Maine Department of Environmental Protection

Remedial Action Guidelines for Contaminated Sites (RAGs)

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Approved by: David Burns

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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:

1. determine which sites pose a risk and therefore warrant abatement, mitigation, and/or remediation;
2. establish target clean-up levels; and
3. 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 and are supported by the Maine CDC.

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

Maine DEP provides two options for assessing the risk posed by a contaminated site, determining target clean-up goals, and determining if the site can be closed out. The first option is to use these RAGs, and the second option is to do a site-specific risk assessment using the procedures in Attachment B. The RAGs are

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

intended to simplify derivation of clean-up goals for sites and speed-up the decision-making process.

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 Party, DEP, EPA, Department of Defense, or other party. The exception to this is if DEP determines, in consultation with Maine 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, No Further Action determinations, Certificate of Completions, 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 RAGs 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, usually 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 and other federal lead agencies consider using this guidance to establish clean-up goals for sites being investigated and remediated under Superfund in Maine. 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 that releases of hazardous waste and constituents be completely removed where practical. When not practical, 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.

Note that RCRA requirements are not risk-based, so additional standards may apply as compared to these RAGs, or additional clean-up may be necessary even if the chemicals do not meet Hazardous Waste classification. For example, A PCB release of less than 50 PPM would not be a hazardous waste but could result in concentrations over the RAG guideline for all scenarios, so further assessment would be warranted to protect public health. Conversely, a site with Bis(2-ethylhexyl) phthalate in soil below 720 mg/kg would not pose a health risk, but the soil would still be considered hazardous waste. See Department Regulations Chapter 850 for lists of hazardous waste. Additionally, EPA's CompTox database can be used to determine if the chemicals at a given site are listed Hazardous Wastes.

3.1.6 Petroleum Remediation Sites

Except for DEP licensed Marine Oil Terminals, the petroleum remediation program utilizes the RAGs to complete risk-based cleanup decisions at oil discharge sites in Maine in accordance with Attachment C of this document.

3.1.7 Not Applicable to other DEP Programs

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

3.1.8 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, as described below.

3.1.8.1 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.

3.1.8.2 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 materials management staff (formerly solid waste 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, as defined in the Uncontrolled Hazardous Substance Sites Law, 38 M.R.S. § 1362.

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 Applicable to Petroleum Only

Except for DEP licensed Marine Oil Terminals, this procedure applies to media that are contaminated with only petroleum. Petroleum only sites must also follow the procedures in Attachment C. Petroleum includes leaded and non-leaded 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.

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 7. 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.

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.[2]

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.

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[2] 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.

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
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

A detailed description of how the RAGs were derived, including the references to the formulas and factors used to develop RAGs for each media/scenario/route-of-exposure is available in Attachment A: Technical Support Document for Maine 2021 Remedial Action Guidelines contains additional information. This section provides an overview of how the RAGs were derived.

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 1×10^{-5}. This goal is presumed to have been met when each contaminant is below its respective media guideline presented in Table 5 through Table 8.

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 by 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. Given the use of subchronic toxicity factors and the relative intensity of the

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[3] EPA Regional Screening Levels (RSLs) webpage: https://www.epa.gov/risk/regional-screening-levels-rsls, downloaded December 14, 2020.

Construction Worker exposure, Construction Worker RAGs are lower than the Residential and/or Soil Leaching to Groundwater RAGs, for some compounds.

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

4.1.4 Contaminant units, wet vs dry weight

The RAGs are expressed as a unit of contaminant per unit of media. For example, in soil the RAG might be expressed as 10 mg/kg. This means for every kilogram of soil, there are 10 milligrams of contaminant. Due to the relatively high weight of water, the weight of soil will vary greatly by location and over time as its moisture content changes. To standardize this variability, RAGs for solids are usually expressed on a dry-weight basis. This means that sample results for solids obtained at a site need to be expressed on a dry-weight basis as well. This is done by drying the sample at a standard temperature while weighing the soil, until the weight does not vary any more. Steps are taken to ensure that volatile or semi-volatile contaminants are not driven off during the drying process.

One exception to expressing solids on a dry weight basis is for fish-tissue, which is expressed as wet-weight. Each RAG table specifies the units of the guideline, and whether the units are based on wet- or dry-weight.

4.1.5 Complete Details on Derivation of RAGs and Factors

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 is 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 may have 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

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[4] *Maine's Uncontrolled Hazardous Substance Sites* law, 38 M.R.S. §§ 1361–1371.

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, air and other media 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 is termed a completed exposure pathway only when all five parts are present.[6]

4.2.9 Exposure Point

"Exposure Point" means an area 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).

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[5] 38 Maine Revised Statutes (MRS) § 3002(4).

[6] Adopted from the Agency for Toxic Substances and Disease Registry (ATSDR) Glossary of Terms: https://www.atsdr.cdc.gov/glossary.html. Downloaded December 14, 2020.

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:

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.

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 Project Lead

The "project lead" is the agency, group, organization or person that is the primary leader and funder 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.

4.2.17 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.

4.2.18 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.

4.2.19 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, 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. 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 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 and properly disposed;
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 properly disposed; and

Neat materials not properly stored and hot spots must be recovered and removed. "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. In keeping with this policy, the RAG values for contaminants in Table 5 through Table 8 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 - 20, 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

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[7] ASTM E1689 - 20, 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.

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

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, 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.

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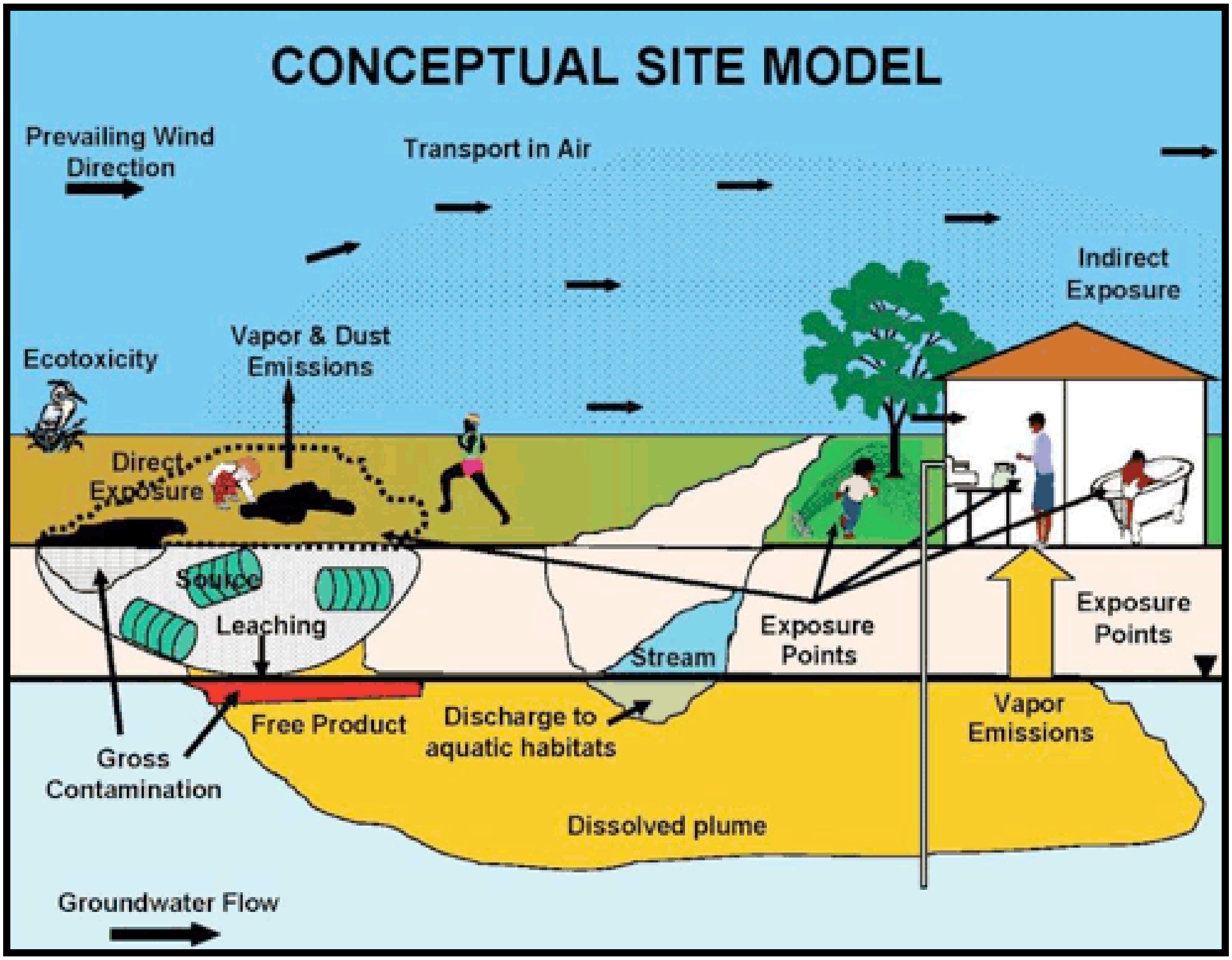
[9] ASTM E1689 - 20, Standard Guide for Developing Conceptual Site Models for Contaminated Sites is available at: https://www.astm.org/Standards/E1689.htm. Downloaded December 14, 2020.

