time, the DEP recommends that the EPA health advisory level be applied at sites where groundwater is currently being used, or may be used in the future, for human consumption. Deviation from this recommendation may be considered on a case-by-case basis. Please see section 7.7, Other Applicable, or Relevant and Appropriate Requirements and section 4.1.1 of the technical support document.

		Water RAG (ppb)	
CAS	**Chemical**	**Residential**	**Construction Worker**
120-82-1	Trichlorobenzene, 1,2,4-	4.0	140
71-55-6	Trichloroethane, 1,1,1-	8,000	29,000
79-00-5	Trichloroethane, 1,1,2-	0.42	12
79-01-6	Trichloroethylene	2.8	12
75-69-4	Trichlorofluoromethane	5,200	5,900
95-95-4	Trichlorophenol, 2,4,5-	1,200	100,000
88-06-2	Trichlorophenol, 2,4,6-	12	690
93-76-5	Trichlorophenoxyacetic Acid, 2,4,5-	160	100,000
93-72-1	Trichlorophenoxypropionic acid, -2,4,5	110	8,400
96-18-4	Trichloropropane, 1,2,3-	0.0075	2.1
526-73-8	Trimethylbenzene, 1,2,3-	55	1,000
95-63-6	Trimethylbenzene, 1,2,4-	56	1,000
108-67-8	Trimethylbenzene, 1,3,5-	60	1,100
118-96-7	Trinitrotoluene, 2,4,6-	9.8	6,800
7440-62-2	Vanadium and Compounds	86	10,000
108-05-4	Vinyl Acetate	410	180
593-60-2	Vinyl Bromide	1.8	16
75-01-4	Vinyl Chloride	0.19	0.22
1330-20-7	Xylenes	190	2,100
7440-66-6	Zinc and Compounds	6,000	100,000

Table 6: Maine Remedial Action Guidelines for Fish Consumption – Recreational Angler

Note: A Site-Specific Risk Assessment must be conducted for Subsistence Anglers

CAS	Chemical	Fish Tissue RAG (milligram per kilogram)
83-32-9	Acenaphthene	150
208-96-8	Acenaphthylene	150
67-64-1	Acetone	2,300
75-05-8	Acetonitrile	NC
98-86-2	Acetophenone	260
107-02-8	Acrolein	1.3
107-13-1	Acrylonitrile	0.13
15972-60-8	Alachlor	1.2
309-00-2	Aldrin	0.0041
107-05-1	Allyl Chloride	3.3
7429-90-5	Aluminum	2,600
62-53-3	Aniline	12
120-12-7	Anthracene	770
7440-36-0	Antimony (metallic)	1.0
12674-11-2	Aroclor 1016	0.18
7440-38-2	Arsenic, Inorganic	0.046
1912-24-9	Atrazine	0.30
7440-39-3	Barium	520
100-52-7	Benzaldehyde	17
71-43-2	Benzene	1.3
56-55-3	Benzo(a)anthracene	0.69
50-32-8	Benzo(a)pyrene	0.069
205-99-2	Benzo(b)fluoranthene	0.69
191-24-2	Benzo(g,h,i)perylene	77
207-08-9	Benzo(k)fluoranthene	6.9
65-85-0	Benzoic Acid	10,000
100-51-6	Benzyl Alcohol	260
100-44-7	Benzyl Chloride	0.41
7440-41-7	Beryllium and compounds	5.2
92-52-4	Biphenyl, 1,1'-	8.7
111-44-4	Bis(2-chloroethyl)ether	0.063
117-81-7	Bis(2-ethylhexyl)phthalate	5.0
7440-42-8	Boron And Borates Only	520
108-86-1	Bromobenzene	21
74-97-5	Bromochloromethane	NC
75-27-4	Bromodichloromethane	1.1

CAS	Chemical	Fish Tissue RAG (milligram per kilogram)
75-25-2	Bromoform	8.8
74-83-9	Bromomethane	3.6
106-94-5	Bromopropane, 1-	NC
106-99-0	Butadiene, 1,3-	0.020
85-68-7	Butyl Benzyl Phthalate	37
104-51-8	Butylbenzene, n-	130
135-98-8	Butylbenzene, sec-	260
DEP2041	C11-C22 Aromatics	77
DEP2042	C19-C36 Aliphatics	5,200
DEP2038	C5-C8 Aliphatics	100
DEP2040	C9-C10 Aromatics	77
DEP2039	C9-C12 Aliphatics	260
DEP2043	C9-C18 Aliphatics	260
7440-43-9	Cadmium (Water)	2.6
86-74-8	Carbazole	2.5
75-15-0	Carbon Disulfide	260
56-23-5	Carbon Tetrachloride	0.99
12789-03-6	Chlordane	0.2
115-28-6	Chlorendic acid	0.76
75-68-3	Chloro-1,1-difluoroethane, 1-	NC
106-47-8	Chloroaniline, p-	0.35
108-90-7	Chlorobenzene	52
67-66-3	Chloroform	2.2
74-87-3	Chloromethane	NC
91-58-7	Chloronaphthalene, Beta-	210
95-57-8	Chlorophenol, 2-	13
76-06-2	Chloropicrin	NC
95-49-8	Chlorotoluene, o-	52
106-43-4	Chlorotoluene, p-	52
16065-83-1	Chromium(III), Insoluble Salts	3,900
18540-29-9	Chromium(VI)	0.14
218-01-9	Chrysene	69
7440-48-4	Cobalt	0.77
7440-50-8	Copper	100
108-39-4	Cresol, m-	130
95-48-7	Cresol, o-	130
106-44-5	Cresol, p-	260
59-50-7	Cresol, p-chloro-m-	260
98-82-8	Cumene	260
57-12-5	Cyanide (CN-)	1.5

CAS	Chemical	Fish Tissue RAG (milligram per kilogram)
110-82-7	Cyclohexane	NC
75-99-0	Dalapon	77
72-54-8	DDD, p,p`- (DDD)	0.077
72-55-9	DDE, p,p'-	0.2
50-29-3	DDT	0.2
53-70-3	Dibenz(a,h)anthracene	0.069
132-64-9	Dibenzofuran	2.6
96-12-8	Dibromo-3-chloropropane, 1,2-	0.087
124-48-1	Dibromochloromethane	0.83
106-93-4	Dibromoethane, 1,2-	0.035
74-95-3	Dibromomethane (Methylene Bromide)	NC
84-74-2	Dibutyl Phthalate	260
110-57-6	Dichloro-2-butene, trans-1,4-	NC
95-50-1	Dichlorobenzene, 1,2-	230
541-73-1	Dichlorobenzene, 1,3-	230
106-46-7	Dichlorobenzene, 1,4-	13
91-94-1	Dichlorobenzidine, 3,3'-	0.15
75-71-8	Dichlorodifluoromethane	520
107-06-2	Dichloroethane, 1,2-	0.76
75-34-3	Dichloroethane,1,1-	12
75-35-4	Dichloroethylene, 1,1-	130
156-59-2	Dichloroethylene, 1,2-cis-	5.2
156-60-5	Dichloroethylene, 1,2-trans-	52
120-83-2	Dichlorophenol, 2,4-	7.7
78-87-5	Dichloropropane, 1,2-	1.9
142-28-9	Dichloropropane, 1,3-	52
542-75-6	Dichloropropene, 1,3-	0.69
60-57-1	Dieldrin	0.0043
84-66-2	Diethyl Phthalate	2,100
108-20-3	Diisopropyl Ether	NC
105-67-9	Dimethylphenol, 2,4-	52
576-26-1	Dimethylphenol, 2,6-	1.5
528-29-0	Dinitrobenzene, 1,2-	0.26
99-65-0	Dinitrobenzene, 1,3-	0.26
100-25-4	Dinitrobenzene, 1,4-	0.26
51-28-5	Dinitrophenol, 2,4-	5.2
121-14-2	Dinitrotoluene, 2,4-	0.22
606-20-2	Dinitrotoluene, 2,6-	0.046
88-85-7	Dinoseb	2.6
123-91-1	Dioxane, 1,4-	0.69

CAS	Chemical	Fish Tissue RAG (milligram per kilogram)
115-29-7	Endosulfan	15
72-20-8	Endrin	0.77
75-00-3	Ethyl Chloride	NC
60-29-7	Ethyl Ether	520
100-41-4	Ethylbenzene	6.3
206-44-0	Fluoranthene	100
86-73-7	Fluorene	100
50-00-0	Formaldehyde	520
76-44-8	Heptachlor	0.015
1024-57-3	Heptachlor Epoxide	0.0076
118-74-1	Hexachlorobenzene	0.043
87-68-3	Hexachlorobutadiene	0.89
319-84-6	Hexachlorocyclohexane, Alpha-	0.011
319-85-7	Hexachlorocyclohexane, Beta-	0.039
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	0.063
67-72-1	Hexachloroethane	1.7
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.63
591-78-6	Hexanone, 2-	13
193-39-5	Indeno(1,2,3)pyrene	0.69
7439-89-6	Iron	1,800
78-59-1	Isophorone	73
121-75-5	Malathion	52
7439-96-5	Manganese (Non-diet)	360
94-74-6	MCPA	1.3
93-65-2	MCPP	2.6
7487-94-7	Mercuric Chloride	0.77
7439-97-6	Mercury (elemental)	NC
72-43-5	Methoxychlor	13
79-20-9	Methyl Acetate	2,600
78-93-3	Methyl Ethyl Ketone (2-Butanone)	1,500
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	NC
22967-92-6	Methyl Mercury	0.26
80-62-6	Methyl Methacrylate	3,600
1634-04-4	Methyl tert-Butyl Ether (MTBE)	39
88-19-7	Methylbenzene sulfonamide, 2-	100
70-55-3	Methylbenzene sulfonamide, 4-	290
75-09-2	Methylene Chloride	15
90-12-0	Methylnaphthalene, 1-	2.4
91-57-6	Methylnaphthalene, 2-	10
7439-98-7	Molybdenum	13

CAS	Chemical	Fish Tissue RAG (milligram per kilogram)
91-20-3	Naphthalene	52
7440-02-0	Nickel Soluble Salts	52
14797-55-8	Nitrate	4,100
100-01-6	Nitroaniline, 4-	3.5
55-63-0	Nitroglycerin	0.26
86-30-6	Nitrosodiphenylamine, N-	14
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	130
117-84-0	Octyl Phthalate, di-N-	26
56-38-2	Parathion	15
87-86-5	Pentachlorophenol	0.17
78-11-5	Pentaerythritol tetranitrate (PETN)	5.2
14797-73-0	Perchlorate and Perchlorate Salts	1.8
375-73-5	Perfluorobutane sulfonic acid (PFBS)	52
1763-23-1	Perfluorooctane sulfonic acid (PFOS)	0.052
335-67-1	Perfluorooctanoic acid (PFOA)	0.052
85-01-8	Phenanthrene	77
108-95-2	Phenol	770
298-02-2	Phorate	0.52
88-99-3	Phthalic Acid	5,200
1336-36-3	Polychlorinated Biphenyls	0.035
103-65-1	Propyl benzene	260
107-98-2	Propylene Glycol Monomethyl Ether	1,800
129-00-0	Pyrene	77
7782-49-2	Selenium	13
7440-22-4	Silver	13
7440-24-6	Strontium, Stable	1,500
100-42-5	Styrene	520
1746-01-6	TCDD, 2,3,7,8-	0.00000053
95-94-3	Tetrachlorobenzene, 1,2,4,5-	0.77
630-20-6	Tetrachloroethane, 1,1,1,2-	2.7
79-34-5	Tetrachloroethane, 1,1,2,2-	0.35
127-18-4	Tetrachloroethylene	15
58-90-2	Tetrachlorophenol, 2,3,4,6-	77
109-99-9	Tetrahydrofuran	2,300
479-45-8	Tetryl (Trinitrophenylmethylnitramine)	5.2
7440-28-0	Thallium (Soluble Salts)	0.026
7440-31-5	Tin	1,500
108-88-3	Toluene	210
87-61-6	Trichlorobenzene, 1,2,3-	2.1

CAS	Chemical	Fish Tissue RAG (milligram per kilogram)
120-82-1	Trichlorobenzene, 1,2,4-	2.4
71-55-6	Trichloroethane, 1,1,1-	5,200
79-00-5	Trichloroethane, 1,1,2-	1.2
79-01-6	Trichloroethylene	1.3
75-69-4	Trichlorofluoromethane	770
95-95-4	Trichlorophenol, 2,4,5-	260
88-06-2	Trichlorophenol, 2,4,6-	2.6
93-76-5	Trichlorophenoxyacetic Acid, 2,4,5-	26
93-72-1	Trichlorophenoxypropionic acid, -2,4,5	21
96-18-4	Trichloropropane, 1,2,3-	0.0023
526-73-8	Trimethylbenzene, 1,2,3-	26
95-63-6	Trimethylbenzene, 1,2,4-	26
108-67-8	Trimethylbenzene, 1,3,5-	26
118-96-7	Trinitrotoluene, 2,4,6-	1.3
7440-62-2	Vanadium and Compounds	13
108-05-4	Vinyl Acetate	2,600
593-60-2	Vinyl Bromide	NC
75-01-4	Vinyl Chloride	0.096
1330-20-7	Xylenes	520
7440-66-6	Zinc and Compounds	770

Notes: NC - not calculated, no oral toxicity values

Attachment A: Technical Support Document for Maine 2018 Remedial Action Guidelines

Effective Date October 19, 2018

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Contents

Table of Tables

1 Introduction

This document presents the technical support for the 2018 Maine Remedial Action Guidelines (RAGs) for Sites Contaminated with Hazardous Substances. The intention is to provide enough information so that the reader can reproduce the calculations that resulted in the 2018 RAG values. The document also explains the multiple changes made to the way RAGs were developed in 2018 as compared to the 2016 RAGs.

1.1 Consistency with Superfund Risk Assessment

The Maine Department of Environmental Protection (DEP) and Maine Center for Disease Control within the Maine Department of Health and Human Services (CDC, together "the Agencies") work collaboratively to develop the RAGs and its updates. The RAGs methodology is consistent with EPA's Superfund[1] Risk Assessment Program. Like the 2016 RAGs, the 2018 RAGs are calculated based on:

- EPA Regional Screening Level (RSL) risk calculators (see Section 2);
- Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals) (RAGs Part B)[2] ; and
- Soil Screening Guidance: User's Guide, Technical Background Document and Supplemental Guidance[3].

1.2 Scenarios, Media, Exposure Routes and Risk End Points

The RAGs are based on exposure scenarios that typically drive the risk at Maine clean-up Sites. namely: Resident, Park User, Outdoor Commercial Worker and Construction Worker. The RAGs derived for these selected scenarios and specific media (i.e., soil, groundwater, sediment, indoor air) incorporate appropriate routes for potential exposure (ingestion, inhalation, and dermal contact). The 2018 RAGs again target the Maine risk goal of not exceeding a 1×10^{-5} increased incremental lifetime cancer risk (ILCR) and/or a hazard quotient (HQ) of 1 for a Reasonably Maximum Exposed Individual (RME). Following Superfund risk assessment protocol, the RME is derived by selecting a combination of average and high-end values for the many factors that go into a risk assessment calculation. This Results in above average exposure, or a "high end" exposure estimate, which is the highest exposure that is reasonably expected to occur at a site but that is still within the range of possible exposures. Following Superfund Risk Assessment protocol, cancer and non-cancer risks are first calculated separately. Then the lowest of the cancer and noncancer screening level is selected as the final RAG. The RAGs are

[1] Superfund is the name given to the *United States Comprehensive Environmental Response, Compensation, and Liability Act*, 42 U.S.C. §§ 9601-9675 .
[2] EPA webpage, "Risk Assessment: Risk Assessment Guidance for Superfund (RAGS): Part A [through part F]" (downloaded on August 27, 2018, from: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part).

presented in Tables 3 to 6 of the 2018 Maine Remedial Action Guidelines (RAGs) for Sites Contaminated with Hazardous Substances.

2 Use of RSL Calculators to Generate Maine RAGs

2.1 Use of RSL calculator new in 2018

Beginning with the 2018 RAGs, the Agencies shifted from using internally developed and maintained excel® workbooks for calculating RAG values, to using the United States Environmental Protection Agency (EPA's) Regional Screening Levels for Chemical Contaminants at Superfund Sites[4] (RSL calculator). Details of factors leading to the differences between the 2016 and 2018 RAGs are detailed in the following sections of this document. Key changes are:

- Use of EPA RSL methodology to calculate most RAGs, instead of Maine-developed excel® workbooks;
- A re-examination and refinement of methodologies used to calculate the RAGs that could not be calculated with the RSL methodology.
- The development of new RAGs for sediment exposure and fish consumption.
- Increased emphasis on the inhalation route of exposure from contaminated soil and water;
- Updated exposure assumptions based on EPA's 2011 Exposure Factors Handbook (including Residential Soil Inhalation Exposure Time),
- a review of available data on Maine specific exposure assumptions;
- Reliance on the EPA hierarchy of toxicity values rather than former Maine approach of CDC researching each individual toxicity value to derive the most defensible; and
- The use of contaminant specific inhalation and dermal contact modeling/exposure in the groundwater pathway, rather than a generic Relative Source Contribution factor of 20%; and
- Different exposure models were used for soil volatilization and soil dispersion modeling for the Construction Worker;

Details of these changes are described in this TSD, and they all impacted RAG values. Although these changes to the RAGs can sometimes represent several orders of magnitude in either direction, analysis of the contaminant data in the Maine Environmental and Geographic Analysis Database (EGAD) suggests that these changes will not affect a significant number of sites.

[4] As of August, 2018, available at: https://www.epa.gov/risk/regional-screening-levels-rsls.

2.2 Introduction to RSLs

The Tables in the RAGs were generated by Maine CDC and DEP (together "the Agencies") using the United States Environmental Protection Agency's (EPA) Regional Screening Levels for Chemical Contaminants at Superfund Sites (RSL). The Agencies used the RSL calculators (last accessed on August 24, 2018) to generate and maintain the extensive risk calculations necessary to derive the RAGs. EPA's RSL team maintains a robust risk assessment methodology for derivation of chemical-specific screening levels for various media (soil, water, air) at contaminated sites (sites) across the country. The EPA RSL website provides a user's guide, documentation of all equations used to generate screening levels, tables that present default chemical-specific parameters, generic screening level tables[5], and a calculator tool that was used to derive more local, site-specific screening levels[6]. Details are provided in in this TSD.