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



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,

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[10] Interstate Technology Regulatory Council (ITRC), Incremental Sampling Methodology Guidance, d downloaded 6/21/20182018December 14, 2020 from: https://www.itrcweb.org/ism-1/3_1_2_Conceptual_Site_Models.htmlhttps://tphrisk-1.itrcweb.org/5-conceptual-site-models-and-investigative-strategies/.

[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. (Downloaded December 14, 2020.)

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 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. Based on the conceptual site model, a more discrete sampling interval may be appropriate, such as the upper six inches for a surface release. Soils below 15 feet are generally considered inaccessible for risk assessment purposes in Maine.

6.4.3 Assessing Vapor Intrusion

Vapor intrusion (VI) is the volatilization of hazardous substances from contaminated soil or groundwater into buildings. DEP considers measurement of contaminants in soil vapor and indoor air to be the best representation of VI potential and risk, as opposed to modeling. For additional information on VI, see DEP’s Supplemental Guidance for Vapor Intrusion of Chlorinated Solvents and Other Persistent Chemicals.[12]

6.4.4 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 significantly with its valence state. Hexavalent Chromium is orders of magnitude more toxic than trivalent chromium.

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

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[12] available at: http://www.maine.gov/dep/spills/publications/guidance/index.html (Downloaded December 14, 2020.)

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.

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 or a site-specific risk assessment to determine whether remedial action is necessary. When remedial action is indicated, establish target clean-up levels. The RAGs in Table 5 through Table 8 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[13] 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(s), and then select the appropriate table (see Table 2: Media to RAG Table);
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. Select the lowest value of the applicable exposure scenario;
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

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[13] Most chemical names have numerous synonyms. See EPA’s CompTox database for a compendium of synonyms, downloaded December 7, 2020 from: https://comptox.epa.gov/dashboard.

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[14] used in identifying the background level;
2. Typical Background Values presented in Table 6 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

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[14] 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 discussed in section 7.2.4. Similar statistical approaches should be used with site specific data to compare the site-specific dataset to the Maine background dataset.

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 6 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 ash, wood ash, degraded asphalt, 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 typical background concentrations of PAHs in Maine[15] 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.

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[15] 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 and downloadable as of December 14, 2020 from: https://www.maine.gov/dep/ftp/Rem0-site-reports-TMP/RAGS-Background-Documents/Background%20Soil_Report_MEDEP_11%2016%202012%20(2).pdf.

The PAH background concentrations in Table 6 should not be used at sites that are undeveloped. In these instances, site specific background samples should be collected.

7.2.5 Background PFAS Concentrations

Background concentrations of per and poly-fluoro alkyl substances (PFAS) have not been established in Maine. As described in the TSD, the background concentrations of PFAS in Table 6 were established based on a background PFAS study conducted in Vermont.

7.2.6 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.

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). 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 Crosswalk

Contaminated Media	Use Table
Soil (including hydric) and Sediment	Table 5
Indoor Air and Ambient Air	Table 6

Groundwater	Table 7
Fish Tissue – Recreational Angler	Table 8

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 5 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)[16] 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 in the future. Any alternative approach must be reviewed and approved by the DEP (see Section 3.1) before being implemented.

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. Use these scenarios for exposures of 26 years or less.

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 and Ambient Air

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

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[16] 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.

Therefore, DEP was not able to develop soil or groundwater guidelines that are protective of the vapor intrusion pathway.

Compare results of direct measurement of contaminants in soil vapor and indoor air to be the Indoor Air RAG; Sub-slab concentrations should be multiplied by an attenuation factor of 0.03, and then compared to Table 6. For additional information on VI, see DEP's Supplemental Guidance for Vapor Intrusion of Chlorinated Solvents and Other Persistent Chemicals.[17]

Exposure to Ambient Air is through breathing, or inhalation of contaminants in outside air. This may be from a non-point source (e.g. off-gassing of volatiles from contaminated soil), point source (e.g. off-gasses from a groundwater treatment system) or mobile sources (either on-road or off-road vehicles and equipment).

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). The agencies discontinued the RSC approach with the 2018 RAG update.

When investigating contaminated groundwater, the sample plan must consider what is being ingested. When sampling monitoring wells, DEP generally recommends using filtered samples to develop exposure point concentrations. However, when sampling drinking water supply wells, DEP recommends using unfiltered sample results to develop exposure point concentrations.

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 areas, 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. Use this scenario for exposures of 26 years or less. 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

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

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.[18]

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. Use this scenario for exposures of 26 years or less. 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.[19]

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 28. 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.

7.3.4.1 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

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[18] EPA Exposure Factors Handbook: 2011 Edition with chapter updates, downloaded December 14, 2020 from: https://www.epa.gov/expobox/about-exposure-factors-handbook.

[19] EPA Exposure Factors Handbook: 2011 Edition with chapter updates, downloaded December 14, 2020 from: https://www.epa.gov/expobox/about-exposure-factors-handbook..

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 workdays 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. Due to the exposure intensity and use of subchronic toxicity factors (see section 4.1.2), for some compounds the Construction Worker soil guideline will be lower than a residential or leaching to groundwater guidelines.

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.

Contaminants associated with suspended colloidal material may be ingested and would affect the receptor the same as the dissolved portion. Therefore, when assessing groundwater exposure risk to construction workers DEP recommends using unfiltered samples to determine Exposure Point Concentrations so that the samples represent total exposure rather than just exposure from the dissolved phase.

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 7, 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 Surface Water

RAGs have not been developed for surface water. Rather, exposure point concentrations should be compared to Chapter 584, Surface Water Quality Criteria for Toxic Pollutants. These rules are available at: https://www.maine.gov/sos/cec/rules/06/chaps06.htm.

7.3.8 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.

7.3.9 Soil Accessibility Determines Exposure

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.

7.3.10 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 6.

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 7 and/or the Leaching to Groundwater RAGs in Table 5 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 Additional Instructions for Select Contaminant Groups

7.5.1 Isomers of xylene, 1,2 dichloroethylene and 1,3-dichloropropane

The following parameters should be addressed as follows:

- Compare the sum of all xylene isomers to the total xylenes RAG.
- Compare 1,2 dichloroethylene results to the cis-1,2-dichloroethylene RAG.
- Compare the trans 1,3-dichloropropane to the 1,3-dichloropropane RAG.

7.5.2 Pesticide Classes

DDT, Endosulfan, Chlordane and Endrin are totaled for each pesticide class and compared to the parent compound's RAG, as follows:

- 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.

7.5.3 Dioxins and Co-Planar PCBs

The number and position of chlorines on the dioxin, furan and PCB molecule dictate its toxicity. Dioxins and furans occur as a mixture of congeners, as do PCBs. To address the additive effect of the toxicity of the mixture, the risk from dioxin is calculated on a toxicity equivalency

(TEQ) basis. Co-planar PCBs have dioxin like impacts. The RAGs are based on the TEQ equivalency for dioxin and these dioxin-like compounds. To calculate the TEQ of dioxin and co-planar PCBs use the following EPA guidance[20]:

> "In order to calculate a TEQ, a toxic equivalent factor (TEF) is assigned to each member of the dioxin and dioxin-like compounds category. The TEF is the ratio of the toxicity of one of the compounds in this category to the toxicity of the two most toxic compounds in the category, which are each assigned a TEF of 1: 2,3,7,8-tetrachlorodibenzo-p-dioxin ([2,3,7,8-TCDD]) and 1,2,3,7,8-pentachlorodibenzo-p-dioxin. TEFs that have been established through international agreements currently range from 1 to 0.0001.
>
> A TEQ is calculated by multiplying the [measured concentration in a given environmental media] of each dioxin and dioxin-like compound by its corresponding TEF (e.g., 10 [pico]grams X 0.1 TEF = 1 [pico]gram TEQ) and then summing the results. The number that results from this calculation is referred to as the TEQ. [This TEQ is then compared directly to the applicable 2,3,7,8-TCDD RAGs.]
>
> For example, consider the following 60g mixture:
> 10g of compound A, with a TEF of 1
> 20g of compound B, with a TEF of 0.5
> 30g of compound C, with a TEF of 0.2.
>
> The TEQ of this mixture would be:
> (10g x 1) + (20g x 0.5) + (30g x 0.2) = 26g TEQ,
>
> In other words, this mixture of 60g of various compounds would be as toxic as 26g of [2,3,7,8-TCDD.]

In cases where the analytical lab has reported two or more dioxin-like-compounds with a single concentration, due to compounds coeluting, the higher, or more stringent corresponding TEF should be applied to the reported concentration for calculation of the TEQ.