The Agencies after careful review, decided to transition to EPA RSL methodology for the Maine RAGs[7]. Use of the calculator eliminates the need for Maine to duplicate much of the infrastructure being maintained by EPA, and enhances consistency between Maine's clean-up guidance with those of the Federal Government, and other States. Maine has adopted most of EPA's default factors for risk assessment that are in the RSL calculator. This Technical Support Document (TSD) focuses on the protocols inherent in the RSL modeling that differ from past Maine calculation protocols, where Maine departs from standard RSL default factors, or where supplemental modeling was necessary.

[5] The screening levels use EPA default parameters from various regions of the US and use several target risk levels (i.e., $1x10^{-6}$ incremental lifetime cancer risk and a hazard quotient of 1 or 0.1). They are useful for screening in contaminants for further evaluation in a risk assessment, but are too conservative to be suitable for clean-up criteria at sites.
[6] EPA Regional Screening Levels: https://www.epa.gov/risk/regional-screening-levels-rsls.
[7] EPA Regional Screening Levels: https://www.epa.gov/risk/regional-screening-levels-rsls.

The home page of the EPA Regional Screening Level Generic Tables provides a convenient index with hyperlinks:

- Home Page[8]
- User's Guide
- What's New
- Frequent Questions
- Equations
- RSL Calculator
- Generic Tables
- Contact Us

The User's Guide and Frequent Questions sections provide explanations of the RSL approaches. The Equations section presents all the equations used for the screening level calculations. Please review the EPA Guidance for details of the default screening level derivation approaches. Maine specific deviations are detailed in the sections below.

2.3 Terminology Differences between RSLs and Maine RAGs

This section discusses several RSL terms that have a different common term in Maine.

2.3.1 Chemical and Contaminant

In the RSL hazardous substances are referred to as "chemicals", while DEP uses the term "contaminant" in the RAGs.

2.3.2 Residential Tapwater and Groundwater Scenario

The groundwater RAGs apply to residents exposed to contaminated groundwater via ingestion, dermal contact, and inhalation. The RSL calculator refers to this pathway as the Tapwater pathway. The Residential receptor is exposed to contaminants in groundwater through ingestion when the groundwater is extracted from the contaminated aquifer by a well and consumed by a resident. Exposure also occurs during showering and bathing, by inhalation and dermal contact. Rather than using the term "groundwater", EPA's RSL team terms this the "Tapwater" route of exposure because in other parts of the country, this exposure can also occur via contamination of water supplies that are then supplied to residences. Such an exposure is improbable in Maine because public water supply standards would usually apply. So, while the RSL Residential calculator refers to this exposure scenario as Tapwater, for the Maine RAGs the Agencies continue to refer to this exposure scenario as the Groundwater scenario.

[8] EPA webpage, "Risk Assessment: Regional Screening Levels (RSLs), (downloaded on August 27, 2018 from: https://www.epa.gov/risk/regional-screening-levels-rsls).

2.3.3 Composite Worker and Commercial Worker

Maine has RAGs for the Commercial Worker. For the 2018 calculations, Maine modeled this scenario using the RSL Composite Worker scenario. The Composite Worker is a full-time employee working mostly outdoors on maintence at a commercial facility. The worker is exposed to surface soils from moderate digging and landscaping. The composite worker is expected to have an elevated soil ingestion rate (100 milligrams per day) compared to an indoor worker, and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and fugitive dust. The RSL Composite Worker scenario assumes year-round exposure (250 days/year), but is otherwise identical to the Outdoor Worker RSL scenario.

2.3.4 Recreator and Park User

The RSL uses the term Recreator while Maine continues to use its traditional term for this receptor, which is Park User. The 2018 Park User soil RAG was derived with the RSL Recreator calculator, using Maine specific inputs for incidental ingestion of soil, dermal contact with contaminants in soil, and inhalation of volatiles and fugitive dust. The RAGs will continue to use the term Park User. The 2018 RAGs also include a new sediment exposure pathway that was derived using the Recreator calculator. The term Recreator is retained for the sediment exposure pathway, to be consistent with the RSL and because the recreation will just as often occur at a lake front seasonal residence (aka camp, cottage, or cabin) in addition to a Park setting.

2.3.5 Ambient Air and Indoor Air

The RSL refers to all air as ambient air. Maine has indoor air RAGs for the Residential and Commercial Worker scenarios that applies to air on the interior of a building. This is important because EPA risk assessment protocols call for an exposure period of 26 years to indoor air, but 70 years for outdoor air. In addition to Indoor Air Guidelines, Maine will continue to calculate and maintain Maine Ambient Air Guidelines (AAGs), which apply to outdoor exposure that assumes a lifetime (70 year) exposure. In summary, while the RSL uses the term “ambient air screening levels”, these levels are derived from the indoor air assumption of an exposure duration of 26 years, and this scenario will continue to be called Indoor Air in the Maine RAGs.

2.4 RSLs for Site-Specific Risk Assessments

The RSL calculators may also be used to conduct site-specific risk assessments for Maine sites. If risks are estimated using the RSL calculators, deviations from the Maine-specific inputs described in this document should be discussed with the Agencies. See attachment C to the RAGs for further details.

3 General Inputs into the RSL Calculators to Generate RAGs

The RSL calculators were used to generate Maine-specific RAGs based on Maine's target risk levels (HI=1, ILCR=10^{-5}) and Maine-specific exposure parameters. Use of the calculators is a two-step process:

In Step 1, the first user input screen of the calculator requires selection of: target risk values, the specific exposure scenario and media being modeled, the chemicals for which RAGs are calculated, and the option to run the calculator in "Site-Specific" with "User-Provided" inputs. To meet the risk target used in Maine, the RSL calculator was run using a HQ of 1 and a target cancer risk level of $1x10^{-5}$.

Step 2 involves modifying the default exposure parameters to Maine-specific values. As detailed below, the 2018 Maine RAGs were mostly derived using the EPA recommended exposure assumptions for Portland, Maine. The remaining Maine specific inputs are climate and activity patterns adjustments that were made due to significant differences from the national average.

3.1 Exposure Inputs

The exposure factors input into the RSL calculator to generate the 2018 RAGs are presented in TSD Table 11 - Default Exposure Assumptions for Maine Remedial Action Guidelines and Site-Specific Risk Assessments . Note that the 2016 RAGs did not include all the frequency and duration of activities from the EPA 2011 Exposure Factors Handbook update that are now included in the 2018 RAGs.

3.2 Regional Specific Climate

Weather factors are an input into the RSL volatilization models. The weather inputs for Portland Maine were selected for several reasons: Portland is the only Maine default city in the RSL model and Portland is representative of climatic conditions in a good portion of the State on a population-weighted basis. A sensitivity analysis indicates that variations in climate inputs within the State do not make a large difference in the final RAG values.

3.2.1 Maine Climate & Soil Exposure Frequencies

Maine has historically departed from EPA default assumptions for the number of days per year that residents and commercial workers are exposed to soil, because a portion of the year in Maine the ground is frozen or snow covered, thus preventing incidental exposure. However, with the 2018 RAGs, the Agencies sought more robust data to establish the number of exposure days. The Agencies derived the number of days that soil is frozen or snow-covered from 2001-2017 climatic data at five representative sites in Maine: (Portland, Bangor, Farmington, Caribou, and Gray). See

TSD Table 1 - Days per Year of Bare, Unfrozen Ground, Precipitation Greater Than or Equal to 0.01 Inches.

The Climate Change Institute (CCI) provided snow depth but not soil temperature. The 2-meter air temperatures (T2) was used as a surrogate for soil temperature. Snow depth and T2 air temperatures were downloaded from the NOAA Applied Climate Information System website (http://scacis.rcc-acis.org/), which compiles various daily climate data sources and includes primarily data from the Global Historical Climatology Network (GHCN; Menne et al., 2012[9]). The CCI calculated daily average temperature by averaging hourly temperature measurements. The number of days per year with bare, unfrozen ground were calculated by subtracting the number of days per year with both bare (snow depth = 0) and frozen ground (average air temperature < 32 F) from the total number of days per year with bare ground. Years with any missing data were dropped from the analysis.

Portland was selected as the RME station for the climatological averages, as it has the most bare, unfrozen ground days of the areas analyzed. The ground is neither frozen or snow covered in the Portland area for an average of 256 days per year. This is an increase from the previous professional estimate of 150 days per year for Residential soil exposure frequency that was used in the 2016 RAGs. The Commercial Worker exposure frequency was based on the 256 days per year adjusted by 5-work-days / 7-day-weeks to account for the work week for a total of 183 days per year.

3.2.2 Maine Rainfall - Construction Worker Soil Dispersion

The number of days with total precipitation amounts greater than or equal to 0.01 inches is a necessary RSL model input to calculate the Construction Worker soil exposure RAG. This factor was calculated from the days with total precipitation of at least 0.01 inches using the GHCN dataset for the five representative sites in Maine.

[9] Menne, M. J., Durre, I., Vose, R. S., Gleason, B. E., & Houston, T. G. (2012). An overview of the global historical climatology network-daily database. *Journal of Atmospheric and Oceanic Technology*, 29(7), 897-910.

TSD Table 1 - Days per Year of Bare, Unfrozen Ground, Precipitation Greater Than or Equal to 0.01 Inches

	Days Bare Unfrozen Ground		Days with Precipitation ≥ 0.01"	
SITE	**Mean**	**Range**	**Mean**	**Range**
Portland	256	231-292	130.8	116-142
Bangor	251	229-278	137.1	115-149
Farmington	215	200-234	139.5	117-156
Caribou	215	197-244	162.5	147-174
Gray	237	216-268	141.7	122-161

The City of Portland was selected for the RAGs with 131 days per year as the number of days with ≥0.01" precipitation.

3.3 RAG Contaminant List

3.3.1 Soil

The list of chemicals for the 2018 RAGs was updated to include all chemicals that have been found at contaminated sites in soil that have available toxicity values. Soil sample results from the Maine DEP Environmental and Geographic Analysis Database (EGAD) were reviewed to determine which contaminants had been detected in at least two samples from the dataset of all contamination sites in the database. The comparison identified 64 contaminants in soil for which a new RAG was necessary. Of the 64, 15 do not have toxicity information so a new RAG could not be developed. New RAGs were developed for the remaining 49 soil contaminants. In addition, site specific RAGs have been derived for 3 contaminants that are not in the EGAD database (Propylene Glycol Monomethyl Ether, 2-Methylbenzene sulfonamide and 4-Methylbenzene sulfonamide). Contaminants with new RAGs are presented in TSD Table 2.

TSD Table 2 - Contaminants That Have Not Previously Had a RAG

CAS	Contaminant	CAS	Contaminant
98-86-2	Acetophenone	7439-97-6	Mercury (elemental)
62-53-3	Aniline	79-20-9	Methyl Acetate
100-52-7	Benzaldehyde	22967-92-6	Methyl Mercury
100-51-6	Benzyl Alcohol	88-19-7	Methylbenzene sulfonamide, 2-
7440-42-8	Boron and Borates Only	70-55-3	Methylbenzene sulfonamide, 4-
108-86-1	Bromobenzene	90-12-0	Methylnaphthalene, 1-
74-97-5	Bromochloromethane	14797-55-8	Nitrate
104-51-8	Butylbenzene, n-	100-01-6	Nitroaniline, 4-
135-98-8	Butylbenzene, sec-	55-63-0	Nitroglycerin
91-58-7	Chloronaphthalene, Beta-	86-30-6	Nitrosodiphenylamine, N-
76-06-2	Chloropicrin	78-11-5	Pentaerythritol tetranitrate (PETN)
95-49-8	Chlorotoluene, o-	375-73-5	Perfluorobutane sulfonic acid
106-43-4	Chlorotoluene, p-	88-99-3	Phthalic Acid
59-50-7	Cresol, p-chloro-m-	103-65-1	Propyl benzene
98-82-8	Cumene	107-98-2	Propylene Glycol Monomethyl Ether
110-82-7	Cyclohexane	7440-24-6	Strontium, Stable
75-99-0	Dalapon	95-94-3	Tetrachlorobenzene, 1,2,4,5-
74-95-3	Dibromomethane	58-90-2	Tetrachlorophenol, 2,3,4,6-
110-57-6	Dichloro-2-butene, trans-1,4-	109-99-9	Tetrahydrofuran
108-20-3	Diisopropyl Ether	479-45-8	Trinitrophenylmethylnitramine
60-29-7	Ethyl Ether	7440-28-0	Thallium (Soluble Salts)
50-00-0	Formaldehyde	7440-31-5	Tin
591-78-6	Hexanone, 2-	96-18-4	Trichloropropane, 1,2,3-
78-59-1	Isophorone	526-73-8	Trimethylbenzene, 1,2,3-
94-74-6	2-Methyl-4-chlorophenoxyacetic acid (MCPA)	95-63-6	Trimethylbenzene, 1,2,4-
93-65-2	Mecoprop (MCPP)	108-67-8	Trimethylbenzene, 1,3,5-

3.3.2 Groundwater

The contaminant list for groundwater was determined by comparing EGAD database for groundwater to the MEGs list. Ultimately, the list chosen was based on the original RAGs list, amended with the new chemicals identified by the EGAD soil analysis. EGAD water was not examined for chemicals without RAGs.

3.3.3 Addressing Contaminants not in RSL

Some contaminants detected at Maine sites are not included in the RSL database. However, RAG values can still be derived using the calculator,

by selecting "Test Chemical" in the pick list and then entering the physical-chemical properties of those contaminants. In the 2018 RAGs this was done for 17 compounds, whose input parameters are presented in TSD Table 12.

3.4 Toxicity Values

3.4.1 Chronic Toxicity Hierarchy

The RSL calculator uses EPA's preferential hierarchy in selection of toxicity values. Historically Maine has departed from this hierarchy, including for the development of the 2016 RAGs. EPA's toxicity hierarchy considers EPA's Integrated Risk Information System (IRIS) as the primary tier. However, historically the toxicity factors in IRIS became outdated so CDC recommended using updated values from another authoritative government sources (e.g., ATSDR, Cal EPA) or that was derived by CDC toxicologists. EPA, however, put additional effort into updating IRIS, and the Agencies now consider IRIS adequate for developing the RAGs. Before deciding to adopt the RSL approach, DEP compared the EPA RSL toxicity values to 2016 RAGs toxicity values and determined the impact of relying on the EPA RSL toxicity values would have on the RAGs. The report: Feasibility of Utilizing the EPA Regional Screening Level Calculators to Support Maine Remedial Action Guidelines, April 2016, is available from CDC upon request. In the final analysis, the Agencies decided to use the RSL hierarchy since the resource efficiencies of using the RSL defaults outweighs the potential loss of accuracy.

3.4.2 Subchronic Toxicity Values

The Construction Worker exposure is a subchronic duration, and thus uses subchronic toxicity values where available. The 'where available' includes some values from the Provisional Peer-Reviewed Toxicity Value (PPRTV) database, which are not as thoroughly vetted as other sources such as IRIS. Some of these toxicity values are even lower than the chronic toxicity values used in the RSL residential calculations. While it does not make sense that a chemical could be more toxic in a subchronic exposure (shorter time-period) than over the long-term at the same concentration, that is the result of using different toxicity data sources. The CDC decided to accept the EPA subchronic toxicity values as presented in the RSL with the expectation that the values will be updated by EPA RSL in the future.

3.4.3 Contaminants Lacking RSL Toxicity Values

Some contaminants in the RSL database do not have assigned toxicity values. For these contaminants, the CDC selected toxicity values and entered them manually. For some compounds toxicity values were not

available, but CDC applied the toxicity factor from a surrogate compound that it believes would have a similar toxic impact. For a summary of these decisions, see TSD Table 3 below.

TSD Table 3 - Source of Toxicity Values for Contaminants Lacking Toxicity Criteria in RSL

Contaminant Lacking RSL Toxicity Criteria	Toxicity Source or Surrogate Compound
Carbazole	Cancer Slope Factor - HEAST 1997
Polychlorinated Biphenyls (noncancer)	Aroclor 1254
Acenaphthylene	Acenaphthene
Phenanthrene	Pyrene
Benzo(g,h,i)perylene	Pyrene
Dichlorobenzene, 1,3-	Dichlorobenzene, 1,2-

3.4.4 RfDs for Manganese and Cadmium

The IRIS database has two oral reference doses for both Manganese and Cadmium. Likewise, the RSL has two entries. After reviewing the basis, CDC determined that:

- **Manganese**: When making the chemical selection for manganese within the RSL calculator, the 'Manganese (Non-diet)' option should be selected for all soil, air and water/tapwater exposure calculations.
- **Cadmium:** When making the chemical selection for cadmium, within the RSL calculator the 'Cadmium (Diet)' option should be selected for all soil and air exposure calculations; the 'Cadmium (Water)' option should be selected for all water/tapwater exposure calculations.

4 Groundwater Calculations

4.1 Residential Exposure to Groundwater

The Residential Groundwater RAGs assume that the groundwater is going to be consumed at a residence that drills a well into the contaminated aquifer. To derive the 2018 residential groundwater RAGs, the Agencies used the RSL calculator for Tapwater and EPA default exposure parameters. A groundwater ceiling value of 100,000 µg/L was applied for contaminants with very high risk based screening levels.

The 2018 approach was a departure from the approach used in 2016. In 2016 RAGs were based on CDC's Maximum Exposure Guidelines (MEGs) [10]. The CDC calculates MEGs based on ingestion risk for contaminated groundwater, and then applies a Relative Source Contribution (RSC) to account for all other factors, like

[10]CDC maintains MEGs to advise private well owners of risk and determine the need to provide public health assistance for private well-owners to test their wells. CDC is in the initial stages of updating its MEGs, including an evaluation of whether to keep the RSC or use the RSL calculator approach.

ingestion from other sources (e.g. soil, air) and other routes of water exposure (e.g. inhalation and dermal contact during showering or bathing). For the 2018 RAGs, the RSL calculator calculates ingestion risk, but rather than the generic RSC approach, also calculates chemical specific risk from dermal contact and inhalation during showering and bathing. As discussed in this TSD, RAGs were also developed to address exposure to contaminants from other media (e.g. soil, sediment, fish tissue). While the Agencies determined that the RSL approach is a more accurate estimate of risk from exposure to groundwater, it results in significant changes between the 2016 and 2018 residential groundwater RAGs.

4.1.1 Perfluoroalkyl Substances (PFAS)

In 2016, EPA Office of Water established a lifetime health advisory[11] of 0.070 µg/L (parts per billion) for PFOA and PFOS individually or the combined concentration in drinking water. The groundwater RAGs for PFOA and PFOS are risk-based values based on the current EPA Office of Water toxicity values. However, toxicity values for PFOA and PFOS are currently under review by the U.S. Agency for Toxic Substances and Disease Registry and lower values have been proposed. Lower toxicity values may result in lower drinking water guidelines.

The EPA drinking water health advisory of 0.070 µg/L is based on the same toxicity values used to drive the RAGs, but applies an RSC approach to allow for possible background exposure from other sources, including diet. Although Maine CDC toxicologists do not believe a default 20% RSC is needed based on currently available exposure data, use of the EPA health advisory does provide an added margin of safety for a possible lowering of toxicity values. The EPA drinking water health advisory also happens to be the threshold that would be applied to public water supplies.

At this time, DEP recommends that the RAGs be applied when determining human health risk and clean-up goals at remediation sites. However, the EPA health advisory level of 0.070 µg/L should be applied at sites where groundwater is currently being used, or may be used in the future, for human consumption (i.e. Residential Groundwater Scenario). Deviation from this recommendation may be considered on a case-by-case basis.

[11] "Health Advisories (HAs) provide information on contaminants that can cause human health effects and are known or anticipated to occur in drinking water. EPA HAs are non-enforceable and provide technical guidance to states agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with [public] drinking water contamination. The tables contain HA values for certain contaminants based on non-cancer health effects for different durations of exposure (for example, one-day, ten-day, and lifetime)." [From; EPA Drinking Water Contaminant Human Health Effects Information website at: https://www.epa.gov/dwstandardsregulations/drinking-water-contaminant-human-health-effects-information, downloaded October 17, 2018.]

4.2 Construction Worker Exposure to Groundwater

Maine is one of the few States that develops clean-up guidance for Construction Worker exposure to contaminated groundwater. These RAGs are based on risks posed to workers performing construction activities or underground utility maintenance, typically in a trench, that may be exposed to contaminated groundwater. They were derived using the EPA RSL calculator for Residential Tapwater exposure but in the site-specific mode. This calculator includes dermal, ingestion and inhalation exposure pathways from water. TSD Table 4 shows the changes made to the various parameters within the RSL Residential Tap Water calculator to adjust for a Construction Worker exposure scenario. This scenario models an average adult Construction Worker that spends half of an eight-hour work day in an excavation trench, in contact with contaminated groundwater, one day per week over a one-year period. The Construction Worker groundwater ingestion rate of 0.015 liter/day is based on U.S. EPA 2011, Table 3-93 Mean ingestion while wading/splashing (3.7 milliliter per hour, 4 hours per day).

The equations used in the RSL Residential Tapwater calculator are appropriate to estimate ingestion and dermal risks for the Construction Worker. However, the Residential model is not appropriate for inhalation of vapors in a trench. Therefore, the Residential Tapwater RSL volatilization factor (VF) was set to 1 and volatilization in an excavation trench was calculated externally using methodology developed by the Virginia Department of Environmental Quality[12]. The modelled VFs were applied to the Residential Tapwater calculator's inhalation pathway output. After the volatilization factor was applied, the calculated screening values for the ingestion, dermal and inhalation exposure pathways were combined and the lower of the cancer and noncancer RAG was selected. A groundwater ceiling value of 100,000 µg/L was applied for contaminants with very high risk based screening levels, consistent with RSL guidance.

[12] Virginia Unified Risk Assessment Model-VURAM User's Guide, Appendix 3, 2016

TSD Table 4 RSL Input for Construction Worker Tap Water RAG

Construction Worker Exposure to Water

Age Segment (yr)	BW (kg)	ED (yr)	EF (day/yr)	ET (hr/event) Dermal	ET (hr/day) Inhalation	EV (events/day)	IRW (L/day)	SA (cm^2)
0-2	0	0	0	0	0	0	0	0
2-6	0	0	0	0	0	0	0	0
6-16	0	0	0	0	0	0	0	0
16-26	80	1	52	4	4	1	0.015	3527
Child (0-6)	0	0	0	0	0	0	0	0
Adult (6-26)	80	1	52	4	4	1	0.015	3527

Abbreviations:

BW	Body Weight
ED	Exposure Duration
EF	Exposure Frequency
ET	Exposure Time
EV	Event Frequency
IRW	Ingetsion Rate Water
SA	Surface Area

4.2.1 Construction Worker Groundwater Changes from 2016

As described above, the 2016 Construction Worker Groundwater RAGs were derived by a DEP contractor, Wilcox & Barton, in 2012[13], while the RSL calculator was used in 2018. The exposure model with the 2016 RAGs differs slightly in the assumed exposure times. The 2016 RAGs used 8 hours for the inhalation route and 0.33 hours for dermal contact route. The 2018 RAGs use 4 hours for inhalation and 4 hours for dermal contact. In addition, the Construction Worker groundwater ingestion rate was changed from 50 milliliters (ml) per event to 15 ml per event.

5 Indoor Air

Use caution with Indoor Air and Ambient Air terminology, as discussed in Section 2.3.5. The 2018 RAGs for Residential Indoor Air were calculated with the RSL calculator, using all of the default RSL inputs (24 hours per day, 350 days per year), including EPA's current default of 26 years exposure versus the 30 years used in 2016 RAGs. To generate the 2018 RAGs for the Commercial Worker exposure to air, the same calculator was used, but exposure frequency was adjusted to an 8 hour per day exposure for 250 working days per year.

[13]Wilcox & Barton Inc. Environmental and Engineering Services, Construction Worker Groundwater Remedial Action Guidelines, prepared for the Maine Department of Environmental Protection (Maine DEP, 17 SHS, Augusta, ME 04333-0017) June 21, 2012.

6 Fish Tissue

The 2018 RAGs for Fish Consumption were calculated using the RSL calculator and an assumed fish tissue ingestion rate of a single 8-ounce meal per week, which equates to 32.4 g per day. This exposure corresponds to a recreational angler in Maine, not a subsistence angler. Please be sure to consult with DEP to determine appropriate fish sampling and analysis as these will have a large impact on accurately calculating Exposure Point Concentrations. All other inputs to the RSL Fish Tissue calculator were EPA defaults. The Agencies were unable to develop RAGs for subsistence Anglers, because consumption rates vary too much between sites. However, the RSL calculator could be use on a site-specific basis to estimate risk for subsistence anglers, after consulting with CDC on appropriate consumption rates for your site.

7 Soil & Sediment Calculations

7.1 General Soil RAGs Modeling

Be sure to review section 2.3 for the terminology differences between the Maine RAGs and RSL calculator. The Agencies ran the RSL calculators to derive the 2018 RAGs for the Resident, Park User, Commercial Worker, Construction Worker and Recreator Sediment exposures using the inputs provided in TSD Table 11. As discussed in section 3.2 above, Maine specific climate inputs were used to generate soil RAGs. The RSL output for each exposure scenario was compiled into the final RAG tables. The RSL calculator has two options to adjust the output for soil: Substitution of the soil-saturation concentration for soil inhalation RSL, and substitution of a theoretical ceiling limit for the total soil RSL. Section 7.3 explains how the Agencies handled this option for hazardous substances and the petroleum hydrocarbon fractions.

7.1.1 Exposure Time to Residential Soil

For the 2018 RAGs, the Agencies use the default EPA exposure time of 24-hours for potential exposure to volatiles from soil. This is a departure from the 2016 RAGs that assumed Residential exposure to volatiles from soil only occurred 2 hours per outside-day. The RSL calculator uses the 24-hour exposure as a protective assumption to compensate for volatiles from soil that may migrate to the air inside a residence.

7.1.2 Soil Ceiling Limit

Maine remediation programs have a long-standing policy of removing neat product and saturated soil before applying risk-based clean-up levels to a site. The RSL Guidance uses a default ceiling limit of 100,000 mg/kg for a contaminant, while historically DEP has selected 10,000 mg/kg as its cutoff point. As stated in the RSL Guidance, the ceiling limit of 100,000 mg/kg is equivalent to a chemical representing 10% by weight of the soil

sample. At this contaminant concentration (and higher), the assumptions for soil contact may be violated (for example, soil adherence and wind-borne dispersion assumptions) due to the presence of the foreign substance itself. Maine has selected to apply the theoretical ceiling limit of the RSL for consistency with EPA. Note that the RSL calculator does not currently present the option to apply the ceiling limit to the Leaching to Groundwater scenario, so any chemicals with calculated Leaching values over 100,000 mg/kg were manually overridden.

7.2 Volatilization Modeling: Infinite Vs. Finite Source

EPA Soil Screening Levels (SSLs) generated with the RSL calculators are protective of the potential risk from the combined exposure pathways of ingestion (SL_{ing}), inhalation (SL_{inh}), and dermal absorption (SL_{der}). The SL_{inh} includes exposure from chemical constituents both adhered to inhaled particulates, and volatilized into the air. For chemicals that are volatile, the RSL calculates a Volatilization Factor (VF) to model vapor released from soil. The RSLs can calculate chemical-specific VFs in two ways: on an assumption of an infinite source of contamination and chemical-specific properties; or on the assumption of a finite source fully volatilizing over a defined period with generic chemical properties. Both approaches have limitations.

The "Unlimited Source" approach has the potential to derive SSLs that defy conservation of mass, particularly in the case of small spills and/or highly volatile chemicals. These compounds would be depleted over time in a real-world scenario, but the model assumes constant replenishment. On the positive side, chemical specific parameters are used to model environmental fate.

The RSL's "Mass-Limit" model of volatilization, on the other hand, limits the total mass that is volatilized. However, the Mass-Limit model does not utilize any chemical specific information[14], instead simply volatilizing the whole mass over the exposure time period. This tends to overestimate volatilization of heavy molecules with low vapor pressures, such as dioxins, that might not fully volatilize on their own over the given time period (26 years for the Residential scenario). Further, the model requires site-specific source depth and area information to calculate the initial contaminant mass at the site, so EPA's RSL recommendation is to only use this model in site-specific circumstances.

[14] The Mass-Limit VF method assumes the entire contaminant mass is released over a defined exposure period regardless of chemical-specific volatilization parameters. The only parameters needed for the Mass-Limit VF equation are a dispersion factor, which is based on climate-specific conditions and contamination area in acres, source depth, soil bulk density and exposure time.

EPA guidance for soil screening levels[15] is to use the Unlimited Source method as the default VF method in SL_{inh} calculations absent site-specific information. This is because the Mass-Limit VF method requires site-specific source depth and area inputs to calculate mass. If, however, site-specific source depth and area are known or can be estimated reliably, EPA's SSL guidance specifies that soil screening levels using the Unlimited Source VF and the Mass-Limit VF should be calculated separately and the higher of the two SSLs selected as the final SSL for each parameter within each exposure pathway (Residential, Construction Worker, Commercial Worker, Park User and Recreational Sediment). While this task is not technically demanding, it does increase the workload when generating and updating RAGs for a broad set of chemicals using the RSL calculator.

7.2.1 Changes from the 2016 RAGs due to VF

The RSL approach to modelling a soil volatilization factor (VF) differs from the 2016 RAGs approach. The RSLs consider volatilization for any chemical with a vapor pressure >1 mmHg or a Henry's Law constant >0.00001 atm*m^3/mole. The 2016 RAGs looked at a subset of those chemicals, with additional constraints of toxicity and whether labs test for them. The 2016 RAGs used an alternative volatilization model that assumed some source limits and allowed for some environmental degradation. The RSL VF model is more simplistic and does not address these two factors, but covers a wider range of contaminants. Use of the RSL in 2018, therefore, resulted in a greater influence by volatile inhalation pathway as compared to the 2016 RAGs. Please see the following sections and/or contact DEP for further information on the VF modeling decisions.

7.2.2 Petroleum – Used Mass-Limited Model

The nature and relative degradability of petroleum contamination makes the RSL's infinite source volatilization model overly conservative for calculation of the petroleum RAGs. To address this over estimation, DEP developed a reasonable worst-case source mass to run the RSL mass-limited volatilization model. This information was input into the RSL

[15] EPA 1996 Soil Screening Guidance: Technical Background Document (EPA Background Document): "The inhalation and migration to ground water pathway equations assume an infinite source. As pointed out by several commenters to the December 1994 draft Soil Screening Guidance (EPA, 1994h), SSLs developed using these models may violate mass-balance for certain contaminants and site conditions (e.g., small sources). To address this concern, EPA has incorporated simple mass-limit models for these pathways assuming that the entire volume of contamination either volatilizes or leaches over the duration of exposure and that the level of contaminant at the receptor does not exceed the health-based limit (Section 2.6). Because they require a site-specific estimate of source depth, these models cannot be used to calculate generic SSLs." EPA RSL User's Guide (EPA RSL User's Guide 2017): "Use of infinite source models to estimate volatilization can violate mass balance considerations, especially for small sources. To address this concern, the Soil Screening Guidance includes a model for calculating a mass-limit SSL that provides a lower limit to the SSL when the area and depth (i.e., volume) of the source are known or can be estimated reliably."

calculator to develop the petroleum Soil RAGs. Previous research by DEP's petroleum program[16] indicates that the reasonable worst-case scenario is that of a release from a large, underground petroleum tank. The total mass is set at 15,000 gallons, because 93% of registered tanks are 15,000 gallons or less. The depth of the contamination mass is limited by the release point, (the bottom of the tank) and the top of the water table, because petroleum is a light non-aqueous phase liquid (NAPL) that floats on the water table. The top of the water table is based on the average depth to groundwater in Maine.

7.2.3 Hazardous Substances - Used Infinite Source Model

Following EPA guidance, the Unlimited Source VF method was used as the default method to generate the 2018 RAGs for hazardous substances because the DEP could not establish the generic default values for thickness of the source area and area of the release. Unlike petroleum, for hazardous substance there is too much variability between individual sites to develop a reasonable worst-case generic scenario.

If site-specific information is available and the project lead wishes to generate site-specific risk-based cleanup goals for a select set of contaminants at a site, the option to use the Mass-Limit VF approach within the RSL calculator is available.

7.3 Soil Saturation with VOCs: Replace SL_{inh} with C_{sat}

For those chemical contaminants that are volatile and liquid at ambient soil temperatures the RSL calculator derives a soil saturation concentration (Csat). The Csat is the contaminant concentration in bulk soil at which free-phase product is predicted to be present. The presence of free-phase product violates a key principal of the volatilization factor (VF) model (i.e., that Henry's Law applies) and makes use of the RSL VF model unreliable at levels above Csat. To ensure that the application of the VF model is valid, per RSL guidance,[17] the modeler evaluates unreliability. In general, the Agencies compared the inhalation-based soil screening level to the Csat and selected the option to substitute the Csat for the inhalation-based soil screening level. In other words, the inhalation soil screening level is set to the Csat if that is lower than the risk-based concentration. This results in a lower allowable soil concentration and therefore a lower RAG. Evoking the RSL Csat substitution in the RSL calculator replaced the SL_{inh} value with the Csat for 22 volatile chemicals for the residential scenario as shown in TSD Table 4, resulting in SLs that are between 1% and 93% of the default soil inhalation model.

[16] Maine DEP, Remediation Guidelines for Petroleum Contaminated Sites in Maine, Appendix D, Development of Leaching Based Soil Guidelines (Maine DEP, 17 SHS, Augusta, Maine 04333-0017. Downloaded from http://www.maine.gov/dep/spills/petroleum/documents/Petroleum_Remediation_Guidelines.pdf on August 10, downloaded August 10, 2018), amended May 23, 2014.

[17] EPA Webpage, " Risk Assessment: Regional Screening Levels (RSLs) - User's Guide, May 2018" (downloaded on August 28, 2018 from https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-november-2017.

If a project lead wants a more accurate site-specific risk-based number, it should measure pore vapor concentrations directly. Alternatively, the project lead can use an appropriate four-phase model with site-specific inputs to more accurately estimate inhalation risk.

7.3.1 No C_{sat} Substitution for Petroleum RAGs

At petroleum remediation sites in Maine, free product/light non-aqueous phase liquid (LNAPL) and oil saturated soils are required to be removed upon discovery, per Maine statute. Therefore, the Csat substitution is not necessary at petroleum contaminated sites for modeling long term exposure risk due to volatilization. The use of the Csat to generate screening levels for petroleum lead to exaggerated inhalation risks (see Section 7.5). Therefore, the Csat substitution option was not utilized for calculating the petroleum RAGs.

7.4 Impacts: Volatilization Model and Soil Saturation

The effect of not considering mass-limited VFs and substituting on the RAGs is illustrated in TSD Table 4 - Effect of C_{sat} Substitution for Inhalation on Residential Soil Screening Levels. In that example, the RSL calculator was used to generate soil RAGs using the default Unlimited Source VF method with and without the Csat substitution (see Section 7.3, above), and the Mass-Limit VF method was used with a source depth 3 meters. As shown in TSD Table 4, for the C5-C8 Aliphatic hydrocarbon fraction Residential exposure, the infinite source VF with Csat substitution results in the lowest screening level 153 mg/kg, without the Csat applied the level is 246 mg/kg. But if a 3-meter source depth is assumed with the mass limited VF model, the screening level is 1660 mg/kg. Particularly for petroleum hydrocarbon fraction, application of the Csat results in much lower screening levels. Four out of the 6 petroleum hydrocarbon fractions RAGs are based on a mass-limited volatilization factor.

TSD Table 4 - Effect of C_{sat} Substitution for Inhalation on Residential Soil Screening Levels

					2018 Residential Soil RAG with Csat (mg/kg)		SL without Csat (mg/kg)	
Chemical	**2018 Residential Soil RAG with Csat (mg/kg)[18]**	**SL without Csat**	**% Csat SL / default model SL**	**Csat**	**Ingestion SL**	**Inhalation SL**	**Ingestion SL**	**Inhalation SL**
Cyclohexane	117	9720	1.2%	117	-	117	-	9720
Chloro-1,1-difluoroethane, 1-	1150	79900	1.4%	1150	-	1150	-	79900
Propyl benzene	258	5390	4.8%	264	10700	264	10700	10900
Trichloroethane, 1,1,1-	639	12100	5.3%	640	214000	640	214000	12800
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	3360	49300	6.8%	3360	-	3360	-	49300
Cumene	262	2840	9.2%	268	10700	268	10700	3860
Styrene	834	8650	9.6%	867	21400	867	21400	14500
Ethyl Chloride	2120	20100	11%	2120	-	2120	-	20100
Toluene	746	6810	11%	818	8550	818	8550	33300
Dichlorobenzene, 1,2-	362	2640	14%	376	9620	376	9620	3630
Mercury (elemental)	3	16	19%	3	-	3	-	16
Xylenes	256	856	30%	260	21400	260	21400	892
Methyl Methacrylate	2320	6580	35%	2360	150000	2360	150000	6890
Trimethylbenzene, 1,3,5-	156	391	40%	182	1070	182	1070	616
Trimethylbenzene, 1,2,4-	181	437	41%	219	1070	219	1070	738
Trimethylbenzene, 1,2,3-	230	483	48%	293	1070	293	1070	880

[18] Risk-based soil concentrations, before rounding to 2 significant figures.