The toxicity equivalency factors to use in this calculation are shown in Table 3.

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[20] EPA Website, "Toxics Release Inventory (TRI) Program, Dioxin and Dioxin-Like Compounds Toxic Equivalency Information, How TEQs Are Calculated"(Downloaded November 19, 2020 from: https://www.epa.gov/toxics-release-inventory-tri-program/dioxin-and-dioxin-compounds-toxic-equivalency-information#:~:text=A%20TEQ%20is%20calculated%20by,and%20then%20summing%20the%20results.&text=In%20other%20words%2C%20this%20mixture,the%20two%20most%20toxic%20compounds.)

Table 3: Recommended toxicity equivalence factors (TEFs) for human health risk assessment of polychlorinated dibenzo-p-dioxins, dibenzofurans, and dioxin-like polychlorinated biphenyls[21]

Compound	TEF
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003
3,3',4,4'-TCB (77)	0.0001
3,4,4',5-TCB (81)	0.0003
3,3',4,4',5-PeCB (126)	0.1
3,3',4,4',5,5'-HxCB (169)	0.03
2,3,3',4,4'-PeCB (105)	0.00003
2,3,4,4',5-PeCB (114)	0.00003
2,3',4,4',5-PeCB (118)	0.00003
2',3,4,4',5-PeCB (123)	0.00003
2,3,3',4,4', 5 -HXCB (156)	0.00003
2,3,3',4,4',5'-HxCB (157)	0.00003
2,3',4,4',5,5'-HxCB (167)	0.00003
2,3,3',4,4',5,5'-HpCB (189)	0.00003
The numbers in parentheses following each PCB are the PCB congener numbers.	

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[21] From: USEPA, Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds (EPA/100/R-10/005, Downloaded November 4, 2020 from: https://www.epa.gov/sites/production/files/2013-09/documents/tefs-for-dioxin-epa-00-r-10-005-final.pdf) December 2010

7.5.4 Per and Poly Fluro Alkyl Substances (PFAS)

7.5.4.1 Incorporate Additional PFAS Guidance

Development of RAGs for per- and poly-fluoroalkyl substances (PFAS) is difficult due to the rapidly evolving science and lack of toxicity information. Currently EPA has identified over 9250 PFAS compounds but has input default toxicity values into its RSL calculator for only three (3) of them: PFOA, PFOS and PFBS. The Agencies calculated RAGs for these three compounds but were unable to recommend toxicity factor inputs for other PFAS compounds for this revision of the RAGs.

Given the evolving science for PFAS remediation, PFAS risk should be addressed as follows:

1. Compare Exposure Point Concentrations to the limited RAG values, published in the RAG tables (groundwater, soil/sediment and fish tissue).
2. Then compare all PFAS EPCs to the "PFAS Screening Levels" at: https://www1.maine.gov/dep/spills/topics/pfas/index.html. In particular compare EPC to the Crop-Specific soil screening levels; If there has been an update to any guidelines at this location, use those guidelines instead of the RAGs; and
3. Further, DEP will determine remedial action for PFAS compounds for which there are no DEP published guidelines on a case-by-case basis.

7.5.4.2 PFAS Groundwater Guidance

In December of 2019, EPA issued interim guidance for groundwater contaminated with PFOA and PFAS at federal remediation sites.[22] This guidance recommended using:

- a level of 40 parts per trillion (ppt) of PFOA and/or PFOS in groundwater as a trigger for further evaluation; and
- a level of 70 ppt PFOA and/or PFOS as the preliminary remediation goal (PRG) for contaminated groundwater.

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[22] EPA, Interim Recommendations to Address Groundwater Contaminated with Perfluorooctanoic Acid and Perfluorooctanesulfonate (Downloaded January 8, 2021 from: https://www.epa.gov/pfas/interim-recommendations-addressing-groundwater-contaminated-pfoa-and-pfos) December 19, 2019.

These recommendations built upon a 2016 EPA lifetime drinking water Health Advisory (HA) of 70 ppt, for the individual or combined concentrations of PFOA and PFOS in public drinking water supplies[23].

In January of 2020, the State of Maine PFAS "Task Force unanimously recommend[ed] that DEP and Maine CDC's [Drinking Water Program] consider applying the EPA health advisory level to the sum of at least PFHxS, PFNA, PFHpA, PFOA, and PFOS when detected in drinking water." [24]. This recommendation is being incorporated into this version of the RAGs for the residential groundwater pathway. For this version of the RAGs, this group of compounds and their salts were grouped together as the "Class II PFAS". Table 4 lists these Class II PFAS by preferred name, a unique CompTox identification number (DTXSID) and the traditional Chemical Abstract System Registry Number (CASRN). On the other hand, "Group I PFAS" are all-other PFAS. EPA maintains a current list of PFAS in its CompTox database, along with known and estimated physical, chemical, and toxicological properties. [25]

Table 4: Group II PFAS

Library Group*	**CASRN****	**PREFERRED NAME**	**DTXSID*****
PFOA	335-67-1	Perfluorooctanoic acid	DTXSID8031865
	NOCAS_893893	Perfluoroalkyl (linear) carboxylic acids	DTXSID00893893
	NOCAS_872963	Mixture of PFOS and PFOA	DTXSID20872963
	1017281-31-0	5,6,7,8-13C4-Perfluorooctanoic acid	DTXSID10892998
	3825-26-1	Ammonium perfluorooctanoate	DTXSID8037708
PFOS	45298-90-6	Perfluorooctanesulfonate	DTXSID80108992
	NOCAS_896832	Perfluoroalkyl (linear) sulfonates	DTXSID30896832
	1763-23-1	Perfluorooctanesulfonic acid	DTXSID3031864
	NOCAS_872963	Mixture of PFOS and PFOA	DTXSID20872963
	251099-16-8	N-Decyl-N,N-dimethyl-1-decanaminium perfluorooctanesulfonate	DTXSID00882964
	1379454-92-8	1-Octanesulfonic acid, 1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluoro-, ammonium salt, ion(1-) (1:1)	DTXSID501015039
PFHpA	375-85-9	Perfluoroheptanoic acid	DTXSID1037303
	NOCAS_893893	Perfluoroalkyl (linear) carboxylic acids	DTXSID00893893

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[23] EPA, Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA). EPA 822-R-16-005. (downloaded January from: https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final-plain.pdf) May 2016; and
EPA, Drinking Water Health Advisory for Perfluorooctanoic Sulfonate (PFOS). EPA 822-R-1 6-004. (downloaded January from: https://www.epa.gov/sites/production/files/2016-05/documents/pfos_health_advisory_final-plain.pdf) May 2016.

[24] Managing PFAS in Maine, Final Report from the Maine PFAS Task Force, January 2020, Pg 20 (downloaded December 14, 2020 from: https://www.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf)

[25] Note, see EPA's CompTox database for the current list of PFAS compounds (on December 14, 2020 this was located at: https://comptox.epa.gov/dashboard/chemical_lists/)

Library Group*	CASRN**	PREFERRED NAME	DTXSID***
PFNA	375-95-1	Perfluorononanoic acid	DTXSID8031863
	NOCAS_893893	Perfluoroalkyl (linear) carboxylic acids	DTXSID00893893
PFHxS	108427-53-8	Perfluorohexanesulfonate	DTXSID80873012
	NOCAS_896832	Perfluoroalkyl (linear) sulfonates	DTXSID30896832
Notes:	*Library Group Name	As assigned in EPA’s CompTox Database	
	**CASRN	Chemical Abstract System Registry Number	
	***DTXSID	Chemical Identification number in EPA's web based CompTox Chemistry Dashboard	

7.5.4.1 PFAS Soil Guidance

Preliminary site investigations in Maine suggests that the soil screening levels based on direct soil contact may be inadequate to protect individuals from exposure through cow’s milk at farms where PFOS is present in the soil. That is, PFAS are an unusual case where, rather than direct soil contact by a child, risk is driven by a soil-to-fodder, fodder-to-cow’s milk, and milk-to-human exposure pathway. Therefore, at PFAS sites where leaching to groundwater standards are not established (e.g. public water is available and land use controls prohibit groundwater extraction), the agricultural exposure pathway must be assessed, in addition to direct contact scenarios.

7.6 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 7. 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[26], 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

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[26] USEPA OSWER Directive 9283.1-33, “Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration (Downloaded December 14, 2020 from: http://www.epa.gov/superfund/contaminant-media-and-site-type-specific-consultation-directives) June 26, 2009.

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
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.

7.7 Variances from Default Exposure Factors

The RAGs were derived using average and conservative default exposure factors in accordance with Superfund Risk Assessment Guidance and the RSL calculator. On the other hand, not all potential pathways were considered (e.g. gardening pathway) and for some contaminants certain routes of exposure could not be quantified (e.g. dermal contact). 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 that were used to establish the RAGs are available in Attachment A. In general, the Agencies used the EPA default exposure factors in the RSL calculator. However, some region-specific exposure factors were selected, particularly related to weather, that are more appropriate for Maine. Attachment A details the exposure factors used the rationale for their use.

7.8 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 the risk-based guidelines 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.

A good way to determine if the chemical(s) detected at a given site may be subject to other standards is to access EPA's CompTox Database and use the list look-up tool. In that database you can also select a list of interest when using the Chemical Batch look-up tool.

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 2), 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

NOTE: Microsoft Excel™ versions of Table 5-Table 8 can be found on the DEP website at:
http://www.maine.gov/dep/spills/publications/guidance/index.html

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

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	**Chemical**	**Chem Class**	**Leaching to Groundwater**	**Resident**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
83-32-9	Acenaphthene	SVOC	300	4,900	62,000	14,000	16,000	48,000			0.2	3.5
208-96-8	Acenaphthylene	SVOC	290	4,900	45,000	14,000	16,000	48,000		0.3	0.39	1.4
67-64-1	Acetone	VOC	160	52,000	100,000	81,000	100,000	98,000				
75-05-8	Acetonitrile	VOC	1.4	1,200	5,100	28,000	100,000	4,600				
98-86-2	Acetophenone	SVOC	32	11,000	100,000	30,000	35,000	100,000				
107-02-8	Acrolein	VOC	0.00046	0.21	0.9	4.7	180	0.58				
107-13-1	Acrylonitrile	VOC	0.0063	3.7	17	34	58	14				
15972-60-8	Alachlor	Pesticide	0.48	130	560	380	440	2,600				
309-00-2	Aldrin	SVOC	0.083	0.54	2.5	1.6	1.8	14				
107-05-1	Allyl Chloride	VOC	0.037	2.5	10	56	1,500	14				
7429-90-5	Aluminum	Metal	100,000	100,000	100,000	100,000	100,000	27,000				
62-53-3	Aniline	SVOC	2.5	610	5,500	1,700	2,000	1,700				
120-12-7	Anthracene	SVOC	3,200	25,000	100,000	70,000	81,000	100,000		0.3	0.4	6.7
7440-36-0	Antimony (metallic)	Metal	19	43	640	120	140	130	0.71			
12674-11-2	Aroclor 1016	PCB	7.4	5.6	70	16	18	16				
7440-38-2	Arsenic, Inorganic	Metal	0.83	9.3	41	26	30	54	16			
1912-24-9	Atrazine	SVOC	0.11	32	140	92	110	770				
7440-39-3	Barium	Metal	8,600	21,000	100,000	61,000	70,000	20,000	470			
100-52-7	Benzaldehyde	SVOC	2.3	2,400	11,000	6,800	7,800	62,000				
71-43-2	Benzene	VOC	0.13	17	75	230	570	240				
56-55-3	Benzo(a)anthracene	SVOC	5.8	16	280	45	52	1,700		0.9	1.6	27
50-32-8	Benzo(a)pyrene	SVOC	16	1.6	29	4.5	5.2	9.9		1.5	1.7	5.2

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	Chemical	Chem Class	Leaching to Groundwater	Resident	Commercial Worker	Park User	Recreator Sediment	Construction Worker	Undeveloped	Rural Developed	Urban Developed	Urban Fill
205-99-2	Benzo(b)fluoranthene	SVOC	170	16	290	45	52	1,700		1.3	2	6.8
191-24-2	Benzo(g,h,i)perylene	SVOC	100,000	2,500	23,000	7,000	8,100	72,000		0.6	0.79	16
207-08-9	Benzo(k)fluoranthene	SVOC	1,600	160	2,900	450	520	17,000		0.7	0.76	12
65-85-0	Benzoic Acid	SVOC	830	100,000	100,000	100,000	100,000	11,000				
100-51-6	Benzyl Alcohol	SVOC	26	8,600	100,000	25,000	28,000	77,000				
100-44-7	Benzyl Chloride	VOC	0.054	16	70	120	180	81				
7440-41-7	Beryllium and compounds	Metal	1,100	210	3,200	610	700	110	2.4			
92-52-4	Biphenyl, 1,1'-	SVOC	0.48	71	300	1,600	3,900	400				
111-44-4	Bis(2-chloroethyl)ether	SVOC	0.002	3.3	15	21	28	62				
117-81-7	Bis(2-ethylhexyl)phthalate	SVOC	730	530	2,200	1,500	1,700	5,100				
7440-42-8	Boron And Borates Only	Metal	700	21,000	100,000	61,000	70,000	43,000				
108-86-1	Bromobenzene	VOC	2.3	380	650	530	2,800	620				
74-97-5	Bromochloromethane	VOC	1.1	220	940	4,000	100,000	330				
75-27-4	Bromodichloromethane	VOC	0.02	4.4	19	83	500	70				
75-25-2	Bromoform	VOC	0.48	280	790	720	4,000	890				
74-83-9	Bromomethane	VOC	0.11	10	45	160	490	120				
106-94-5	Bromopropane, 1-	VOC	3.5	330	970	970	100,000	970				
106-99-0	Butadiene, 1,3-	VOC	0.021	1.1	4.9	17	52	1.6				
85-68-7	Butyl Benzyl Phthalate	SVOC	130	3,900	17,000	11,000	13,000	99,000				
104-51-8	Butylbenzene, n-	VOC	180	5,400	80,000	15,000	18,000	34,000				
135-98-8	Butylbenzene, sec-	VOC	320	11,000	100,000	30,000	35,000	34,000				
98-06-6	Butylbenzene, tert-	VOC	86	11,000	100,000	30,000	35,000	34,000				
DEP2041	C11-C22 Aromatics	Fuel	340	2,600	33,000	7,300	8,400	74,000				
DEP2042	C19-C36 Aliphatics	Fuel	NC	100,000	100,000	100,000	100,000	100,000				
DEP2038	C5-C8 Aliphatics	Fuel	92	1,700	11,000	7,500	9,500	430				
DEP2040	C9-C10 Aromatics	Fuel	15	660	3,500	4,700	7,000	2,600				
DEP2039	C9-C12 Aliphatics	Fuel	5,800	2,500	14,000	17,000	24,000	2,300				
DEP2043	C9-C18 Aliphatics	Fuel	26,000	2,500	14,000	17,000	24,000	4,800				
7440-43-9	Cadmium (Diet)	Metal	38	98	1,400	280	320	42	0.26			
86-74-8	Carbazole	SVOC	15	270	110	750	870	6,700				0.5

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	**Chemical**	**Chem Class**	**Leaching to Groundwater**	**Resident**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
75-15-0	Carbon Disulfide	VOC	13	690	740	720	35,000	720				
56-23-5	Carbon Tetrachloride	VOC	0.097	9.7	43	150	450	160				
12789-03-6	Chlordane	Pesticide	1.5	24	110	69	80	100				
115-28-6	Chlorendic acid	SVOC	15	0.81	35	230	270	2,000				
75-68-3	Chloro-1,1-difluoroethane, 1-	VOC	2,900	1,200	1,200	1,200	100,000	1,200				
106-47-8	Chloroaniline, p-	SVOC	0.086	37	160	110	120	130				
108-90-7	Chlorobenzene	VOC	2.9	410	740	680	7,000	740				
67-66-3	Chloroform	VOC	0.034	4.7	21	97	1,000	75				
74-87-3	Chloromethane	VOC	2.7	160	690	1,300	100,000	1,300				
91-58-7	Chloronaphthalene, Beta-	SVOC	210	6,500	82,000	19,000	22,000	48,000				
95-57-8	Chlorophenol, 2-	SVOC	4.9	540	8,000	1,500	1,800	2,700				
76-06-2	Chloropicrin	VOC	0.014	2.9	12	66	100,000	1.7				
95-49-8	Chlorotoluene, o-	VOC	13	2,100	32,000	6,100	7,000	800				
106-43-4	Chlorotoluene, p-	VOC	13	2,100	32,000	6,100	7,000	68,000				
16065-83-1	Chromium(III), Insoluble Salts	Metal	100,000	100,000	100,000	100,000	100,000	27,000				
18540-29-9	Chromium(VI)	Inorganic	0.37	4.2	89	12	14	46				
218-01-9	Chrysene	SVOC	5,000	1,600	29,000	4,500	5,200	100,000		1	2.3	6.4
7440-48-4	Cobalt	Metal	15	32	480	91	110	100	15			
7440-50-8	Copper	Metal	1,600	4,300	64,000	12,000	14,000	3,400	23			
108-39-4	Cresol, m-	SVOC	41	4,300	56,000	12,000	14,000	100,000				
95-48-7	Cresol, o-	SVOC	41	4,300	56,000	12,000	14,000	51,000				
106-44-5	Cresol, p-	SVOC	82	8,600	100,000	25,000	28,000	5,100				
59-50-7	Cresol, p-chloro-m-	SVOC	94	8,600	100,000	25,000	28,000	26,000				
98-82-8	Cumene	VOC	41	260	270	270	35,000	270				
57-12-5	Cyanide (CN-)	Inorganic	0.81	33	220	160	210	38				
110-82-7	Cyclohexane	VOC	720	120	120	120	100,000	120				
75-99-0	Dalapon	Herbicide	6.8	2,600	34,000	7,400	8,500	7,700				
72-54-8	DDD, p,p`- (DDD)	Pesticide	0.82	2.6	34	7.4	8.5	7.7				
72-55-9	DDE, p,p'-	Pesticide	6	27	130	79	92	100				