					2018 Residential Soil RAG with Csat (mg/kg)		SL without Csat (mg/kg)	
Chemical	**2018 Residential Soil RAG with Csat (mg/kg)[18]**	**SL without Csat**	**% Csat SL / default model SL**	**Csat**	**Ingestion SL**	**Inhalation SL**	**Ingestion SL**	**Inhalation SL**
Methyl Ethyl Ketone (2-Butanone)	19700	38300	51%	28400	64200	28400	64200	94800
Carbon Disulfide	691	1130	61%	738	10700	738	10700	1270
Acetone	52300	83900	62%	114000	96200	114000	96200	656000
Diisopropyl Ether	2260	3330	68%	2260	-	2260	-	3330
Propylene Glycol Monomethyl Ether	43900	57200	77%	106000	74900	106000	74900	243000
Bromobenzene	379	408	93%	679	855	679	855	780

TSD Table 5 - Soil RAGs for Petroleum Hydrocarbon Fractions, Selection of Volatilization Model

	Infinite source VF, Csat substitution	Infinite Source VF	Mass Limited VF 3M source depth	Maximum	Soil RAG[19] (mg/kg)
Resident					
C5-C8 Aliphatics	153	246	1660	1660	1700
C9-C12 Aliphatics	21.8	1120	2520	2520	2500
C9-C10 Aromatics	174	385	663	663	660
C11-C22 Aromatics	2550	2550	2550	2550	2600
C19-C36 Aliphatics	100000	100000	100000	100000	100000
C9-C18 Aliphatics	13.7	2030	2520	2520	2500
Commercial Worker					
C5-C8 Aliphatics	161	1090	11000	11000	11000
C9-C12 Aliphatics	21.8	5210	13600	13600	14000
C9-C10 Aromatics	188	1830	3480	3480	3500
C11-C22 Aromatics	32800	32800	32800	32800	33000
C19-C36 Aliphatics	100000	100000	100000	100000	100000
C9-C18 Aliphatics	13.7	10400	13600	13600	14000
Park User					
C5-C8 Aliphatics	158	3510	7540	7540	7500
C9-C12 Aliphatics	21.8	12200	16700	16700	17000
C9-C10 Aromatics	184	3850	4720	4720	4700
C11-C22 Aromatics	7250	7250	7250	7250	7300
C19-C36 Aliphatics	100000	413000	413000	413000	410000
C9-C18 Aliphatics	13.7	15600	16700	16700	17000
Recreator Sediment					
C5-C8 Aliphatics	9520	9520	9520	9520	9520
C9-C12 Aliphatics	23800	23800	23800	23800	23800
C9-C10 Aromatics	6950	6950	6950	6950	6950
C11-C22 Aromatics	8370	8370	8370	8370	8370
C19-C36 Aliphatics	100000	100000	100000	100000	100000
C9-C18 Aliphatics	23800	23800	23800	23800	23800

[19] Risk-based value not rounded to 2 significant figures.

	Infinite source VF, Csat substitution	Infinite Source VF	Mass Limited VF 3M source depth	Maximum	Soil RAG[19] (mg/kg)
Construction Worker					
C5-C8 Aliphatics	157	157	432	432	430
C9-C12 Aliphatics	21.8	2300	1300	2300	2300
C9-C10 Aromatics	189	2640	1070	2640	2600
C11-C22 Aromatics	73600	73600	73600	73600	74000
C19-C36 Aliphatics	100000	100000	100000	100000	100000
C9-C18 Aliphatics	13.7	4820	1300	4820	4800

7.5 Other Inputs for Petroleum Hydrocarbons Fractions

Petroleum consists of a complex mixture of hydrocarbons. After grouping the petroleum hydrocarbons into hydrocarbon fractions, risk assessors apply toxicity factors to each fraction, and thereby calculate the risk of the whole mixture. The Agencies have employed this approach in Maine since 2010. However, the default RSL calculator for petroleum breaks the petroleum fractions down into different groupings than Maine has historically used, and except for the C5-C8 and C9-C18 aliphatics, the RSL ranges do not correspond to the results of any established laboratory method, so it is not possible to develop an exposure point concentration to compare to the RSL. Further, since Maine has traditionally assessed the most toxic components of the ranges separately as additional petroleum "target compounds", use of the RSL TPH classes would be overly conservative.

For these reasons, the soil RAGs for the petroleum hydrocarbon fractions are derived using the "test chemical" mode of the RSL calculator and the traditional hydrocarbon fractions measured by the Extractable Petroleum Hydrocarbon (EPH) and Volatile Petroleum Hydrocarbon (VPH) test methods (see TSD Table 6). This allows the RAGs to utilize the physical/chemical inputs that correspond to the MADEP hydrocarbon fractions that have historically been used by the Maine DEP to assess petroleum contamination.

TSD Table 6 - EPH/VPH Defined Hydrocarbon Fractions

Hydrocarbon Fraction	Analytical Method
C9-C18 aliphatics	EPH
C19-C36 aliphatics	EPH
C11-C22 aromatics	EPH
C5-C8 aliphatics	VPH
C9-C12 aliphatics	VPH
C9-C10 aromatics	VPH

7.5.1 Deriving RAGs for Petroleum Hydrocarbon Fractions

RAGs for the petroleum hydrocarbon fractions were generated under the "test chemical" mode of the RSL calculator, using DEP CAS numbers. The petroleum hydrocarbon fractions presented within the RSL calculators are grouped into 6 categories: low, medium and high molecular weight aliphatic or aromatic compounds. They represent classes that have similar environmental fate. The six TPH fractions in the RSL were assigned representative compounds for determination of physical/chemical input parameters, and usually the toxicity of the same compound was also used. The Agencies obtained these inputs from the MADEP "Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology" MADEP 2003 and "Characterizing Risks Posed by Petroleum Contaminated Sites" MADEP 2002. These constants are presented in

TSD Table 12.

For example, the properties of the C9-C12 aliphatic class is represented by the properties for the C9 compound n-nonane. The physical chemical properties used by the MADEP for their hydrocarbon fractions are based on the effective carbon number in the classes of petroleum hydrocarbons reported by the EPH and VPH methods, and are a better estimate of the behavior of the mixture than the RSL defaults. Because EPH/VPH methods also report concentrations for specific petroleum target compounds, the reported fractions represent the remainder of the TPH mixture, after the target compound concentrations have been subtracted.

See Sections 7.2.2 and 7.3.1 for other decisions needed to generate the petroleum Soil RAGs. These sections discuss how the petroleum soil RAGs were generated using 3 volatilization models: Infinite source with no Csat substitution, use of Csat substitution for the inhalation pathway and use of mass-limited volatilization with a source depth of 3 meters[20]. The three RSL results were compared and the highest value was selected as the RAG (per EPA's RSL guidance).

[20] Average depth to groundwater in Maine.

7.6 Construction Worker Parameters for Particulate Emission Factor

The RSL Construction Worker scenario considers inhalation of dust kicked up from truck traffic and earthwork, a scenario that was not considered under the 2016 Construction Worker RAGs. The Agencies found this to be a legitimate concern, as most construction sites will have heavy equipment off road. The 2016 RAGs used a simplified wind-driven 'empty site' approach that is more appropriate for long-term commercial, park, and residential exposures but missed the equipment feature of construction sites.

Specifically, the Construction Worker RSL calculator uses a particulate emission factor (PEF) based on mechanical disturbance of the soil with vehicle traffic as opposed to a default weather-driven PEF, as used for the other receptor exposure scenarios. As explained in the RSL Guidance, the equation to calculate the subchronic PEF for the Construction Worker (PEFsc) focuses exclusively on emissions from truck traffic on unpaved roads, typically the major contribution of dust emissions during construction. The PEFsc equation requires estimates of parameters such as the number of days with at least 0.01 inches of rainfall, the mean vehicle weight, and the sum of fleet vehicle distance traveled during construction. Derivation of the days with total precipitation of at least 0.01 inches is discussed in Section 3.2.2 above. The input parameters for the Construction Worker PEF are presented in TSD Table 7.

TSD Table 7 - Construction Worker Soil Exposure Parameters for Particulate Emission Factor

Parameter	Abbreviation	Value	Source
Days worked (days/week)	DWcw	5	RSL Default
Overall duration of construction (weeks/year)	EWcw	50	RSL Default
Number of cars	-	20	RSL Default
Number of trucks	-	10	RSL Default
Tons/car	-	2	RSL Default
Tons/truck	-	20	RSL Default
Days per year with at least 0.01" precipitation	p	131	GHCN dataset for Portland, ME

7.7 Soil Leaching to Groundwater

The RAGs Fish Consumption assumed a fish tissue ingestion rate of a single 8-ounce meal per week, which equates to 32.4 g per day. Please consult with DEP to determine appropriate fish sampling and analysis.

7.7.1 RSL Calculator for Soil to Groundwater

The Agencies calculated the soil leaching to groundwater RAGs differently in 2016 than they did in 2018. For the 2018 RAGs, the RSL

calculator was used. The RSL calculator estimates screening levels in soil (SSLs) that are protective of groundwater by back-calculating the amount of chemical allowed in soil before groundwater will exceed the tap-water RSL, which as described in 4.1 above is the groundwater RAG. This calculation is computed with a soil-water partition equation that uses chemical-specific parameters, such as Henry's Law constants and organic carbon partition coefficients (Koc), and system-specific parameters such as water-filled porosity, air-filled porosity, and bulk soil density.

The partition equation models the migration of chemicals from the soil to the groundwater at the source. A generic dilution attenuation factor (DAF), rather than a contaminant-specific DAF, is used to account for dilution that occurs during migration of the chemical through the groundwater from the source to the receptor. EPA suggests using DAF of 1 (i.e., no dilution) or 20. MEDEP has ascertained that a DAF of 55 is more appropriate based on Maine-specific data and previous modeling results, as detailed in Section 7.7.1.1.

7.7.1.1 Estimation of the DAF

The DAF used in the EPA RSL calculator is defined as the groundwater concentration at the source divided by the groundwater concentration at the receptor. Multiplying this factor by the groundwater criteria accounts for the attenuation of the chemical as it migrates through the groundwater from the source to the receptor. In developing the previous 2016 leaching to groundwater RAGs for 37 common contaminants, MEDEP used a modeling program, SEVIEW which incorporated an unsaturated soil transport model (SESOIL) and a groundwater transport model (AT123D). These models estimated the groundwater concentrations at the source and the groundwater concentrations at the receptor based on a Maine-specific spill scenario, Maine-specific climate data, and Maine-specific hydrogeologic data. These groundwater concentrations were used to calculate chemical specific DAFs for each of the 37 chemicals, which produced a range of DAFs from 38.6 to 1420, with a mean of 119 and a median of 56.1. A histogram of these DAFs shows that there are two outliers, bis (2-ethylhexyl) phthalate and fluoranthene. The removal of the outliers results in a range of 38.6 to 88.1, with a mean of 58.6 and a median of 55.7, so although the mean value changes with the removal of outliers, the median value is very similar. The Agencies chose a DAF of 55 as a protective rounding of the median value of these modeled DAFs.

The transport of chemicals in the groundwater from the source area to the receptor is dependent on certain chemical properties, such as Henry's Law Constant and the Koc, so the use of a single DAF to account for this attenuation for all chemicals is a simplification that will result in the overestimate of the RAG for some chemicals and the underestimate of the RAG for others. Using a DAF of 55 is supported by the fact that it is based on model results from the same models that were used to establish the previous leaching to groundwater RAGs. Further, site specific information from Maine Sites indicates that the 2016 leaching the groundwater RAGs were protective of groundwater resources, so calibration of the RSL leaching to groundwater model to the 2016 RAG modeling efforts made sense to the Agencies.

7.7.1.2 Differences between the 2016 & 2018 LTGW RAGs

There are some significant discrepancies between the 2016 Leaching to Groundwater RAGs and 2018 RAGs for several chemicals. These discrepancies can arise for two primary reasons; there is a significant difference between the 2016 and 2018 Residential Groundwater RAGs (see section 4.1) or there are differences between the SEVIEW leaching models (used in 2016) and the RSL soil to groundwater SSL calculator (used in 2018).

The following list explains the largest differences:

- Acetone has an RSL-based soil to groundwater RAG that is 60 times lower than the 2016 leaching to groundwater RAG because the SEVIEW modeling done for the 2016 RAGs included biodegradation, but the RSL calculator does not. The 2018 RAG err on the protective side (i.e., will have a lower screening level) because it doesn't take biodegradation of acetone into account.
- Bis (2-ethylhexyl) phthalate has an SSL 14 times lower than the 2016 leaching to groundwater RAG. This difference is probably due to 3.5-fold decrease in the groundwater RSL compared to the MEG. Also, the modeled DAF for bis (2-ethylhexyl) phthalate is an outlier (1415) that greatly exceeds the DAF of 55 that was used to estimate the 2018 RAG. Bis (2-ethylhexyl) phthalate has an overly conservative 2018 RAG.
- Chlorendic acid has a 2018 RAG that is 60 times greater than the 2016 leaching to groundwater RAG. The Koc value that was used in the SEVIEW modeling for the 2016 RAGs is 8.32 L/kg whereas the Koc used in the RSL calculator is 2400 L/kg, which may be the primary reason for the discrepancy.
- 1,4-dichlorobenzene has a 2018 RAG that is 17 times lower than the 2016 leaching to groundwater RAG. This difference is most likely because the 2018 groundwater RAG is 14 times lower than the 2016 Groundwater RAG.

- MTBE has a 2018 RAG that is 9 times greater than the 2016 RAG, probably because the 2018 groundwater RAG is 4 times the 2016 groundwater RAG and the RSL soil to groundwater calculator gives a higher result than the SEVIEW models.
- The 2018 PFOA RAG is 32 times lower than the 2016 RAG, mainly because of changes in the chemical-specific modeling parameters since the 2016 RAGs were developed. PFAS chemicals are emerging contaminants so certain chemical parameters are still being established.
- 1,2,4-trichlorobenzene has a 2018 RAG that is 13 times lower than the 2016 RAG, primarily because the groundwater RSL is 17 times lower than the 2016 MEG.

8 Lead Modeling

The process for deriving RAGs for Lead are very different from the other contaminants, because EPA acknowledges lead to be a special case because of the difficulty in identifying the classic "threshold" needed to develop a noncancer toxicity value, as scientists have been unable to identify a safe level of exposure to lead for young children. In the absence of a toxicity value, a screening level cannot be derived using the standard EPA RSL equations and calculator.

To derive a guidance value for lead in soil the EPA recommends the use of two biokinetic models: The Integrated Exposure Uptake Biokinetic (IEUBK) model for residential scenarios and the Adult Lead Methodology (ALM) for non-residential scenarios. The IEUBK model estimates a blood lead level from the combined exposure of soil, indoor dust, water, air, and diet in children from infancy up to 84 months (7 years old). The ALM estimates a fetal blood lead level in a pregnant female worker exposed to lead from soil and dust in a non-residential, workplace setting. Both the IEUBK model and ALM are designed to determine the probability that an exposed individual or population at a lead contaminated site will have a blood lead level exceeding a predetermined reference level. EPA's approach to lead-contaminated sites has been to limit the probability of a typical child's blood lead level, or fetal blood lead level of a pregnant female worker, exceeding 10 micrograms per deciliter (10 µg/dL) to 5% or less after cleanup.

In developing RAGs for lead in soil, the CDC follows EPA guidance and utilizes the IEUBK model and ALM. The 2018 lead soil RAGs were derived using a lower blood lead level reference level (5 µg/dL) and the most recent EPA recommended updates to input parameters in the IEUBK model and ALM. The change from a 10 ug/dL to a 5 ug/dL blood lead reference level reflects the recent US Centers for Disease Control and Prevention (USCDC) recommendation[21], Maine's statutory definition of a "Lead Poisoned" child, and EPA regional guidance to consider blood lead levels lower than 10 ug/dL[22].

[21] USCDC blood lead reference level: https://www.cdc.gov/nceh/lead/acclpp/blood_lead_levels.htm.
[22] EPA updated scientific considerations for lead: https://semspub.epa.gov/lead/considerations.pdf.

8.1 Blood Lead Reference Level Update

Since 1994 the EPA has recommended the use of a "blood lead level of concern" of 10 µg/dL when deriving lead soil guideline values for cleanup at a contaminated site[23]. At the time, a blood lead level of 10 µg/dL had been identified as a "level of concern" by the USCDC, meaning a blood lead level where case management activities to reduce exposure were warranted. In 2012, the USCDC dropped use of 10 µg/dL as a "blood lead level of concern" given the scientific consensus that levels of blood lead less than 10 µg/dL have been shown to affect IQ, the ability to pay attention, and academic achievement. USCDC now recommends use of a blood lead "reference level" of 5 µg/dL to identify children who have been exposed to lead and who should receive case management. The 5 µg/dL reference level was adopted by USCDC in 2012 and represents the blood lead level at the 97.5th percentile from a nationally representative sampling of children 1 to 5 years old. In Maine, the State Legislature adopted the USCDC reference level as the definition of "Lead Poisoned" within Maine's Lead Poisoning Control Act, a definition that triggers public health intervention (22 M.R.S. § 1315.5.C and § 1320-A). Additionally, the EPA recommends that regional offices consider the current scientific conclusions that adverse health effects are associated with blood lead levels less than 10 µg/dL to determine soil screening levels for residential cleanups.

Given the lower USCDC recommended reference level, the States statutory adoption of the updated reference level, and EPA regional guidance to consider lower blood lead reference levels, the blood lead reference level in the IEUBK model and ALM was updated to 5 µg/dL, from the previous 10 µg/dL value, for the 2018 lead soil RAGs.

8.2 General IUEBK model and ALM updates

The EPA recently recommended several updates to the default IEUBK model and ALM input values. In the IEUBK model, the recommendation for the default child age range is now 12 to 72 months (1 to 5 year-old children)[24]. Previously, when assessing soil lead levels using the IEUBK model the recommendation was to focus modeling efforts on a 6 to 84 month (6 month to 7 year-old) age group. The EPA suggests that the 1 to 5 year-old population is a more highly exposed age group due to age-dependent differences in soil contact and hand to mouth activity; making this age group the primary population of concern at lead-contaminated sites for residential use.