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	**Chemical**	**Chem Class**	**Leaching to Groundwater**	**Resident**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
50-29-3	DDT	Pesticide	43	26	120	73	85	160				
124-18-5	Decane	VOC	NC	NC	NC	NC	NC	100,000				
53-70-3	Dibenz(a,h)anthracene	SVOC	53	1.6	29	4.5	5.2	170		0.3	0.23	4.5
132-64-9	Dibenzofuran	SVOC	8	110	1,600	300	350	1,400				
96-12-8	Dibromo-3-chloropropane, 1,2-	Pesticide	7.9E-05	0.078	0.96	1.5	8.6	3.5				
124-48-1	Dibromochloromethane	VOC	0.13	110	530	320	370	3,000				
106-93-4	Dibromoethane, 1,2-	VOC	0.0012	0.54	2.4	6.8	16	8.9				
74-95-3	Dibromomethane (Methylene Bromide)	VOC	0.11	35	150	800	100,000	190				
84-74-2	Dibutyl Phthalate	SVOC	130	8,600	100,000	25,000	28,000	100,000				
110-57-6	Dichloro-2-butene, trans-1,4-	VOC	0.00034	0.11	0.48	2.5	100,000	1.8				
95-50-1	Dichlorobenzene, 1,2-	SVOC	16	360	380	370	32,000	380				
541-73-1	Dichlorobenzene, 1,3-	SVOC	16	290	300	290	32,000	300				
106-46-7	Dichlorobenzene, 1,4-	VOC	0.25	39	170	770	5,800	620				
91-94-1	Dichlorobenzidine, 3,3'-	SVOC	0.45	17	70	47	54	400				
75-71-8	Dichlorodifluoromethane	VOC	17	130	550	830	70,000	730				
107-06-2	Dichloroethane, 1,2-	VOC	0.027	6.9	30	110	340	110				
75-34-3	Dichloroethane,1,1-	VOC	0.43	53	230	980	5,500	850				
75-35-4	Dichloroethylene, 1,1-	VOC	5.6	340	1,200	1,100	18,000	200				
156-59-2	Dichloroethylene, 1,2-cis-	VOC**	0.57	200	1,400	480	700	1,400				
156-60-5	Dichloroethylene, 1,2-trans-	VOC**	1.2	100	450	1,400	7,000	1,200				
120-83-2	Dichlorophenol, 2,4-	SVOC	1.2	260	3,400	740	850	5,100				
78-87-5	Dichloropropane, 1,2-	VOC	0.15	23	99	420	840	14				
142-28-9	Dichloropropane, 1,3-	VOC**	7.1	2,100	32,000	6,100	7,000	68,000				
542-75-6	Dichloropropene, 1,3-	VOC	0.093	27	120	210	310	120				
60-57-1	Dieldrin	Pesticide	0.039	0.46	2	1.3	1.5	12				
84-66-2	Diethyl Phthalate	SVOC	330	69,000	100,000	100,000	100,000	100,000				
108-20-3	Diisopropyl Ether	VOC	21	2,300	2,300	2,300	100,000	2,000				
105-67-9	Dimethylphenol, 2,4-	SVOC	23	1,700	22,000	4,900	5,700	13,000				

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	**Chemical**	**Chem Class**	**Leaching to Groundwater**	**Resident**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
576-26-1	Dimethylphenol, 2,6-	SVOC	0.7	52	670	150	170	1,500				
528-29-0	Dinitrobenzene, 1,2-	SVOC	0.098	8.6	110	25	28	260				
99-65-0	Dinitrobenzene, 1,3-	SVOC	0.097	8.6	110	25	28	130				
100-25-4	Dinitrobenzene, 1,4-	SVOC	0.097	8.6	110	25	28	260				
51-28-5	Dinitrophenol, 2,4-	SVOC	2.4	170	2,200	490	570	5,100				
121-14-2	Dinitrotoluene, 2,4-	SVOC	0.18	24	100	68	78	600				
606-20-2	Dinitrotoluene, 2,6-	SVOC	0.037	5	21	14	16	130				
88-85-7	Dinoseb	Pesticide	7.1	86	1,100	250	280	260				
123-91-1	Dioxane, 1,4-	SVOC	0.052	74	340	260	310	1,700				
115-29-7	Endosulfan	Pesticide	76	640	9,600	1,800	2,100	1,700				
72-20-8	Endrin	Pesticide	5.1	26	340	74	85	77				
75-00-3	Ethyl Chloride	VOC	330	2,100	2,100	2,100	100,000	2,000				
60-29-7	Ethyl Ether	VOC	48	21,000	100,000	61,000	70,000	8,100				
97-63-2	Ethyl Methacrylate	VOC	8.1	1,100	1,100	1,100	100,000	830				
100-41-4	Ethylbenzene	VOC	0.92	86	380	400	2,800	470				
107-21-1	Ethylene Glycol	VOC	450	100,000	100,000	100,000	100,000	100,000				
111-76-2	Ethylene Glycol Monobutyl Ether	VOC	22	8,600	100,000	25,000	28,000	18,000				
206-44-0	Fluoranthene	SVOC	4,900	3,300	41,000	9,300	11,000	24,000		2	3.23	10
86-73-7	Fluorene	SVOC	300	3,300	41,000	9,300	11,000	96,000		0.2	0.29	4.4
16984-48-8	Fluoride	Anion	6,600	4,300	64,000	12,000	14,000	12,000				
50-00-0	Formaldehyde	VOC	0.043	160	720	1,100	1,500	2,500				
76-44-8	Heptachlor	Pesticide	0.063	1.9	8.7	5.9	6.9	34				
1024-57-3	Heptachlor Epoxide	Pesticide	0.016	0.97	4.5	2.9	3.4	4.4				
118-74-1	Hexachlorobenzene	SVOC	0.068	3	14	15	20	3.4				
87-68-3	Hexachlorobutadiene	SVOC	0.15	15	16	16	350	17				
319-84-6	Hexachlorocyclohexane, Alpha-	Pesticide	0.023	1.2	5	3.4	3.9	29				
319-85-7	Hexachlorocyclohexane, Beta-	Pesticide	0.081	4.1	17	12	14	100				

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	**Chemical**	**Chem Class**	**Leaching to Groundwater**	**Resident**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	Pesticide	0.13	7.8	35	22	26	3				
67-72-1	Hexachloroethane	SVOC	0.11	27	120	210	250	450				
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	WMD	0.2	110	530	320	370	3,000				
110-54-3	Hexane, N-	VOC	570	140	140	140	100,000	140				
591-78-6	Hexanone, 2-	VOC	0.48	290	2,000	1,000	1,800	300				
193-39-5	Indeno(1,2,3)pyrene	SVOC	540	16	290	45	52	1,700		0.4	0.74	3.3
7439-89-6	Iron	Metal	19,000	75,000	100,000	100,000	100,000	100,000				
78-59-1	Isophorone	SVOC	14	7,800	33,000	22,000	26,000	100,000				
67-63-0	Isopropanol	Alcohol	4.6	8,300	36,000	93,000	100,000	94,000				
7439-92-1	Lead	Metal	250	140	440	290	290	460	32			
121-75-5	Malathion	Pesticide	5.6	1,700	22,000	4,900	5,700	4,900				
7439-96-5	Manganese (Non-diet)	Metal	1,600	2,600	38,000	7,300	8,400	280	840			
94-74-6	MCPA	Herbicide	0.11	43	560	120	140	130				
93-65-2	MCPP	Herbicide	0.26	86	1,100	250	280	2,600				
7487-94-7	Mercuric Chloride	Metal	NC	32	480	91	110	490				
7439-97-6	Mercury (elemental)	Metal	1.8	3.1	3.1	3.1	100,000	3.1				
72-43-5	Methoxychlor	Pesticide	110	430	5,600	1,200	1,400	1,300				
79-20-9	Methyl Acetate	VOC	230	100,000	100,000	100,000	100,000	740				
78-93-3	Methyl Ethyl Ketone (2-Butanone)	VOC	64	20,000	28,000	25,000	100,000	11,000				
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	VOC	78	3,400	3,400	3,400	100,000	3,300				
22967-92-6	Methyl Mercury	Metal	770	11	160	30	35	100,000				
80-62-6	Methyl Methacrylate	VOC	17	2,300	2,400	2,400	100,000	2,200				
1634-04-4	Methyl tert-Butyl Ether (MTBE)	VOC	1.8	690	3,000	5,600	17,000	8,200				
88-19-7	Methylbenzene sulfonamide, 2-	SVOC	2.3	3,500	33,000	9,800	11,000	10,000				