For the ALM, the recommended value for the maternal blood lead level, used as the baseline blood lead level, is now 0.6 µg/dL[25]. The variation in maternal blood lead levels as described by the geometric standard deviation (GSD) was also updated to 1.8 from the previous value of 1.7. Both the maternal blood lead level and GSD

[23] EPA lead at hazardous waste sites guidance: https://soil/lead/guidance/1994.pdf.
[24] EPA recommendations for default age range in the IEUBK model: https://semspub.epa.gov/recommendations/age.pdf.
[25] EPA ALM blood lead baseline and GSD recommendation: https://semspub.epa.gov/work/HQ/196766.pdf.

were updated in 2017 based on more recent analysis of USCDC national blood lead biomonitoring data. Per EPA recommendations for the ALM, both parameters were updated to these new values to derive the Commercial Worker and Construction Worker lead soil RAGs. The maternal blood lead level is also used in the IEUBK model. Although the 0.6 µg/dL maternal blood lead level in the IEUBK model has a negligible impact on blood lead levels in 1 to 5 year-old children, this input value was updated in the modeling effort for consistency with current EPA recommendations.

8.3 Lead Residential Soil

For the Residential Soil RAG, the IEUBK model using EPA default parameter inputs (TSD Table 8) for a 12 to 72 month age range was run iteratively to determine a soil lead concentration corresponding to a less than a 5% probability that child's blood lead level would exceed 5 µg/dL. This soil concentration was 142 mg/kg, rounded to 140 mg/kg for the final RAG value.

8.4 Lead Park User Soil

The soil lead RAG for the Park User scenario is based on the IEUBK modeling results, since the concern at a park will be lead exposure in children, especially the younger 1 to 5 year-old age group with typically more hand to mouth activity. For a child exposed intermittently at a non-residential site, the EPA recommends the use of a time weighting approach[26]. This approach allows a total soil lead concentration goal where there is less than a 5% probability that child's blood lead level would exceed 5 µg/dL (i.e., 142 mg/kg) to be apportioned to park soil and residential yard soil as presented in equation 1.

$$PbS_{total} = (PbS_{yard} \times f_{yard}) + (PbS_{park} \times f_{park}) \quad \text{(eq. 1)}$$

where:

- PbS_{total} = Total lead soil concentration (mg/kg) goal corresponding to less than a 5% probability of exceeding a blood lead level of 5 µg/dL
- PbS_{yard} = Background soil lead concentration (mg/kg) in a residential yard
- f_{yard} = Fraction of weekly time spent in the yard (days in yard/7 days per week)
- PbS_{park} = Park soil lead concentration (mg/kg)
- f_{park} = Fraction of weekly time spent at the park (days at park/7 days per week)

Equation 1 can be rearranged to solve for PbS_{park} where:

$$PbS_{park} = (PbS_{total} - (PbS_{yard} \times f_{yard}))/f_{park} \quad \text{(eq. 2)}$$

[26] EPA intermittent or variable exposures at lead sites: https://semspub.epa.gov/work/HQ/176288.pdf.

The 142 mg/kg soil lead concentration was selected as the total soil level goal as this concentration corresponds to less than a 5% probability of exceeding a blood lead level of 5 µg/dL for a 1 to 5-year-old child. A value of 32 mg/kg was selected for the background soil lead concentration in a Maine yard (see background metal soil levels documentation section). The fraction of weekly time spent at the park is the Maine Park User exposure frequency of 3 days per week expressed as a fraction (i.e., 3 days/7 days). The remaining 4 days per week is used as the weekly time spent in the yard. Using these input values, the time-weighted Park User soil RAG is 288 mg/kg rounded to 290 mg/kg.

8.5 Lead Commercial Worker and Construction Worker Soil

The ALM was used to develop the non-residential soil RAGs for the Commercial and Construction Worker scenarios. The EPA recommended default exposure factors (ingestion rate and exposure frequency) for the ALM are intended to be representative of non-residential exposure scenarios occurring at a workplace. The default soil ingestion rate of 50 mg/day is a central tendency estimate for a non-contact intensive indoor worker. As the RAGs for the commercial and Construction Worker scenarios are intended to be protective of more contact intensive work at a site, such as grounds-keeping for a Commercial Worker or digging/excavating for a Construction Worker, a 100 mg/day ingestion rate was used for these two exposure scenarios. A 100 mg/day ingestion rate is recommended by the EPA to be more representative of soil contact intensive work for the ALM[27].

The ALM default exposure frequency of 219 days/year was adjusted to better model RAG Commercial and Construction Worker scenarios. For the Commercial Worker, the 2018 RAG default exposure frequency of 183 days/year was used. This exposure frequency is based on Maine climate-specific data for days per year where the ground is neither frozen or snow covered (256 days/year) and adjusted for a 5 day/week work week. As this exposure frequency is approximately half a year, the default averaging time of 365 days/year in the ALM was adjusted to 256 days/year to prevent an effect of diluting out the exposure over a full year. With the 100 mg/day ingestion rate, 183 days/year exposure frequency, 256 days/year averaging time, and the remaining parameters at the most recent EPA recommended default values (TSD Table 10), the Commercial Worker lead soil RAG is 441 mg/kg rounded to 440 mg/kg.

For the Construction Worker scenario, the same default parameters used for the Commercial Worker scenario were used except for exposure frequency, which was set at the 2018 RAG default value of 250 days/year, and averaging time set at the ALM default of 365 days/year. The ALM model with these adjustments results in a soil lead RAG of 460 mg/kg for a Construction Worker scenario.

[27] EPA Adult Lead Methodology https://www.epa.gov/superfund/lead-superfund-sites-frequent-questions-risk-assessors-adult-lead-methodology#ingestion%20rate.

8.6 Lead Recreational Sediment

New to the 2018 RAGs are values for Recreational exposure to sediment. This exposure scenario is intended to account for sediment exposure while wading or swimming for 3 days per week from May through October (26 weeks) in Maine. The Recreational sediment RAG for lead is 290 mg/kg. This is the same as the Park User soil RAG for lead derived using a weekly time-weighted approach. Since the Park User soil and Recreational sediment scenarios are both based on a 3 day per week exposure, the weekly time-weighted approach produces equivalent RAGs for these scenarios.

8.7 Lead Residential Groundwater

The residential lead water RAG of 5 µg/L was developed using the IEUBK model with the soil lead concentration set at the residential soil RAG of 140 mg/kg. The residential soil RAG is based on the IEUBK model where approximately no more than 5% of children would have a blood lead level > 5 µg/dL using the USEPA default water level of 4 µg/L. The 140 mg/kg soil value is the result of rounding down from a soil level breakpoint of 142 to 143 mg/kg where the model predicted percent of children with a blood lead level > 5 µg/dL is 4.9 and 5.0%, respectively. At 140 mg/kg lead in soil and 4 µg/L lead in water, with all other parameters set at U.S. EPA defaults (TSD Table 8), the predicted percent of children with a blood lead level > 5 µg/dL is 4.7%. The reduction from 142/143 to 140 mg/kg lead in soil allows for some adjustment in the water lead level due to the reduction in the percentage of children with a blood lead level > 5 µg/dL.

Increasing the water lead level to 4.5 µg/L, while the soil level remains constant at 140 mg/kg, the model predicts that 5.1% of children age 1 to 5 years old would have a blood lead level > 5 µg/dL. For the final RAG, the 4.5 µg/L water value was rounded to 5 µg/L. At 5 µg/L the predicted percent of children with a blood lead level > 5 µg/dL is slightly above the goal of no more than 5%. It is important to note in the IEUBK model that the dominant exposure source contributing to blood lead levels at the 140 mg/kg residential soil RAG is in fact soil. At a background soil lead level of 32 mg/kg water lead levels could be as high as 17 µg/L with < 5% of children exceeding a 5 µg/dL blood lead level.

TSD Table 8 - IEUBK Input Parameters for 2018 Residential Soil Lead

Parameter	Units	Values				
		Age groups (years)				
Soil and dust		1-2	2-3	3-4	4-5	5-6
Soil and dust intake, age-specific	g/day	0.135	0.135	0.135	0.100	0.090
Soil to dust ingestion weighting factor	%	45				
Soil relative bioavailability	%	30				
Soil to household dust lead level conversion factor	unitless	0.7				
Air to household dust lead level conversion factor	unitless	100				
Indoor dust lead concentration	µg/g	Calculated from outdoor soil and air lead contributions 109.4 (when soil level 142 µg/g)				
Dust relative bioavailability	%	30				
Water						
Drinking water intake, age-specific	L/day	0.5	0.52	0.53	0.55	0.58
Drinking water lead concentration	µg/L	4				
Water relative bioavailability	%	50				
Air						
Time spent outdoors	hours/day	2	3	4	4	4
Ventilation rate	m^3/day	3	5	5	5	7
Outdoor air lead	µg/m^3	0.1				
Indoor air lead concentration (percent of outdoor air concentration)	%	30				
Lung absorption	%	32				
Diet						
Dietary lead intake	g/day	1.96	2.13	2.04	1.95	2.05
Diet relative bioavailability	%	50				
Maternal						
Maternal blood lead level	µg/dL	0.6				
Blood lead reference value						
Child blood lead level	µg/dL	5				

TSD Table 9 - Commercial and Construction Worker Inputs for the Adult Lead Model

Parameter	Description	Units	Value
BLL fetal goal	Target fetal blood lead level	µg/dL	5
fetal/maternal BLL ratio	Ratio of fetal blood lead to maternal blood lead	unitless	0.9
GSD adult $^{1.645}$	Geometric standard deviation for the adult population used to calculate the 95th percentile blood lead level	unitless	1.8
BLL adult baseline	Adult population, female of childbearing age, background blood lead level	µg/dL	0.6
Averaging time	Total days per year	days/year	- [a]
Biokinetic slope factor	Factor relating lead uptake per day to a blood lead level in adults	µg/dL per µg/day	0.4
Ingestion rate	Total soil/dust ingestion rate	g/day	0.1
Absorption fraction	Fraction of lead absorbed in the GI tract	unitless	0.12
Exposure frequency	Duration of time in days per year spent at a site	days/year	- [a]

[a] Values are scenario specific. See text for commercial and Construction Worker scenario parameter values.

8.8 Lead Leaching to Groundwater Lead

The RSL calculator does not provide an output for Lead in the Leaching to Groundwater calculator. It does calculate an MCL-based value, for the EPA Lead MCL of 15 µg/L. The Lead Leaching to Groundwater value presented in the 2018 RAGs is calculated in the same way, but based on residential lead water RAG of 5 µg/L, the Maine DAF of 55, and default RSL parameters, as presented in TSD Table 10:

TSD Table 10 – Lead Input Factors for Leaching to Groundwater

Lead water conc. (ug/L)	DAF	Kd (L/kg)	Water filled soil Porosity (L/L)	Soil bulk density (kg/L)	Lead RAG (mg/kg)
5	55	900	0.3	1.5	247.6

9 Soil Background Concentrations

9.1 How Soil Background Concentrations Were Derived

In site-specific circumstances, statistically valid sampling may demonstrate that a local background concentration of a contaminant is higher than a soil guideline that is based strictly on the above risk-based calculations. Maine DEP's policy, is that when background concentrations of a contaminant are higher than a risk-based

RAG, DEP will not require a clean-up of site soil to be more stringent than the local background concentration.

9.2 Metals

To assist with determining site-specific clean-up goals at Maine sites, DEP added background concentrations for select metals to the soil RAGs table. These background concentrations were based on data collected by the US Geological Survey's Geochemical Landscapes Project[28]. The dataset used to establish background metal concentrations was from a transect from Canada to Mexico, consisting of 105 sites that were selected to exclude local contributions. From the dataset, DEP used an Excel® workbook "USGS_GeoChemLandscape" to calculate the 90th percentile from 105 samples collected in Maine. Additionally, the RAGs provide for the use of site specific or other data when helping to determine background concentrations at a site.

9.3 PAHs

Background Concentration of Polycyclic Aromatic Hydrocarbons (PAHs) often exceed risk based guidelines. DEP commissioned a study of typical background concentrations of PAHs in Maine. The study compiled background data from investigations in Maine, determined data gaps, and then obtained samples to fill those data gaps. The researchers evaluated key sources of PAHs, and determined that asphalt and urban fill materials, such as coal ash, are prime contributors to PAH concentrations found in Maine. After evaluating multiple possibilities, ultimately the researchers determined that a consistent, statistically valid split in the sample results was found between PAH concentrations in urban versus rural sites. The definition of urban and rural data was based on the Department of Transportation's compact urban zones, which are geographically located in GIS layers. Additional information is available in the PAH study[29].

10 Multi-contaminant Risk

Risk Assessment theory holds that the risk from multiple contaminants that are below their respective RAGs could, when summed, exceed the risk targets in Maine (a HI=1 and ILCR=10^{-5}; see section 1.2). Prior to the 2010 RAGs, risks from multi- contaminants were not routinely considered in remedial decisions made with the RAGs. Beginning with the 2010 RAGs, the Agencies developed multi-contaminant risk calculators to assess residual risk from sites once all contaminants were below their respective RAGs. However, their use did not result in any additional remediation when the individual contaminants met its

[28] Smith, David B. and William F. Cannon, et al, Major and Trace Element Concentrations in Soils from Two Continental-Scale Transects of the United States and Canada (USGS Open File Report 2005-1253, http://pubs.usgs.gov/of/2005/1253/), July 2005.
[29] MEDEP, Summary Report for Evaluation of Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Background Soils in Maine (Prepared for Maine DEP, Augusta, Maine; Prepared by AMEC Environment & Infrastructure, Inc., Portland, Maine project no. 361211, October 14, 2011.

respective RAG. This is because the contaminants were co-located such that the remediation addressed all of them and/or because one recalcitrant contaminant typically drives a clean-up; by the time the RAG is achieved for this risk-driver, the other contaminants are well below their respective RAGs. Since maintenance and use of the risk calculators had resource costs with no associated risk reduction, their use has been ended. That is, no multi-contaminant calculations will be required to demonstrate that cumulative risks do not exceed a hazard index of 1 or an ILCR of 10^{-5} when the RAGs are met, even though the RAGs individually are set at a hazard quotient of 1 and an ILCR of 10^{-5}.

11 Erratum

Corrective Copy issued October 26, 2018 to:

- add the residential groundwater RAG for lead in table 5 of the RAGs document and excel workbook, which had been inadvertently omitted; and
- correct the page numbering in the Technical Support Document.

TSD Table 11 - Default Exposure Assumptions for Maine Remedial Action Guidelines and Site-Specific Risk Assessments

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
Ingestion Rate	Soil	Resident Adult/Older Child	100	mg/day	U.S. EPA 1991a (pg. 15)	RSL default
	Soil	Resident Young Child <6	200	mg/day	U.S. EPA 1991a (pg. 15)	RSL default
	Soil	Outdoor Commercial Worker	100	mg/day	U.S. EPA 1991a (pg. 15)	RSL default
	Soil	Indoor Commercial Worker	50	mg/day	U.S. EPA 1991a (pg. 15)	RSL default
	Soil	Construction Worker	330	mg/day	U.S. EPA 2002 Exhibit 5-1	RSL default
	Sediment	Recreator Adult/Older Child	100	mg/day	U.S. EPA 1991a (pg. 15)	RSL default
	Sediment	Recreator Young Child <6	200	mg/day	U.S. EPA 1991a (pg. 15)	RSL default
	Surface Water	Swimmer - Child	49	ml/hour	U.S. EPA 2011, Table 3-5 Mean value for water ingestion while swimming - children	Maine
	Surface Water	Swimmer - Adult	21	ml/hour	U.S. EPA 2011, Table 3-5 Mean value for water ingestion while swimming - adults	Maine
	Drinking Water	Resident Adult	2.5	L/day	U.S. EPA 2011, Table 3-33; 90th percentile of consumer-only ingestion of drinking water (>= 21 years)	RSL default
	Drinking Water	Resident Young Child <6	0.78	L/day	U.S. EPA 2011, Tables 3-15 and 3-33; weighted average of 90th percentile consumer-only ingestion of drinking water (birth to <6 years)	RSL default
	Drinking Water	Commercial Worker	2.5	L/day	U.S. EPA 2011, Table 3-33; 90th percentile of consumer-only ingestion of drinking water (>= 21 years)	RSL default

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
	Groundwater	Construction Worker	15	ml/day	U.S. EPA 2011, Table 3-93 Mean ingestion while wading/splashing (3.7 milliliter per hour, 4 hours per day)	Maine
	Fish	Adult	32400	mg/day	One 8-oz. fish meal/week; upper estimate of sport fish consumption	Maine
	Homegrown Produce exposed fruit	Resident	1.8	g/kg-day	U.S. EPA 2011, Table 9-18 Mean values for households in the Northeast (exposed fruit)	Maine
	Homegrown Produce exposed vegetables	Resident	1.4	g/kg-day	U.S. EPA 2011, Table 9-20 Mean values for households in the Northeast (exposed vegetables)	Maine
	Homegrown Produce root vegetables	Resident	1.1	g/kg-day	U.S. EPA 2011, Table 9-22 Mean values for households in the Northeast (root vegetables)	Maine
Exposure Frequency	Soil	Resident Child/Adult	256	days/year	Climate-specific data for days when ground is neither frozen or snow covered in the Portland area	Maine
	Soil	Park User Child/Adult	90	days/year	3 days/week, 30 weeks/year (April-October)	Maine
	Soil	Trespasser - Older Child (6>16)	52	days/year	2 days/week, 26 weeks/year (May-October)	Maine
	Soil	Outdoor Commercial Worker	183	days/year	Climate-specific data for days when ground is neither frozen of snow covered in the Portland area, adjusted to 5 days/week	Maine
	Soil	Indoor Commercial Worker	183	days/year	Climate-specific data for days when ground is neither frozen of snow covered in the Portland area, adjusted to 5 days/week	Maine

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
	Soil	Construction Worker	250	days/year	USEPA RSL default value - 1 year construction period adjusting for 5 days/week workweek out of 350 days/year	RSL default
	Sediment	Recreator - Child/Adult	78	days/year	3 days/week, 26 weeks/year (May-October)	Maine
	Surface Water	Swimmer - Adult	40	days/year	4 days/week, 10 weeks/year (2 weeks of June, all of July & August)	Maine
	Surface Water	Swimmer - Child	40	days/year	4 days/week, 10 weeks/year (2 weeks of June, all of July & August)	Maine
	Surface Water	Wader - Child/Adult	78	days/year	3 days/week, 26 weeks/year (May-October)	Maine
	Tap Water	Resident Child/Adult	350	days/year	U.S. EPA 1991a (pg. 15)	RSL default
	Drinking Water	Commercial Worker	250	days/year	U.S. EPA 1991a (pg. 15)	RSL default
	Groundwater	Construction Worker	52	days/year	1 day/week, 52 weeks/year	Maine
	Homegrown Produce	Resident	182	days/year	7 days/week, 26 weeks (May-October)	Maine
	Air	Resident Child/Adult	350	days/year	U.S. EPA 1991a (pg. 15)	RSL default
Exposure Frequency (continued)	Air	Indoor Commercial Worker	250	days/year	U.S. EPA 1991a (pg. 15)	RSL default
	Air	Construction Worker	250	days/year	U.S. EPA 2002 Exhibit 5-1	RSL default
Exposure Time	Surface Water	Swimmer - Adult	3.2	hours/day	U.S. EPA 2011, Table 3-92 95th UCL of mean value for swimming duration in freshwater or seawater - male and female adults	Maine
	Surface Water	Swimmer - Child	4.3	hours/day	U.S. EPA 2011, Table 3-92 95th UCL of mean value for swimming duration in freshwater or seawater - children	Maine
	Surface Water	Wader	3.2	hours/day	Assumed to be the same as swimming.	Maine

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
	Surface Water	Wader	4.3	hours/day	Assumed to be the same as swimming.	Maine
	Household Water	Resident Bathing - Child	0.54	hour/bath	U.S. EPA 2011, Table 16-28; weighted average of 90th percentile time spent bathing (birth to <6 years)	RSL default
	Household Water	Resident Showering - Adult	0.71	hour/shower	U.S. EPA 2011, Tables 16-30 and 16-31; weighted average of adult (21 to 78) 90th percentile of time spent bathing/ showering in a day, divided by mean number of baths/showers taken in a day.	RSL default
	Groundwater	Construction Worker	4	hours/day	USEPA 2002 Section 4.2.3	Maine
	Air	Resident Child/Adult (Indoors)	24	hours/day	The whole day	RSL default
	Air	Resident Child/Adult (Outdoors)	2.3	hours/day	USEPA 2011 Mean of Time Outdoors at a residence (Table 16-1, ages 0<26 years)	Maine
	Soil	Resident	24	hours/day		RSL default
	Soil	Park User	3	hours/day	U.S. EPA 2011, Table 16-20 Mean time, 184.9 minutes per/day (3.08 hours), spent at park or golf course in the Northeast	Maine
	Sediment	Recreator	3.7	hours/day	U.S. EPA 2011, Table 16-20 Mean time, 220.7 minutes per/day (3.68 hours), spent outdoors at a pool/river/lake in the Northeast	Maine
	Air	Commercial Worker (Indoors)	8	hours/day	The work day	RSL default
	Air	Commercial Worker (Outdoors)	8	hours/day	The work day	RSL default
	Air	Construction Worker	8	hours/day	The work day	RSL default

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
Exposed Surface Area	Soil	Adult - Resident/Park User	6032	cm2	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.	RSL default
	Soil	Young Child <6 - Resident/Park User	2373	cm2	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)	RSL default
	Soil	Trespasser - Older Child (6>16)	3749	cm2	USEPA 2011 mean value for head, hands, forearms, and lower legs. The forearm-to-arm ratio (0.45) and lower leg to-leg ratio (0.4) were obtained from the EPA RAGs Part E dermal guidance (EPA 2004).	Maine
	Soil	Indoor Commercial Worker	3527	cm2	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)	RSL default
	Soil	Outdoor Commercial Worker	3527	cm2	ibid.	RSL default
	Soil	Construction Worker	3527	cm2	ibid.	RSL default

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
	Sediment	Recreator Adult	6032	cm2	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.	RSL default
	Sediment	Recreator Young Child <6	2373	cm2	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)	RSL default
Exposed Surface Area (continued)	Surface Water	Adult - Swimming	19652	cm2	U.S. EPA 2011, Tables 7-9; weighted average of mean values for male and female adults.	RSL default
	Surface Water	Young Child <6 - Swimming	6365	cm2	U.S. EPA 2011, Table 7.9, weighted average of mean values for children <6 years.	RSL default
	Surface Water	Adult - Wading	6032	cm2	U.S. EPA 2011, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data.	RSL default

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
	Surface Water	Young child <6 - Wading	2373	cm^2	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere)	RSL default
	Surface Water	Trespasser - Older Child (6>16)	3749	cm^2	Assumed to be the same as soil	Maine
	Household Water	Bathing - Child	6365	cm^2	U.S. EPA 2011, Table 7.9, weighted average of mean values for children <6 years.	RSL default
	Household Water	Showering - Adult	19652	cm^2	U.S. EPA 2011, Tables 7-9; weighted average of mean values for male and female adults.	RSL default
	Groundwater	Construction Worker	3527	cm^2	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)	RSL default
Adherence Factors	Soil	Adult - Resident/Park User	0.07	mg/cm^2	U.S. EPA 2002 (Exhibit 1-2)	RSL default
	Soil	Young Child - Resident/Park User	0.2	mg/cm^2	U.S. EPA 2002 (Exhibit 1-2)	RSL default
	Soil	Outdoor Commercial Worker	0.12	mg/cm^2	U.S. EPA 2011, Table 7-20 and Section 7.2.2; arithmetic mean of weighted average of body part- specific (hands, forearms, and face) mean adherence factors for adult commercial/industrial activities	RSL default
	Soil	Construction Worker	0.3	mg/cm^2	U.S. EPA 2002 (Exhibit 5-1)	RSL default
	Sediment	Recreator Adult	0.07	mg/cm^2	U.S. EPA 2002 (Exhibit 1-2)	RSL default

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
	Sediment	Recreator Young Child <6	0.2	mg/cm^2	U.S. EPA 2002 (Exhibit 1-2)	RSL default
	Sediment	Recreator Older Child 11-<18	0.07	mg/cm^2	U.S. EPA 2002 (Exhibit 1-2)	RSL default
Body Weight	All	Young Child <6	15	kg	U.S. EPA 1991a (pg. 15)	RSL default
	All	Adult (>18)	80	kg	U.S. EPA 2011, Table 8-3; weighted mean values for adults 21 - 78	RSL default
	All	Worker	80	kg	ibid.	RSL default
	All	Young Child - Resident/Park User	6	years	U.S. EPA 1991a (pg. 15)	RSL default
	All	Adult - Resident/Park User	20	years	EDres (26 years) - EDres-c (6 years)	RSL default
	All	Trespasser - Older Child (6>16)	10	years	Ages 6>16 years USEPA Region 4 2017	Maine
	All	Commercial Worker	25	years	U.S. EPA 1991a (pg. 15)	RSL default
	All	Construction Worker	1	years	U.S. EPA 2002 Exhibit 5-1	RSL default
	Air	Resident	26	years	EPA 2011, Table 16-108; 90th percentile for current residence time.	RSL default
	Soil	Park User	26	years	ibid.	RSL default
	Homegrown Produce	Resident	26	years	ibid.	RSL default
Averaging Period	All	Carcinogenic Effects	70	years	U.S. EPA 1989 (pg. 6-23)	RSL default
	All	Non-Carcinogenic Effects	Equal to exposure duration			RSL default
	All	Young Child - Resident/Park User	6	Years	U.S. EPA 1989 (pg. 6-23)	RSL default
	All	Adult - Resident/Park User	26	Years	U.S. EPA 1989 (pg. 6-23)	RSL default

Exposure Factor	Medium	Receptor	Value	Units	Notes	Maine or RSL
	All	Trespasser - Older Child (6>16)	10	Years	Averaging period = exposure duration	Maine
	All	Commercial Worker	25	Years	U.S. EPA 1989 (pg. 6-23)	RSL default
	All	Construction Worker	1	Years	U.S. EPA 1989 (pg. 6-23)	RSL default
Particulate Emission Factor	Soil	All	1.36E+09	m^3/kg	USEPA 2002 Equations 4-3 and 4-4	Maine
Number of days with ≥0.01" precipitation	Soil	Construction worker	1.31E+02	days/year	Maine-specific climate data based on the Portland area	Maine

Abbreviations
mg - milligram
kg - kilograms
ml - milliliters
L - liter
cm^2 - square centimeter

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TSD Table 12 - Physical/Chemical Properties and Toxicity Values for Manual Entry into RSL Calculator

	Acenaphthylene	Benzo[g,h,i]perylene	Carbazole	Dichlorobenzene, 1,3-	Dichloroethylene, 1,2-cis-	Dichloroethylene, 1,2-trans-	Phenanthrene	Phthalic Acid	2-Methylbenzene sulfonamide	4-Methylbenzene sulfonamide	Chlorendic acid	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics	C11-C22 Aromatics	C19-C36 Aliphatics	C9-C18 Aliphatics
CAS Number	**208-96-8**	**191-24-2**	**86-74-8**	**541-73-1**	**156-59-2**	**156-60-5**	**85-01-8**	**88-99-3**	**88-19-7**	**70-55-3**	**115-28-6**	**DEP2038**	**DEP2039**	**DEP2040**	**DEP2041**	**DEP2042**	**DEP2043**
Chronic Oral Reference Dose (mg/kg-day)	0.06	0.03	-	0.09	0.002	0.2	0.03	2	0.04	0.114		0.04	0.1	0.03	0.03	2	0.1
Chronic Inhalation Reference Concentration (mg/m3)	-	-	-	0.2	0.8	0.8	-	0.02	NV	NV		0.2	0.2	0.05	0.05	0	0.2
Subchronic Oral Reference Dose (mg/kg-day)	0.2	0.3	-	0.6	0.02	0.2	0.3	2	0.04	0.114		0.4	1	0.3	0.3	6	1
Subchronic Inhalation Reference Concentration (mg/m3)	-	-	-	2	0.8	0.8	-	0.02	NV	NV		0.2	0.6	0.5	0.5	0	0.6
Oral Slope Factor (mg/kg-day)-1	-	-	0.028	-			-				0.091	-	-	-	-	-	-
Inhalation Unit Risk (µg/m3)-1	-	-	-	-			-				2.60E-05	-	-	-	-	-	-

	Acenaphthylene	Benzo[g,h,i]perylene	Carbazole	Dichlorobenzene, 1,3-	Dichloroethylene, 1,2-cis-	Dichloroethylene, 1,2-trans-	Phenanthrene	Phthalic Acid	2-Methylbenzene sulfonamide	4-Methylbenzene sulfonamide	Chlorendic acid	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics	C11-C22 Aromatics	C19-C36 Aliphatics	C9-C18 Aliphatics
CAS Number	**208-96-8**	**191-24-2**	**86-74-8**	**541-73-1**	**156-59-2**	**156-60-5**	**85-01-8**	**88-99-3**	**88-19-7**	**70-55-3**	**115-28-6**	**DEP2038**	**DEP2039**	**DEP2040**	**DEP2041**	**DEP2042**	**DEP2043**
RAGS Part E Dermal Absorption Factor	**Physical/chemical properties in the RSL**								0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.2
RAGS Part E Gastrointestinal Absorption Factor GIABS	**Physical/chemical properties in the RSL**								1	1	1	1	1	0.92	0.92	1	1
Relative Bioavailability (RBA)	**Physical/chemical properties in the RSL**								1	1	1	1	1	1	1	1	1
Henry`s Law Constant (atm-m3/mol)	**Physical/chemical properties in the RSL**								4.70E-07	4.70E-07	1.12E-13	1.296	1.56	0.008	7.2E-04	-	1.656
Henry`s Law Constant	**Physical/chemical properties in the RSL**								1.92E-05	1.92E-05	4.58E-12	53	63.8	0.324	0.029		67.72
Log of Octanol-Water Partition Coefficient logP	**Physical/chemical properties in the RSL**								0.84	0.82	2.255	3.85	5.52	3.93	5.09	11	5.94
Molecular Weight (g/mol) MW	**Physical/chemical properties in the RSL**								171.2	171.2	388.9	93	149	120	152	0	170
Vapor Pressure (mm Hg) VP	**Physical/chemical properties in the RSL**								6.00E-05	9.60E-05	3.04E-08	76	0.661	2.204	0.024	0	0.106
Organic Carbon Partition Coefficient (L/kg) Koc	**Physical/chemical properties in the RSL**								68	66	2404	2265	1.5E+05	1778	5000	-	6.80E+05

	Acenaphthylene	Benzo[g,h,i]perylene	Carbazole	Dichlorobenzene, 1,3-	Dichloroethylene, 1,2-cis-	Dichloroethylene, 1,2-trans-	Phenanthrene	Phthalic Acid	2-Methylbenzene sulfonamide	4-Methylbenzene sulfonamide	Chlorendic acid	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics	C11-C22 Aromatics	C19-C36 Aliphatics	C9-C18 Aliphatics
CAS Number	**208-96-8**	**191-24-2**	**86-74-8**	**541-73-1**	**156-59-2**	**156-60-5**	**85-01-8**	**88-99-3**	**88-19-7**	**70-55-3**	**115-28-6**	**DEP2038**	**DEP2039**	**DEP2040**	**DEP2041**	**DEP2042**	**DEP2043**
Soil-Water Partition Coefficient (cm3/g) Kd	**Physical/chemical properties in the RSL**								0.136	0.132	4.808	4.53	300	3.556	10	-	1360
Skin Permeability Constant (cm/hr) Kp	**Physical/chemical properties in the RSL**								6.25E-04	6.06E-04	3.24E-04	0.166	-	0.132	-	-	-
Absorbed Chemical Fraction FA (unitless)	**Physical/chemical properties in the RSL**								1	1	1	1	1	1	1	1	1
Water Solubility (mg/L) S	**Physical/chemical properties in the RSL**								1620	3160	3500	11	0.07	51	5.8	-	0.01
Volatile	**Physical/chemical properties in the RSL**								N	N	N	Y	Y	Y	N	Y	Y
Inside EPD?	**Physical/chemical properties in the RSL**								Y	Y	Y	Y	N	Y	N	N	N
Liquid or solid	**Physical/chemical properties in the RSL**								S	S	S	L	L	L	S	L	L

Notes

The constants for chlorendic acid were obtained from the Risk Assessment Information System (RAIS) https://rais.ornl.gov
The constants for 2-Methylbenzene sulfonamide and 4-Methylbenzene sulfonamide were obtained from https://pubchem.ncbi.nlm.nih.gov/
The toxicity values for 2-Methylbenzene sulfonamide and 4-Methylbenzene sulfonamide were derived by Maine CDC.
The constants for the petroleum hydrocarbon fractions were obtained from the Massachusetts Department of Environmental Protection.
"Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology" MassDEP 2003 and
"Characterizing Risks Posed by Petroleum Contaminated Sites" MassDEP 2002.

Attachment B: Supplemental Guidance for Conducting Site-Specific Risk Assessments in Maine

Effective Date: October 19, 2018

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Contents

1 Disclaimer

This guidance provides an approach for determining risk to human health at remediation sites that is accepted by the Maine Department of Environmental Protection (DEP) and the Maine Center for Disease Control (MeCDC, together "the Agencies"). These guidelines are not rules and are not intended to have the force of law. This guidance does not create or affect any legal rights of any individual, all of which are determined by applicable law. This guidance does not supersede statutes or rules.

2 Introduction

2.1 Current Guidance

This document replaces the Guidance for Human Health Risk Assessments for Hazardous Waste Sites in Maine, February 2011 and updated on May 23, 2013. This guidance is current until a revised guidance is posted on Maine DEP's website[1].

2.2 Purpose

The Agencies have produced this Supplemental Guidance for Human Health Risk Assessments at Hazardous Substance Sites in Maine. This revision is intended to supplement the United States Environmental Protection Agency's (EPA) Risk Assessment Guidance for Superfund (EPA RAGS): Parts A through F[2]. EPA RAGS are used at contaminated sites to:

- Establish baseline human health risk from contaminants at a site;
- Provide the basis for preparation of preliminary remediation goals (PRGs); and
- Assist in the site remediation decision-making process.

This supplemental guidance:

- Fosters a consistent framework for conducting risk assessment at Maine sites;
- Expedites Agency review of risk assessments;
- Minimize revision and resubmittal of risk assessment documents; and
- Identifies when the Agencies and other Parties should be consulted.

In addition to EPA guidance, the Agencies recognized that the Interstate Technology Regulatory Council has compiled risk assessment guidance that is

[1] See Maine DEP's web page, "Remediation Program Guidance: Guidance for the Investigation and Clean-up of Hazardous Substance Sites in Maine", (downloaded on August 15, 2018 from: http://www.maine.gov/dep/spills/publications/guidance/index.html)

[2] EPA Website "Risk Assessment Guidance for Superfund (RAGS): Part A" (downloaded August 15, 2018 from: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part)

useful in completing human health risk assessments and undertaking risk management based on the risk assessment.[3]

2.3 Acronyms and Abbreviations

For the purposes of this guidance, the following list of acronyms and abbreviations have the following meanings:

COPC – Chemical of Potential Concern

DEP - Maine Department of Environmental Protection

ED - Exposure Duration

EGAD – Maine Environmental and Geographic Analysis Database

EPA - U.S. Environmental Protection Agency

EPA RAGS – EPA's Risk Assessment Guidelines, parts A-F

m^3/kg – cubic meter per kilogram

Maine Agencies – DEP and MeCDC

Maine RAGs – Maine Remedial Action Guidelines for Hazardous Substance Sites

MCL – Maximum Contaminant Level

MeCDC - Maine Center for Disease Control

mg/kg - milligram per kilogram

mg/L - milligram per liter

ORNL - Oak Ridge National Laboratory

PCB – polychlorinated biphenyls

Project Lead- the Party that is undertaking the risk assessment. This may be DEP, a Potential Responsible Party, or other organization.

RBC – Risk Based Concentration

RME - Reasonably Maximum Exposure

RSL – EPA Regional Screening Level

SL – Screening Level

SVOCs – semi-volatile organic compounds

TEQ – toxicity equivalency

VF – Volatilization factor

VOCs – volatile organic compounds

ug/kg – microgram per kilogram

ug/l – microgram per liter

[3] ITRC, Webpage "Decision Making at Contaminated Sites: Issues and Options in Human Health Risk Assessment" (Downloaded on August 13, 2018 from: https://www.itrcweb.org/risk-3/)

2.4 RSL Calculator

The EPA's "Regional Screening Levels for Chemical Contaminants at Superfund Sites" (RSL) Guidance includes a tool for calculation of site-specific risks from exposures to soil, water, air and fish consumption.[4] Use of this tool is acceptable to the Maine Agencies, to the extent that the relevant exposure pathways for the site are included in the tool. The risk assessor should consult with the DEP before using inputs that differ from those in the Technical Support Document for the Maine Remedial Action Guidelines, Technical Support Document TSD Table 12 - Default Exposure Assumptions for Maine Remedial Action Guidelines and Site-Specific Risk Assessments.