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	Chemical	Chem Class	Leaching to Groundwater	Resident	Commercial Worker	Park User	Recreator Sediment	Construction Worker	Undeveloped	Rural Developed	Urban Developed	Urban Fill
70-55-3	Methylbenzene sulfonamide, 4-	SVOC	41	9,900	94,000	28,000	32,000	29,000				
75-09-2	Methylene Chloride	VOC	1.5	490	2,500	1,200	2,100	1,900				
90-12-0	Methylnaphthalene, 1-	SVOC	3.3	240	990	680	790	6,000				
91-57-6	Methylnaphthalene, 2-	SVOC	10	330	4,100	930	1,100	960		0.2	0.09	0.4
7439-98-7	Molybdenum	Metal	110	540	8,000	1,500	1,800	7,400	0.98			
91-20-3	Naphthalene	SVOC	0.21	29	120	150	190	130		0.1	0.22	0.8
7440-02-0	Nickel Soluble Salts	Metal	1,400	2,100	32,000	6,100	7,000	990	39			
14797-55-8	Nitrate	Nutrient	NC	100,000	100,000	100,000	100,000	100,000				
100-01-6	Nitroaniline, 4-	SVOC	0.87	350	1,600	980	1,100	2,500				
55-63-0	Nitroglycerin	WMD	0.047	8.6	110	25	28	26				
86-30-6	Nitrosodiphenylamine, N-	SVOC	37	1,500	6,400	4,300	5,000	37,000				
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	WMD	70	5,300	78,000	15,000	17,000	17,000				
117-84-0	Octyl Phthalate, di-N-	SVOC	3,100	860	11,000	2,500	2,800	26,000				
56-38-2	Parathion	Pesticide	24	520	6,700	1,500	1,700	110				
608-93-5	Pentachlorobenzene	SVOC	1.3	86	1,300	240	280	2,700				
87-86-5	Pentachlorophenol	Herbicide	0.031	14	54	40	46	190				
78-11-5	Pentaerythritol tetranitrate (PETN)	WMD	3.2	170	2,200	490	570	510				
14797-73-0	Perchlorate and Perchlorate Salts	Inorganic		75	1,100	210	250	240				
375-73-5	Perfluorobutane sulfonic acid (PFBS)	PFAS*	7.1	1,700	22,000	4,900	5,700	51,000	0.00059			
1763-23-1	Perfluorooctane sulfonic acid (PFOS)	PFAS*	0.0036	1.7	22	4.9	5.7	5.1	0.0034			
335-67-1	Perfluorooctanoic acid (PFOA)	PFAS*	0.0017	1.7	22	4.9	5.7	5.1	0.0016			
85-01-8	Phenanthrene	SVOC	320	2,500	23,000	7,000	8,100	72,000		0.8	1.6	6.1
108-95-2	Phenol	SVOC	180	26,000	100,000	74,000	85,000	100,000				

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	**Chemical**	**Chem Class**	**Leaching to Groundwater**	**Resident**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
298-02-2	Phorate	Pesticide	0.19	17	220	49	57	51				
88-99-3	Phthalic Acid	SVOC	790	100,000	100,000	100,000	100,000	94,000				
1336-36-3	Total Polychlorinated Biphenyls (high persistence)	PCB	3.8	3.1	13	9.6	11	74				
103-65-1	Propyl benzene	VOC	67	260	260	260	35,000	260				
107-98-2	Propylene Glycol Monomethyl Ether	VOC	36	44,000	97,000	71,000	100,000	100,000				
129-00-0	Pyrene	SVOC	720	2,500	31,000	7,000	8,100	72,000		2	2.8	9.5
7782-49-2	Selenium	Metal	29	540	8,000	1,500	1,800	1,700	0.61			
7440-22-4	Silver	Metal	44	540	8,000	1,500	1,800	1,700				
7440-24-6	Strontium, Stable	Metal	23,000	64,000	100,000	100,000	100,000	100,000				
100-42-5	Styrene	VOC	73	830	870	860	70,000	860				
1746-01-6	TCDD, 2,3,7,8- Dioxin and Dioxin Like PCBs, TEQ	Dioxin/ Furan***	3.3E-05	6.5E-05	0.0003	0.0002	0.0002	0.0016				
95-94-3	Tetrachlorobenzene, 1,2,4,5-	SVOC	0.44	32	480	91	110	10				
630-20-6	Tetrachloroethane, 1,1,1,2-	VOC	0.12	30	130	410	1,200	480				
79-34-5	Tetrachloroethane, 1,1,2,2-	VOC	0.016	8.9	39	88	160	150				
127-18-4	Tetrachloroethylene	VOC	1	120	160	150	2,100	84				
58-90-2	Tetrachlorophenol, 2,3,4,6-	SVOC	9.9	2,600	34,000	7,400	8,500	77,000				
109-99-9	Tetrahydrofuran	VOC	41	27,000	100,000	100,000	100,000	20,000				
479-45-8	Tetryl (Trinitrophenylmethylnitramine)	WMD	20	210	3,200	610	700	6,800				
7440-28-0	Thallium (Soluble Salts)	Metal	0.78	1.1	16	3	3.5	14				
7440-31-5	Tin	Metal	100,000	64,000	100,000	100,000	100,000	100,000				
108-88-3	Toluene	VOC	42	750	810	790	28,000	820				
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	VOC	1,400	910	910	910	100,000	910				
87-61-6	Trichlorobenzene, 1,2,3-	VOC	1.2	86	1,300	240	280	2,700				
120-82-1	Trichlorobenzene, 1,2,4-	SVOC	0.64	86	380	360	1,100	400				

Dry Weight Basis			Soil RAG (mg/kg)						Background (mg/Kg)			
CAS	**Chemical**	**Chem Class**	**Leaching to Groundwater**	**Resident**	**Commercial Worker**	**Park User**	**Recreator Sediment**	**Construction Worker**	**Undeveloped**	**Rural Developed**	**Urban Developed**	**Urban Fill**
71-55-6	Trichloroethane, 1,1,1-	VOC	150	640	640	640	100,000	640				
79-00-5	Trichloroethane, 1,1,2-	VOC	0.0074	2.2	9.4	49	550	13				
79-01-6	Trichloroethylene	VOC	0.056	6.1	28	77	180	4.2				
75-69-4	Trichlorofluoromethane	VOC	180	32,000	100,000	91,000	100,000	940				
95-95-4	Trichlorophenol, 2,4,5-	SVOC	220	8,600	100,000	25,000	28,000	77,000				
88-06-2	Trichlorophenol, 2,4,6-	SVOC	0.64	86	1,100	250	280	260				
93-76-5	Trichlorophenoxyacetic Acid, 2,4,5-	Pesticide	3.7	860	11,000	2,500	2,800	26,000				
93-72-1	Trichlorophenoxypropionic acid, -2,4,5	Herbicide	3.4	690	9,000	2,000	2,300	2,100				
96-18-4	Trichloropropane, 1,2,3-	VOC	0.00018	0.07	1.5	0.2	0.23	4.3				
526-73-8	Trimethylbenzene, 1,2,3-	VOC	4.4	230	290	270	3,500	290				
95-63-6	Trimethylbenzene, 1,2,4-	VOC	4.4	180	220	200	3,500	220				
108-67-8	Trimethylbenzene, 1,3,5-	VOC	4.8	160	180	170	3,500	180				
118-96-7	Trinitrotoluene, 2,4,6-	SVOC	3.1	50	700	140	160	150				
7440-33-7	Tungsten	Metal	130	86	1,300	240	280	2,700				
7440-62-2	Vanadium and Compounds	Metal	4,800	540	8,000	1,500	1,800	490	100			
108-05-4	Vinyl Acetate	VOC	4.8	1,400	2,700	2,700	100,000	140				
593-60-2	Vinyl Bromide	VOC	0.059	3.8	17	87	100,000	61				
75-01-4	Vinyl Chloride	VOC	0.0036	0.64	24	0.71	1	63				
1330-20-7	Total Xylenes**	VOC	11	260	260	260	70,000	260				
7440-66-6	Zinc and Compounds	Metal	21,000	32,000	100,000	91,000	100,000	100,000	100			

Notes: PFAS*, also see the guidelines at: https://www1.maine.gov/dep/spills/topics/pfas/index.html
VOC** see section 7.5.1
DIOXIN/FURAN*** for Dioxins and Co-Planar PCBs see section 7.5.3
NC means “not calculated”.
WMD means “Weapons of Mass Destruction”

Table 6: Maine Remedial Action Guidelines for the Indoor Air Exposure Pathway, by Exposure Scenario

Notes:

1. Multiply sub slab concentrations by an attenuation factor of 0.03 before comparing the results to the appropriate indoor air RAG in this table (see Section 6.4.2).
2. Conversion to parts per billion (volume): Concentration (ug/m^3) = 0.0409 x concentration (ppb) x molecular weight, when at 1 ATM pressure and temperature of 25^o Celsius. [27]
3. The Ambient Air Lead RAG is based on the National Ambient Air Quality Standard for Lead, which was last reviewed in 2016, and adopted by Maine under 38 MRS §584-A[28]
4. Note: VOC** see section 7.5.1
5. DIOXIN/FURAN*** for Dioxins and Co-Planar PCBs see section 7.5.3

				Air RAG (microgram per cubic meter) (Dry Weight)		
CAS	**Chemical**	**Chemical Class**	**Molecular Weight (g/mol)**	**Indoor Air Residential**	**Indoor Air Commercial**	**Ambient Air**
67-64-1	Acetone	VOC	58.081	32,000	140,000	31,000
75-05-8	Acetonitrile	VOC	41.053	63	260	60
107-02-8	Acrolein	VOC	56.065	0.021	0.088	0.020
107-13-1	Acrylonitrile	VOC	53.064	0.41	1.8	0.15
309-00-2	Aldrin	SVOC	364.92	0.0057	0.025	0.0020
107-05-1	Allyl Chloride	VOC	76.526	1.0	4.4	1.0
7429-90-5	Aluminum	METAL	26.982	5.2	22	5.0

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[27] Center for Hazardous Substance Research, Understanding Units of Measure (Downloaded January 29, 2021 from: https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileid/14285) October 2006

[28] EPA Lead Air Pollution Website, National Ambient Air Quality Standards (NAAQS) for Lead (Pb) Fact Sheets and Additional Information, Downloaded January 29, 2021 from: https://www.epa.gov/lead-air-pollution/national-ambient-air-quality-standards-naaqs-lead-pb-fact-sheets-and-additional#:~:text=On%20September%2016%2C%202016%2C%20EPA,a%203%2D%20month%20average%20concentration.

CAS	Chemical	Chemical Class	Molecular Weight (g/mol)	Air RAG (microgram per cubic meter) (Dry Weight)		
				Indoor Air Residential	Indoor Air Commercial	Ambient Air
62-53-3	Aniline	SVOC	93.129	1.0	4.4	1.0
12674-11-2	Aroclor 1016	PCB	257.55	1.4	6.1	0.50
7440-38-2	Arsenic, Inorganic	METAL	74.922	0.0065	0.029	0.0023
7440-39-3	Barium	METAL	137.33	0.52	2.2	0.50
71-43-2	Benzene	VOC	78.115	3.6	16	1.3
56-55-3	Benzo(a)anthracene	SVOC	228.3	0.17	2.0	0.10
50-32-8	Benzo(a)pyrene	SVOC	252.32	0.0021	0.0088	0.0020
205-99-2	Benzo(b)fluoranthene	SVOC	252.32	0.17	2.0	0.10
207-08-9	Benzo(k)fluoranthene	SVOC	252.32	1.7	20	1.0
100-44-7	Benzyl Chloride	VOC	126.59	0.57	2.5	0.20
7440-41-7	Beryllium and compounds	METAL	9.01	0.012	0.051	0.0042
92-52-4	Biphenyl, 1,1'-	SVOC	154.21	0.42	1.8	0.40
111-44-4	Bis(2-chloroethyl)ether	SVOC	143.01	0.085	0.37	0.030
117-81-7	Bis(2-ethylhexyl)phthalate	SVOC	390.57	12	51	4.2
7440-42-8	Boron And Borates Only	METAL	13.84	21	88	20
108-86-1	Bromobenzene	VOC	157.01	63	260	60
74-97-5	Bromochloromethane	VOC	129.38	42	180	40
75-27-4	Bromodichloromethane	VOC	163.83	0.76	3.3	0.27
75-25-2	Bromoform	VOC	252.73	26	110	9.1
74-83-9	Bromomethane	VOC	94.939	5.2	22	5.0
106-94-5	Bromopropane, 1-	VOC	122.99	100	440	100
106-99-0	Butadiene, 1,3-	VOC	54.092	0.94	4.1	0.33
DEP2041	C11-C22 Aromatics	FUEL	152	52	220	50
DEP2038	C5-C8 Aliphatics	FUEL	93	210	880	200
DEP2040	C9-C10 Aromatics	FUEL	120	52	220	50
DEP2039	C9-C12 Aliphatics	FUEL	149	210	880	200

CAS	Chemical	Chemical Class	Molecular Weight (g/mol)	Air RAG (microgram per cubic meter) (Dry Weight)		
				Indoor Air Residential	**Indoor Air Commercial**	**Ambient Air**
DEP2043	C9-C18 Aliphatics	FUEL	170	210	880	200
7440-43-9	Cadmium (Diet)	METAL	112.4	0.010	0.044	0.0056
75-15-0	Carbon Disulfide	VOC	76.139	730	3,100	700
56-23-5	Carbon Tetrachloride	VOC	153.82	4.7	20	1.7
12789-03-6	Chlordane	PESTICIDE	409.78	0.28	1.2	0.10
115-28-6	Chlorendic acid	SVOC	388.9	1.1	4.7	0.39
75-68-3	Chloro-1,1-difluoroethane, 1-	VOC	100.5	52,000	220,000	50,000
108-90-7	Chlorobenzene	VOC	112.56	52	220	50
67-66-3	Chloroform	VOC	119.38	1.2	5.3	0.44
74-87-3	Chloromethane	VOC	50.488	94	390	90
76-06-2	Chloropicrin	VOC	164.38	0.42	1.8	0.40
18540-29-9	Chromium(VI)	INORGANIC	52	0.00012	0.0015	0.000072
218-01-9	Chrysene	SVOC	228.3	17	200	10
7440-48-4	Cobalt	METAL	58.93	0.0031	0.014	0.0011
108-39-4	Cresol, m-	SVOC	108.14	630	2,600	600
95-48-7	Cresol, o-	SVOC	108.14	630	2,600	600
106-44-5	Cresol, p-	SVOC	108.14	630	2,600	600
98-82-8	Cumene	VOC	120.2	420	1,800	400
57-12-5	Cyanide (CN-)	INORGANIC	26.018	0.83	3.5	0.80
110-82-7	Cyclohexane	VOC	84.163	6,300	26,000	6,000
72-54-8	DDD, p,p`- (DDD)	PESTICIDE	320.05	0.41	1.8	0.15
72-55-9	DDE, p,p'-	PESTICIDE	318.03	0.29	1.3	0.10
50-29-3	DDT	PESTICIDE	354.49	0.29	1.3	0.10
53-70-3	Dibenz(a,h)anthracene	SVOC	278.36	0.017	0.20	0.010
96-12-8	Dibromo-3-chloropropane, 1,2-	PESTICIDE	236.33	0.0017	0.020	0.0010
106-93-4	Dibromoethane, 1,2-	VOC	187.86	0.047	0.20	0.017

CAS	Chemical	Chemical Class	Molecular Weight (g/mol)	Air RAG (microgram per cubic meter) (Dry Weight)		
				Indoor Air Residential	Indoor Air Commercial	Ambient Air
74-95-3	Dibromomethane (Methylene Bromide)	VOC	173.84	4.2	18	4.0
110-57-6	Dichloro-2-butene, trans-1,4-	VOC	125	0.0067	0.029	0.0024
95-50-1	Dichlorobenzene, 1,2-	SVOC	147	210	880	200
106-46-7	Dichlorobenzene, 1,4-	VOC	147	2.6	11	0.91
91-94-1	Dichlorobenzidine, 3,3'-	SVOC	253.13	0.083	0.36	0.029
75-71-8	Dichlorodifluoromethane	VOC	120.91	100	440	100
107-06-2	Dichloroethane, 1,2-	VOC	98.96	1.1	4.7	0.39
75-34-3	Dichloroethane,1,1-	VOC	98.96	18	77	6.3
75-35-4	Dichloroethylene, 1,1-	VOC	96.944	210	880	200
156-59-2	Dichloroethylene, 1,2-cis-	VOC**	96.944	830	3,500	790
156-60-5	Dichloroethylene, 1,2-trans-	VOC**	96.944	42	180	40
78-87-5	Dichloropropane, 1,2-	VOC	112.99	4.2	18	2.7
542-75-6	Dichloropropene, 1,3-	VOC**	110.97	7.0	31	2.5
60-57-1	Dieldrin	PESTICIDE	380.91	0.0061	0.027	0.0022
108-20-3	Diisopropyl Ether	VOC	102.18	730	3,100	700
121-14-2	Dinitrotoluene, 2,4-	SVOC	182.14	0.32	1.4	0.11
123-91-1	Dioxane, 1,4-	VOC	88.107	5.6	25	2.0
75-00-3	Ethyl Chloride	VOC	64.515	10,000	44,000	10,000
97-63-2	Ethyl Methacrylate	VOC	114.15	310	1,300	300
100-41-4	Ethylbenzene	VOC	106.17	11	49	4.0
107-21-1	Ethylene Glycol	VOC	62.069	420	1,800	400
111-76-2	Ethylene Glycol Monobutyl Ether	VOC	118.18	1,700	7,000	1,600
16984-48-8	Fluoride	ANION	38	14	57	13
50-00-0	Formaldehyde	VOC	30.026	2.2	9.4	0.77
76-44-8	Heptachlor	PESTICIDE	373.32	0.022	0.094	0.0077