2.5 Communication and Dispute Resolution

Timely, frequent and clear communication is critical to efficient development of risk assessments and risk management. The intent of this guidance is to provide direction on issues that have arisen in the past on risk assessments. When development of a risk assessment is first contemplated, it is important to immediately establish project teams with appropriate inter-disciplinary subject experts from the Maine Agencies and Project Lead organizations, and to clearly communicate (preferably in writing) the roles and responsibilities of each team member, and how communication will flow between project team members. For Example: Will all communication flow to and from the Project Managers of the Lead Organization and Maine Agencies, or will risk assessors/geologists/engineers talk directly to each other? What iterative process for deliverables will be used: conceptual design, 30%, 90% and as built? Will routine weekly/monthly/quarterly check-in meeting or calls be held?

Inevitably differences of opinion will arise that are not covered in this guidance as the team works through development of the risk assessment. The key to resolving conflicts is to talk them through with technical experts at the project team level as soon as possible, and if not resolved at that level, to quickly elevate the issue to decision makers. This should be done in a step-wise, tiered approach, where decisions are made at the lowest level possible. Often dispute resolution is spelled out in Administrative Orders or other agreements, such as the Defense-State Memorandum of Agreement. Those established processes should be used. If a process is not established, one should be established by the project team, ideally *before* the first dispute arises. The following is a typical dispute resolution process that may be used as a template.

[4] EPA webpage, "Risk Assessment: Regional Screening Levels (RSLs)" (downloaded August 15, 2018 from: https://www.epa.gov/risk/regional-screening-levels-rsls)

If a Party objects to any action taken or not taken pursuant to completing the risk assessment and the objections cannot be resolved informally at the project team level:

1. The aggrieved Party will notify DEP's Director of the Division of Remediation, the Maine State Toxicologist, and their tier-I management equivalent for the Project Lead in writing of its objection(s) within 5 (five) days after such action. The tier-I Parties will have 14 (fourteen) days from receipt of the written objection(s) to resolve the dispute (the "Negotiation Period").
2. If the tier I Party representatives are unable to reach an agreement within the Negotiation Period, the DEP Remediation Division Director will, within 5 days of the end of the Negotiation Period, notify DEP's Director of the Bureau of Remediation and Waste Management ("BRWM"), the Maine DHHS Director of the Maine Center for Disease Control and Prevention and their tier II equivalent for the Project Lead of the dispute. The tier II Parties representatives will have a 14 (fourteen) day negotiation period from receipt of the written objection(s) to resolve the dispute.
3. If the tier II Party representatives are unable to reach an agreement within the Negotiation Period, DEP's BRWM Director will, within 5 days of the end of the Negotiation Period, notify DEP's Commissioner, the Commissioner of the Maine Department of Health and Human Services, and their tier III equivalents for the Project Lead of the dispute. The Parties will have a 14 (fourteen) day negotiation period from receipt of the written objection(s) to resolve the dispute.
4. If the dispute is not resolved, the DEP Commissioner will make the final decision and issue a written Dispute Decision Document within thirty (30) days of the end of the tier III negotiation period. The Dispute Decision Document shall upon signature be incorporated into Risk Assessment.
5. Any agreement reached by the Parties pursuant to this Dispute Resolution Process shall be in the form of a written Dispute Decision Document and will, upon signature by the Parties, be incorporated into the Risk Assessment.
6. The Negotiation Periods for each tier may be extended up to 30-days by mutual agreement of the parties. Such extension may be granted verbally but must be confirmed in writing.

3 Planning and Scope of The Risk Assessment

3.1 Work Plan

When a site-specific risk assessment is needed, generally DEP Programs require that Project Leads prepare and submit a Work Plan for the site-specific risk assessment. The Work Plan provides a platform for discussion between the Agencies and the Project Lead on the scope-of-work for the risk assessment. The Work Plan should include a schedule for completion, details concerning the content, format, and submittal of interim deliverables, and a dispute resolution process (section 2.5). Interim deliverables provide an opportunity to collaborate with the agencies as the risk assessment is being developed. To standardize and facilitate review of submitted risk assessments, risk assessors are encouraged to use the reporting format specified in the EPA Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part D)[5]. Suggested interim deliverables that are submitted prior to the draft risk assessment report, include:

- Conceptual Site Model (CSM) identifying the media, exposure points, receptors, and exposure pathways of concern (see Figure C-1);[6]
- Selection of chemicals of potential concern (COPCs);
- Receptor-specific exposure assumptions;
- Exposure Units (see section 3.2);
- Models run reports when models are used to estimate risks or hazards, including any statistical programs, and fate and transport models;
- Exposure point concentration (EPC) calculations (Section 5.4); and
- Draft risk and hazard calculations.

As discussed in EPA RAGS part D, the planning stage of a risk assessment should begin early in the site investigation and include a discussion of goals and expectations between the risk assessor and the Agencies. Persons performing the risk assessment should be involved with the preparation of the CSM as it relates to risk assessment. The use and grouping of exposure units should be discussed and agreed upon at this stage. The data necessary for the risk assessment should be considered when drafting the Sampling and Analysis Plan (SAP) for the site because the number, location and analytical requirements for environmental samples in each identified exposure unit will need to be able to support the risk assessment calculations.

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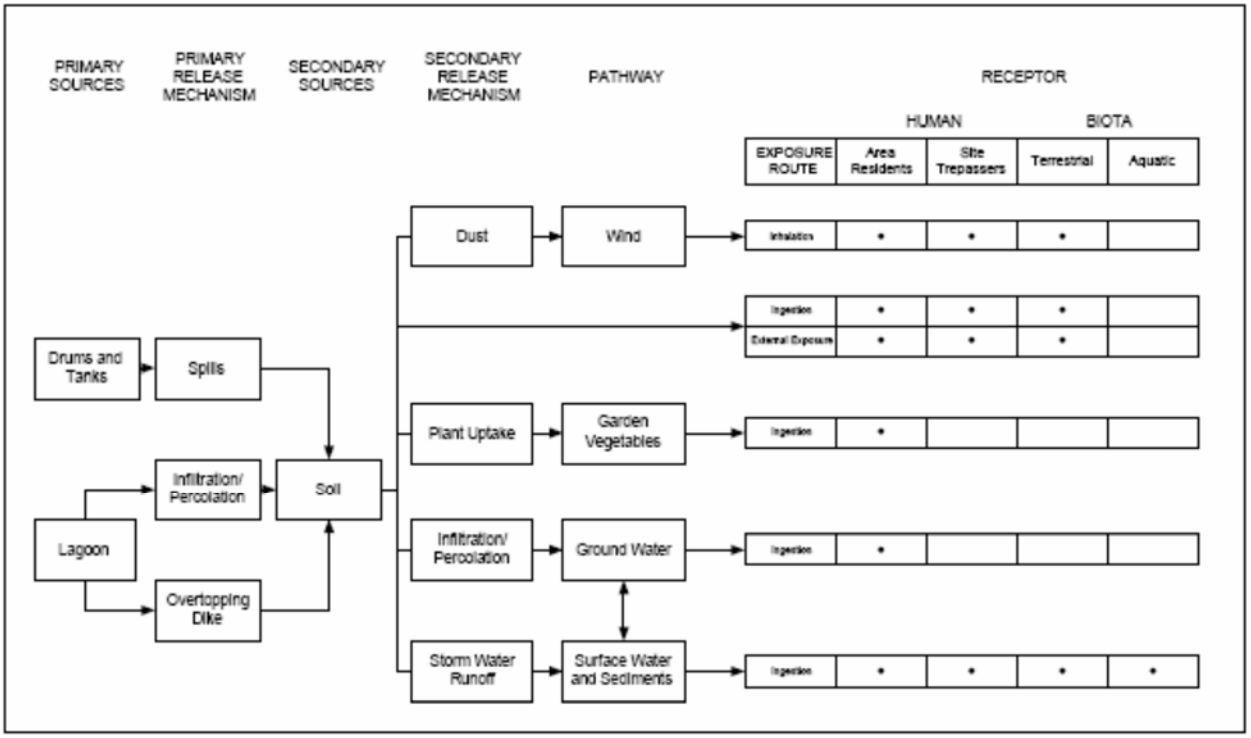
[5] EPA webpage, "Risk Assessment: Risk Assessment Guidance for Superfund (RAGS): Part D" (downloaded August 15, 2018 from: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-d).

[6] EPA, Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model (OSWER, EPA 542-F-11-011, available at: https://www.epa.gov/sites/production/files/2015-04/documents/csm-life-cycle-fact-sheet-final.pdf) July 2011.



Example Conceptual Site Model Schematic

From: EPA/Techlaw PowerPoint Presentation, Conceptual Site Model (Downloaded August 10, 2018 from: https://archive.epa.gov/epawaste/hazard/web/pdf/csm.pdf), undated.

3.2 Exposure Units

An exposure unit is the portion of the site that a Reasonably Maximum Exposed (RME) individual may be exposed to site contaminants. Exposure units reflect areas by environmental media (e.g. soil, groundwater, etc.) that are grouped together based on typical human activities, and the CSM's current and future site use. They are described by location and size. In the quantitative risk assessment, data are grouped separately by exposure units to calculate exposure point concentrations. An example of an exposure unit is the proposed lot size (e.g. ¼ acre) for a proposed residential development. Typically, separate operable units at a site are evaluated as separate exposure units.

Exposure areas should not unnecessarily combine areas of high contamination with areas of low contamination. At sites with small "pockets" or localized areas of high contamination, exposure points need to focus on these areas while considering typical exposure behavior. For example, quantify the exposure of a child to the hot-spot if a future sand-box or swing is in that area, considering that the child will use other areas of a yard as well. Unimpacted portions of the site may not be appropriate for inclusion in an exposure point (but may be used to quantifying site-specific background conditions for the site, if necessary).

Individual drinking water wells should be considered a unique exposure unit. However, it may be appropriate to group monitoring wells (see 5.4.1). Similarly, exposure units for sediment and surface water (e.g., rivers, ponds, lakes, estuaries, coastal, and wetland environments) should be proposed on a site-specific basis, giving consideration to the distribution of contamination in depositional areas, tidal influence, and known human exposure patterns in the area.

3.3 Data Usability

Prior to use in the risk assessment, the quality of analytical data should be assessed using methods detailed in EPA guidance for data usability including the collection and evaluation of appropriate blank and duplicate data. For data to be considered adequate for a risk assessment, the following criteria should be met:

- There is sufficient analytical data to characterize the site;
- Data should have been collected consistent with DEP and EPA guidance and an approved Sampling and Analytical Work Plan that includes a Quality Assurance Project Plan;
- Sampling and analytical procedures should give accurate chemical-specific concentrations;
- The data should be validated; and
- Method detection limits and sample quantitation limits to the extent practicable should be below risk screening criteria (see section 4.1).

3.3.1 Reporting Limits

One goal for data usability is to set analytical detection limits such that reporting limits are at least three-fold less than medium-specific screening criteria appropriate for selecting COPCs (see Section 4.1), as well as any applicable regulatory standards and guidelines. For highly toxic compounds with low screening criteria, this goal may not be achievable. In these cases, an analytical method should be selected that provides a reporting limit less than or as close as possible to the screening criteria.

3.3.2 Field Data

In general, field screening data are not recommended for use in a quantitative risk assessment unless the chemical-specific results correlate well with fixed laboratory analysis conducted in parallel with the collection of field screening data.

3.3.3 Tentatively Identified Compounds

Data for tentatively identified compounds (TICs), if available/identifiable, should be evaluated to determine the need for chemical/compound specific analysis. TICs detected at a concentration higher than equipment's

background noise, and/or determined to exhibit a high degree of chemical-specific toxicity should be evaluated.

3.3.4 Qualified & Rejected Data

Qualified data should be appropriately used and explained in the uncertainty section (i.e., discussion on potential bias from qualified data and how it might result in the over or under estimation of risk). Rejected data should not be used for risk assessment purposes.

3.3.5 Data Usability Criteria

The risk assessment data usability criteria listed below should be assessed during scoping for the risk assessment. Consult DEP when discussing how to best address inadequate data.

- Data Sources – Data should be from comparable sources (i.e., analytical methods, areas of concern, sampling methodologies).
- Documentation – Deviations from the sampling and analytical work plan (SAP) and standard operating procedures (SOPs) should be documented so that risk assessors are aware of any potential limitations in the data.
- Analytical Methods – Analytical methods should be capable of analyzing all COPCs at a reporting limits that are at or below applicable screening levels, as well as applicable or relevant and appropriate requirements (ARARs).
- Data Quality Objectives – EPA's Data quality objectives (DQOs) Guidance[7] for analytical data should be met.
- Data Review – Use of preliminary or partially reviewed data is not recommended. A full data quality review needs to be completed.
- Reports – A data review report that includes evaluation of the adequacy of the analytical quantitation limits, demonstration that DQOs have been met as described above, and a narrative discussing any qualified data and potential impacts resulting in uncertainties in the risk estimates should be provided.

[7] EPA, Data Quality Objectives Process for Hazardous Waste Site Investigations (QA/G-4HW), January 2000, (downloaded August 10, 2018 at: https://www.epa.gov/sites/production/files/2015-07/documents/g4hw-final.pdf); and

EPA, Guidance on Systematic Planning Using the Data Quality Objectives Process (QA/G-4), February 2006, (downloaded August 10, 2018 at: https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf).

And

EPA, EPA Guidance for Wuality Assurance Project Plans, February 1998 (downloaded August 28, 2018 from: https://clu-in.org/conf/tio/sysplan_031501/epaqag5.pdf)

4 Hazard Assessment

4.1 Selection of Chemicals of Potential Concern

If the number of chemicals detected at a site is large, it may be appropriate to narrow the list of chemicals to be quantitatively evaluated in the risk assessment. This is done by eliminating chemicals that could not pose, even when additive risks are considered, an unacceptable risk at the site (i.e. exceed an ILCR of 10^{-5} or a HI of 1). The retained chemicals are known as Chemicals of Potential Concern (COPCs). Select COPCs by comparing maximum concentrations in a given media to the latest media specific RSL tables set at a HQ=0.1 and an ILCR of 10^{-6}, and retain compounds that exceed the screening tables. The intent of the COPC selection process is to generate a list of COCs for inclusion in the risk assessment evaluation. The screening criteria are intended to be conservative to prevent the omission of compounds that may impact cumulative risk calculations.

Do not eliminated chemicals based on frequency of detection alone since just one detect could be indicative of a localized contaminant "hot spot".

If a chemical is not represented in the RSL table, the Maine RAG may be adjusted to the COPC selection Target Risk by multiplying the Maine RAG by 0.1. For site contaminants that are missing from the RSL tables and Maine RAGs, consult Maine MeCDC on the appropriate concentration representing an ILCR of 10^{-6} or a HQ of 0.1. Additionally, retain lead as a COPC when a maximum exposure concentration exceeds its respective Maine RAG value.

In accordance with EPA Guidance, at this stage retain compounds for quantitative evaluation of risks that may stem from background contamination[8]. However, in accordance with EPA RAGS part A, eliminate low concentrations of essential human nutrients, which are chemicals denoted by EPA as essential human nutrients at low concentrations and toxic only at very high doses: namely magnesium, calcium, and potassium.

5 Exposure Assessment

The purpose of the exposure assessment is to estimate the pathways by which humans are potentially exposed, the magnitude of actual and/or potential exposures, and the frequency and duration of these exposures the. This is specific to the environmental medium (soil, groundwater, etc.) and receptor (residential, park user, etc.) for each exposure unit. When fate and transport models are used to estimate exposure, the report should present pertinent information needed to verify the model and to recreate the output. Required information includes input parameters and assumptions.

Consult with the Agencies prior to running calculations when departing from the default exposure assumptions used for the Maine RAGs as shown in TSD Table 12.

[8] Handling of background contamination is risk making decisions is described in section 7.2 of the Maine RAGs narrative.

5.1 Receptors and Exposure Pathways

Generally, DEP programs require that the baseline risk assessment consider all current and future land uses at each exposure unit through the evaluation of all potentially complete exposure pathways. Applicable receptors and exposure pathways should be identified and justified as part of the CSM prepared for the site. Depending on the CSM, potential receptors could include residents, indoor commercial workers, outdoor commercial workers, various construction workers, excavation workers, recreators, farmers, gardeners, anglers, trespassers, etc. Figure C-1 depicts an example CSM with standard default exposure pathways of concern by land use and receptor. Some additional pathways and/or receptors that may require consideration for evaluation include:

- Ingestion of homegrown meat and dairy products for a home farm scenario;
- Ingestion of game and waterfowl for hunters and their families;
- Inhalation of volatiles from surface water;
- Inhalation of particulates by dirt biking trespassers, residents, or recreational users; and/or
- Ingestion of fish and shellfish as part of a regular subsistence diet for certain populations (e.g., Native American, off-shore island families, etc.)

DEP Programs almost always require that an unrestricted use (i.e. future residential) scenario for each site be included in the base-line risk assessment. Even if current and likely future site use and/or local zoning is non-residential, the unrestricted use scenario determines whether institutional controls are necessary on (part of) the site, the type of control, and how stringent such controls need to be.

The exposure pathways should be identified for all probable current and future site use scenarios. For example, for groundwater there may not be a current complete exposure pathway because there is not a potable well at or near the site, but there is a potential future pathway if a well can installed in the future. Therefore, the groundwater pathway should be considered as a future complete pathway. If the COPCs include contaminants in soil vapor, then the vapor intrusion pathway should be considered for future occupied buildings, even if such buildings currently do not exist at the site. See the Maine RAGs for a further discussion of excluding exposure pathways, implementation of institutional controls, and exposure to soil at depth.

5.2 Exposure Assumptions - RME

The selection of exposure assumptions to be used in Maine risk assessment should be consistent with the intent of a Reasonable Maximum Exposure (RME) scenario, defined by EPA as the highest exposure that is reasonably anticipated to occur at a site. Exposure parameters specific to the default exposure pathways for the State of Maine are listed in Table TSD 12. Deviation from these recommended values

should be discussed beforehand with the Agencies and be based on well-documented site-specific justification.

5.3 Exposure Models

For quantitative risk assessment, DEP recommends the use of monitoring data rather than modeled results whenever possible. For example, reported concentrations in indoor air are preferable to concentrations estimated by modeling subsurface migration and dilution into indoor air. However, when the use of monitoring data is not feasible, conservative application of the model within its limitations to derive EPCs is acceptable. Specific models and associated parameters and assumptions should be discussed with DEP before implementation. Modeling of other medium-specific environmental contaminant concentrations (e.g., contaminant uptake into edible fish or game) or the use of other available models should be proposed on a site-specific basis and likewise discussed with DEP before completion of the risk assessment.

Consult EPA's latest guidance for modeling Exposure Point Concentrations[9], which provides assessment models and tools by media, including air, water, sediment, soil, dust, food, aquatic biota and consumer products. ITRC also lists exposure models that may be useful[10]. Additionally, the following sections provide general guidance relative to the use of some specific models to estimate EPCs.

5.3.1 Soil and Groundwater to Indoor Air

Direct measurement of soil gas concentrations is a much better tool to evaluate Vapor Intrusion than available models. To evaluate the subsurface migration of volatile compounds to the indoor air of occupied buildings, (known as Vapor Intrusion or VI), DEP has developed Vapor Intrusion Guidance[11], which Supplements EPA's recent VI guidance. DEP's VI supplemental guidance should be followed to determine whether impacts to indoor air require investigation, and if so, how to conduct the evaluations. When direct measurement is not possible, consult DEP on the value of modeling, and whether pre-emptive remedies will be

[9] EPA webpage ExpoBox (A Toolbox for Exposure Assessors), which provides models and other tools by media (Downloaded August 15, 2018 from: https://www.epa.gov/expobox)

[10] ITRC webpage, "Decision making at Contaminated Sites, Issues and Options in Human Health Risk Assessment, chapter 6. Exposure Assessment: Appendix C. Models Routinely Used to Estimate Exposure Concentrations for Different Exposure Scenarios and Exposure Pathways" (downloaded on August 15, 2018 from: https://www.itrcweb.org/risk-3/Content/Appendix%20C.%20Models%20Routinely%20Used%20to%20Estimate%20Exposure%20Concentrations%20for%20Different%20Exposure%20Scenarios%20and%20Exposure%20Pathways.htm).

[11] See DEP's **Vapor Intrusion Guidance:** Investigation procedures to determine if contaminants have volatilized from contaminated soil or water into indoor air, & associated risk-based evaluation guidance. This guidance is available from DEP's webpage entitled Remediation Program Guidance: Guidance for the Investigation and Clean-up of Hazardous Substance Sites in Maine, available at: http://www.maine.gov/dep/spills/publications/guidance/index.html#vi.

more cost-effective. The RSL model includes some crude VI modeling algorithms.

5.3.2 Shower Model

The RSL calculator include volatilization of contaminants from water while showering, and can be used to model this exposure.

5.3.3 Inhalation of Volatiles in a Trench

The Virginia Department of Environmental Quality (VDEQ) trench air models are used to assess the inhalation pathway for workers in an excavation trench impacted by volatiles in groundwater[12]. Two distinct models have been developed by VDEQ for groundwater greater than 15 feet below ground surface and groundwater less than 15 feet below ground surface. Again, maximum groundwater concentrations should be used to model trench air concentrations for COPC selection. Once COPCs are selected, groundwater EPCs (e.g., 95% UCLs) may be used to generate trench air EPCs.

5.4 Exposure Point Concentrations

The Exposure Point Concentrations (EPCs) are the concentrations of the COPCs in the environmental media at the point of human exposure, such as groundwater in a drinking water well and soil in a residential yard. Consistent with EPA guidance[13] the 95th percentile upper confidence limit (UCL) on the arithmetic mean concentrations is recommended for use as the EPC for soil, sediment, and surface water exposure points. DEP recommends the use of EPA's ProUCL to calculate the 95%. Other statistical software should be preapproved by DEP. Please use the current version of ProUCL available from EPA as a free downloadable program. The ProUCL output pages should be included in the appendices of the Risk Assessment report. The ProUCL input files should be submitted in digital format.

The maximum concentration may be used as the EPC when there is an insufficient number of samples to calculate a 95% UCL or if following application of ProUCL recommendations, the 95% UCL still exceeds the maximum value. The most current ProUCL version recommends a minimum of eight samples to calculate a reliable UCL on the arithmetic mean for an exposure point in soil.

In the case of Multi-Incremental Sampling (i.e., establishing grid-based Decision Units and compositing soil samples within a Decision Unit), the Decision Unit may represent the EPC. If an EPC is represented by multiple Decision Units, then the

[12] Virginia Department of Environmental Quality, Virginia Unified Risk Assessment Model – VURAM 2.0 Users Guide for Risk Assessors (downloaded August 15, 2018 from https://www.deq.virginia.gov/Portals/0/DEQ/Land/RemediationPrograms/VRPRisk/VURAMUsersGuide.pdf) 2018

[13] EPA, Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (Downloaded August 23, 2018 from: https://www.epa.gov/sites/production/files/2016-03/documents/upper-conf-limits.pdf). December 2002.

95th upper confidence interval of the mean of the Decision Unit samples must be calculated to determine the EPC.

5.4.1 EPCs for Groundwater

EPC for groundwater should be at a potential future RME receptor such as a resident consuming drinking water from a well near the most contaminated part of the plume at the site. This is a conservative approach but generally the remedial action selected for sites where there is no current drinking water receptor is an institutional control, such as a covenant on the property deed restricting groundwater use. Whether an active groundwater remedy is needed should be evaluated under certain criteria and will be determined following a feasibility study.

Consistent with EPA guidance[14], for monitoring well data being evaluated for the household water use pathway, the groundwater EPC should be the 95% UCL on the arithmetic mean based on at least 10 data points from the core of a contaminant plume (or the maximum value if the 95% UCL exceeds the maximum value). For evaluating risk at an existing drinking water well, typically the maximum concentration is used as the EPC.

For direct contact with groundwater by an excavation worker, it may be appropriate to use UCLs for groundwater COPCs for each exposure point with appropriate justification provided. For sites with multiple rounds of groundwater data, temporal averaging may be used prior to the identification of maximum concentrations as long as enough data have been collected to adequately characterize seasonal variability (e.g., quarterly sampling).

5.4.2 EPCs for surface water

EPCs for groundwater discharging at a surface water body near the site should be determined through direct measurement of surface water concentrations. Failing that, modeling for groundwater to surface water loading calculations may be conducted.

5.4.3 Data Handling

Total water analytical results, rather than filtered results, are recommended for use in EPC estimation because unfiltered samples yield a better representation of what would actually be consumed by residences or contacted by construction workers. Prior to EPC estimation, duplicate sample results should be averaged. Estimated values (e.g., "J" qualified results) should be used without adjustment. Non-detects in the dataset should be treated as recommended in the ProUCL User's Guide.

[14]EPA. Memorandum for Determining Groundwater Exposure Point Concentrations, Supplemental Guidance. (downloaded August 13, 2018 from: U.S. EPA. Memorandum for Determining Groundwater Exposure Point Concentrations, Supplemental Guidance. 2014), 2014

6 Toxicity Assessment

6.1 Toxicity Hierarchy

Maine uses the EPA toxicity hierarchy and the chronic and subchronic toxicity values selected by EPA for use in the RSL calculators[15].

6.2 Toxicity Equivalence Factors for Dioxins and Coplanar PCBs

For chlorinated dibenzo-p-dioxin, chlorinated dibenzofuran and co-planar polychlorinated biphenyl (PCB) data, the relative potencies of the isomers and congeners should be addressed through the use of toxicity equivalency factors (TEFs) recommended by the RSL. The raw analytical data should be adjusted using the TEFs prior to the estimation of EPCs. EPCs should be expressed as Toxicity Equivalents (TEQs) and evaluated as 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD).

6.3 Petroleum Hydrocarbon Fractions

As discussed in the RAGs TSD, EPA RSL guidance for petroleum contamination uses fractions for which analytical methods have not be developed. Therefore, DEP continues to use the Massachusetts Department of Environmental Protection's (MassDEP's) volatile petroleum hydrocarbon (VPH), extractable petroleum hydrocarbon (EPH) and air-phase petroleum hydrocarbon (APH) analytical methods for petroleum hydrocarbon fractions and MassDEP's toxicity values for these fractions for use in Maine risk assessments.[16]

6.4 Chemical Isomers xylene, 1,2 dichloroethylene and 1,3-dichloropropane

Unless otherwise agreed to by MeCDC, handle the risk of these parameters as follows:

- Sum the xylene isomers and assess risk using the toxicity factors for total xylenes.
- Use the toxicity information for cis-1,2-dichloroethylene to evaluate 1,2 dichloroethylene.
- Sum the cis and trans 1,3-dichloropropane isomers and assess risk using the toxicity factors for 1,3-dichloropropane.

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[15] EPA, Memorandum for Human Health Toxicity Values in Superfund Risk Assessments (OSWER Directive 9285.7-53, downloaded August 14, 2018 from: https://www.epa.gov/sites/production/files/2015-11/documents/hhmemo.pdf) December 5, 2003.

[16] Specific details concerning the MassDEP petroleum methods can be found at https://www.mass.gov/lists/risk-assessment-information#petroleum- https://www.mass.gov/lists/policies-guidance-technical-support-for-site-cleanup - risk-assessment-

6.5 Pesticide Classes

Unless otherwise agreed to by MeCDC, total each of the following pesticides in the following pesticide classes and assess risk using the toxicity factors for the parent compound:

Total DDT. The terms "DDT", "DDE", and "DDD" are used to refer to the sum of isomer concentrations of p,p'-DDT and o,p'-DDT, p,p'-DDE and o,p'-DDE, and p,p'-DDD and o,p'-DDD, respectively. "DDTs" refers to any or all of the six compounds identified above, as well as the metabolites and degradation products of these six compounds. "Total DDT" refers to the sum of the concentrations of p,p'-DDT, o,p'-DDT, p,p'-DDE, o,p'-DDE, p,p'-DDD, and o,p'-DDD.

Total Endosulfan is the sum of α- and β-isomers, endosulfan diol, endosulfan ether, endosulfan sulfate, and endosulfan lactone.

Total Chlordane is the sum of cis and trans-chlordane, heptachlor, heptachlor epoxide, oxychlordane and cis-nonachlor, trans-nonachlor.

Total Endrin is the sum of endrin, endrin aldehyde, endrin ketone, heptachlorobicycloheptene, hexachloronorbornadiene, and isodrin.

6.6 Chemicals without Toxicity Values

If no risk-based concentration is available for a given chemical in a given medium, that chemical should be retained in the quantitative risk assessment, unless a risk-based concentration for a conservative surrogate compound is selected for screening and its maximum detected concentration is less than the conservative surrogate screening value. The use of surrogate screening values should be identified in footnotes on the COPC screening table.

Surrogate assignments recommended by the Agencies include:

Compound Lacking Toxicity Criteria in RSL	Toxicity Surrogate Compound
PCBs (noncancer)	Aroclor 1254
Acenaphthylene	Acenaphthene
Phenanthrene	Pyrene
Benzo(g,h,i)perylene	Pyrene
Dibromochlormethane	Bromochloromethane
Dichlorobenzene, 1,3-	Dichlorobenzene, 1,2-

Some per- and polyfluoroalkyl substances (PFAS) do not have toxicity values. As of March 2017, EPA researchers have partnered with researchers at the National Toxicology Program to develop a tiered testing approach to quickly generate

toxicity and kinetic information for approximately 75 PFAS compounds[17]. Until toxicity values are released, PFAS will be assessed on a site-specific basis.

Toxicity Factors for compounds may underestimate the risk of the compounds if the compounds are in Nano form (less than 100 nanometers in at least one direction). To assess the toxicity of nano-materials, consult the latest EPA guidance.[18]

6.7 Risk Assessment for Lead

If lead is found to be a COPC, sites specific risk models such as the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) and the Adult Lead Model (ALM) should be used to determine lead cleanup levels. In a residential scenario, the most sensitive receptor is a child exposed to lead and, therefore, the IEUBK should be used to determine appropriate cleanup levels. In a non-residential setting, such as a commercial or industrial scenario, the most sensitive receptor is the fetus of a worker who develops a body burden as a result of non-residential exposure to lead. The ALM should be used in this instance.

The IEUBK attempts to predict blood-lead (PbB) concentrations for children exposed to lead in their environment. The model allows the user to input relevant absorption parameters (e.g., the fraction of lead absorbed from water) as well as intake and exposure rates. Using these inputs, the IEUBK model rapidly calculates and recalculates a complex set of equations to estimate the potential concentration of lead in the blood for a hypothetical child (6 months to 7 years of age).

The United States Center for Disease Control and Prevention (USCDC) has determined that childhood PbB concentrations at or above 5 micrograms of lead per deciliter of blood (µg Pb/dL) present a potential risk to children's health[19], and the Maine Legislature in 2015 effectively adopted this level as the definition of lead poisoning[20].

The ALM should be used to assess exposure to lead in a non-residential setting. The ALM assesses non-residential adult risks utilizing a methodology that relates soil lead intake to blood lead concentrations in women of childbearing age. The ALM estimates the soil lead concentration at which the probability of blood lead

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[17] EPA webpage, "Assessing and Managing Chemicals under TSCA: Risk Management for Per- and Polyfluoroalkyl Substances (PFASs) under TSCA (downloaded August 15, 2018 from: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-and-polyfluoroalkyl-substances-pfass).

[18] EPA webpage, "Exposure Assessment Tools by Chemical Classes – Nanomaterials" (downloaded August 15, 2018 from: https://www.epa.gov/expobox/exposure-assessment-tools-chemical-classes-nanomaterials).

[19] U.S. Centers for Disease Control and Prevention website, "What Do Parents Need to Know to Protect Their Children?", downloaded August 23, 2018 from: https://www.cdc.gov/nceh/lead/acclpp/blood_lead_levels.htm).

[20] 22 M.R.S, §1315 §§ 5-C, which states: "**Lead poisoning.** "Lead poisoning" means a confirmed elevated level of blood lead that is injurious, as defined in rules adopted by the department using reference levels no higher than the 97.5th percentile of blood lead levels in children established by a national health and nutrition examination survey adopted by the federal Department of Health and Human Services, Centers for Disease Control and Prevention." (downloaded August 23, 2018 from: http://legislature.maine.gov/statutes/22/title22sec1315.html).

concentrations exceeding 10 µg Pb/dL in fetuses of women exposed to environmental lead is no greater than 5%.

The default parameters incorporated in the IEUBK and the ALM can be found in EPA guidance[21, 22].

If alternate bioavailability values are proposed (based either on in vivo studies, blood lead studies, or other studies) for use in the IEUBK model or the Adult model, the proposed values should be submitted to MeCDC and the Technical Review Workgroup (TRW) for Lead for review. The proposed values should be compared to current guidance regarding use of the IEUBK, blood lead studies, and other studies.

7 Risk Characterization

The information from the exposure assessment and the toxicity assessment is integrated to form the basis for the characterization of human health risks. The risk characterization presents qualitative and quantitative descriptions of potential risks with a discussion of the assumptions and uncertainties. The risk characterization serves as the bridge between risk assessment and risk management.

The risk characterization should include the following elements in the final discussion:

- Confidence that key site-related contaminants have been identified, and their nature and extent fully characterized;
- Description of known or predicted health risks;
- Confidence in the toxicity information supporting the risk estimates;
- Confidence in the exposure assessment estimates;
- Magnitude of the cancer and noncancer risks relative to the site-remediation goals; and
- Major factors driving the risks including contaminants, pathways, and scenarios.

For more information regarding risk characterization, refer to EPA RAGs Step 4, Risk Characterization.

For each receptor, cancer risks and hazard quotients should be summed across all contaminants and media of concern to estimate the cumulative cancer risk and hazard index

[21] EPA Website, "Lead at Superfund Sites: Software and Users' Manuals" downloaded August 14, 2018 from: https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals

[22] EPA website, "Lead at Superfund Sites: Guidance" downloaded August 14, 2018 from: https://www.epa.gov/superfund/lead-superfund-sites-guidance, including:

- Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (1994)
- IEUBK model (2009)
- Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil (2003) and
- ALM Spreadsheet (USEPA, 2003)

for that receptor. Cancer risk should additionally be summed across age groups (e.g., adult plus child resident cancer risks) to generate a total receptor cancer risk, as applicable. The Agencies use a benchmark Incremental Lifetime Cancer Risk (ILCR) level of 1 x 10^{-5} and a benchmark Hazard Index (HI) of 1. These benchmarks are compared with the cumulative HI (added across all contaminants and media of concern) and the total ILCR for each receptor. Where the cumulative HI exceeds 1, consider providing a target organ segregation rationale to demonstrate that the COPCs contributing to the HI in excess of 1 act thorough distinct mechanisms of actions and on different target organs. Use this information to calculate target organ-specific hazards. The DEP uses the benchmark HI and ILCR above to determine when remedial action or mitigation is necessary to protect public health.

8 Acute Toxicity Values

When the risk assessment indicates that there is a significance exceedance of chronic risk endpoints, then acute health risk should be assessed to determine if emergency or early actions are needed. As with subchronic toxicity values, there is no centralized database for acute toxicity values. ATSDR develops MRLs for acute exposures ranging from 1 to 14 days in duration[23]. For inhalation exposures, EPA maintains a website with acute toxicity values from a variety of sources and for a variety of exposure durations (generally ranging from 1 hour to 8 hour exposures)[24].

Risk assessors are encouraged to work closely with MeCDC toxicologists to select acute toxicity values most applicable to the exposure scenario of interest. However, use of Acute Exposure Guideline Levels (AEGLs) is inappropriate for assessing acute air exposure risk at remediation sites since AEGLs were developed to assess the risk resulting from a once-in-a-lifetime exposure to airborne chemicals from catastrophic events.

9 Development of Alternative Cleanup Levels

Consult the latest EPA guidance on calculating Preliminary Remediation Goals (PRGs).[25]

[23] ATSDR Webpage: Toxic Substances Portal, Minimal Risk Levels (MRLs) – For Professionals, downloaded August 14, 2018 from: http://www.atsdr.cdc.gov/mrls/index.html

[24] EPA webpage "Dose-Response Assessment for Assessing Health Risks Associated With Exposure to Hazardous Air Pollutants" downloaded August 14, 2018 from: https://www.epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants

[25] EPA Region 8 Website, "Calculating Preliminary Remediation Goals (PRGs)" downloaded August 15, 2018 from: https://www.epa.gov/region8/calculating-preliminary-remediation-goals-prgs.