CAS	Chemical	Chemical Class	Molecular Weight (g/mol)	Air RAG (microgram per cubic meter) (Dry Weight)		
				Indoor Air Residential	**Indoor Air Commercial**	**Ambient Air**
1024-57-3	Heptachlor Epoxide	PESTICIDE	389.32	0.011	0.047	0.0039
118-74-1	Hexachlorobenzene	SVOC	284.78	0.061	0.27	0.022
87-68-3	Hexachlorobutadiene	SVOC	260.76	1.3	5.6	0.46
319-84-6	Hexachlorocyclohexane, Alpha-	PESTICIDE	290.83	0.016	0.068	0.0056
319-85-7	Hexachlorocyclohexane, Beta-	PESTICIDE	290.83	0.053	0.23	0.019
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	PESTICIDE	290.83	0.091	0.40	0.032
67-72-1	Hexachloroethane	SVOC	236.74	2.6	11	0.91
110-54-3	Hexane, N-	VOC	86.178	730	3,100	700
591-78-6	Hexanone, 2-	VOC	100.16	31	130	30
193-39-5	Indeno(1,2,3)pyrene	SVOC	276.34	0.17	2.0	0.10
78-59-1	Isophorone	SVOC	138.21	2,100	8,800	2,000
67-63-0	Isopropanol	ALCOHOL	60.097	210	880	200
7439-92-1	Lead	METAL	207.2			0.15
7439-96-5	Manganese (Non-diet)	METAL	54.938	0.052	0.22	0.050
7487-94-7	Mercuric Chloride	METAL	271.5	0.31	1.3	0.30
7439-97-6	Mercury (elemental)	METAL	200.59	0.31	1.3	0.30
78-93-3	Methyl Ethyl Ketone (2-Butanone)	VOC	72.108	5,200	22,000	5,000
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	VOC	100.16	3,100	13,000	3,000
80-62-6	Methyl Methacrylate	VOC	100.12	730	3,100	700
1634-04-4	Methyl tert-Butyl Ether (MTBE)	VOC	88.151	110	470	39
75-09-2	Methylene Chloride	VOC	84.933	630	2,600	600
91-20-3	Naphthalene	SVOC	128.18	0.83	3.6	0.29
7440-02-0	Nickel Soluble Salts	METAL	58.71	0.094	0.39	0.039
100-01-6	Nitroaniline, 4-	SVOC	138.13	6.3	26	6.0
86-30-6	Nitrosodiphenylamine, N-	SVOC	198.23	11	47	3.9

CAS	Chemical	Chemical Class	Molecular Weight (g/mol)	Air RAG (microgram per cubic meter) (Dry Weight)		
				Indoor Air Residential	**Indoor Air Commercial**	**Ambient Air**
87-86-5	Pentachlorophenol	HERBICIDE	266.34	5.5	24	2.0
108-95-2	Phenol	SVOC	94.114	210	880	200
88-99-3	Phthalic Acid	SVOC	166.13	21	88	20
1336-36-3	Total Polychlorinated Biphenyls (very low persistence)	PCB	291.99	0.049	0.22	0.018
103-65-1	Propyl benzene	VOC	120.2	1,000	4,400	1,000
107-98-2	Propylene Glycol Monomethyl Ether	VOC	90.123	2,100	8,800	2,000
7782-49-2	Selenium	METAL	78.96	21	88	20
100-42-5	Styrene	VOC	104.15	1,000	4,400	1,000
1746-01-6	TCDD, 2,3,7,8- Dioxin and Dioxin Like PCBs, TEQ	DIOXIN/ FURAN	321.98	0.00000074	0.0000032	0.00000026
630-20-6	Tetrachloroethane, 1,1,1,2-	VOC	167.85	3.8	17	1.4
79-34-5	Tetrachloroethane, 1,1,2,2-	VOC	167.85	0.48	2.1	0.17
127-18-4	Tetrachloroethylene	VOC	165.83	42	180	39
109-99-9	Tetrahydrofuran	VOC	72.108	2,100	8,800	2,000
108-88-3	Toluene	VOC	92.142	5,200	22,000	5,000
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	VOC	187.38	5,200	22,000	5,000
120-82-1	Trichlorobenzene, 1,2,4-	SVOC	181.45	2.1	8.8	2.0
71-55-6	Trichloroethane, 1,1,1-	VOC	133.41	5,200	22,000	5,000
79-00-5	Trichloroethane, 1,1,2-	VOC	133.41	0.21	0.88	0.20
79-01-6	Trichloroethylene	VOC	131.39	2.1	8.8	2.0
88-06-2	Trichlorophenol, 2,4,6-	SVOC	197.45	9.1	40	3.2
96-18-4	Trichloropropane, 1,2,3-	VOC	147.43	0.31	1.3	0.30
526-73-8	Trimethylbenzene, 1,2,3-	VOC	120.2	63	260	60
95-63-6	Trimethylbenzene, 1,2,4-	VOC	120.2	63	260	60

				Air RAG (microgram per cubic meter) (Dry Weight)		
CAS	**Chemical**	**Chemical Class**	**Molecular Weight (g/mol)**	**Indoor Air Residential**	**Indoor Air Commercial**	**Ambient Air**
108-67-8	Trimethylbenzene, 1,3,5-	VOC	120.2	63	260	60
7440-62-2	Vanadium and Compounds	METAL	50.94	0.10	0.44	0.10
108-05-4	Vinyl Acetate	VOC	86.091	210	880	200
593-60-2	Vinyl Bromide	VOC	106.95	1.9	8.2	0.67
75-01-4	Vinyl Chloride	VOC	62.499	1.7	28	1.1
1330-20-7	Xylenes	VOC	106.17	100	440	100

Table 7: Maine Remedial Action Guidelines for the Groundwater Exposure Pathway, by Exposure Scenario

CAS	Chemical	Chemical Class	Water RAG (ppb or ug/L) Residential	Water RAG (ppb or ug/L) Construction Worker	Notes
83-32-9	Acenaphthene	SVOC	540	74,000	
208-96-8	Acenaphthylene	SVOC	520	71,000	
67-64-1	Acetone	VOC	14,000	100,000	CW Ceiling
75-05-8	Acetonitrile	VOC	130	4,800	
98-86-2	Acetophenone	SVOC	1,900	100,000	CW Ceiling
107-02-8	Acrolein	VOC	0.042	0.53	
107-13-1	Acrylonitrile	VOC	0.52	11	
15972-60-8	Alachlor	PESTICIDE	11	16,000	
309-00-2	Aldrin	SVOC	0.0092	2.9	
107-05-1	Allyl Chloride	VOC	2.1	44	
7429-90-5	Aluminum	METAL	20,000	100,000	CW Ceiling
62-53-3	Aniline	SVOC	130	86,000	
120-12-7	Anthracene	SVOC	1,800	100,000	CW Ceiling
7440-36-0	Antimony (metallic)	METAL	7.8	2,100	
12674-11-2	Aroclor 1016	PCB	1.4	350	
7440-38-2	Arsenic, Inorganic	METAL	0.52	5,800	
1912-24-9	Atrazine	SVOC	3.0	11,000	
7440-39-3	Barium	METAL	3,800	100,000	CW Ceiling
100-52-7	Benzaldehyde	SVOC	190	100,000	CW Ceiling
71-43-2	Benzene	VOC	4.6	350	
56-55-3	Benzo(a)anthracene	SVOC	0.30	470	
50-32-8	Benzo(a)pyrene	SVOC	0.25	11,000	
205-99-2	Benzo(b)fluoranthene	SVOC	2.5	100,000	CW Ceiling
191-24-2	Benzo(g,h,i)perylene	SVOC	600	100,000	CW Ceiling
207-08-9	Benzo(k)fluoranthene	SVOC	25	100,000	CW Ceiling
65-85-0	Benzoic Acid	SVOC	75,000	100,000	CW Ceiling
100-51-6	Benzyl Alcohol	SVOC	2,000	100,000	CW Ceiling
100-44-7	Benzyl Chloride	VOC	0.89	26	
7440-41-7	Beryllium and compounds	METAL	25	1,400	
92-52-4	Biphenyl, 1,1'-	SVOC	0.83	29	
111-44-4	Bis(2-chloroethyl)ether	SVOC	0.14	54	
117-81-7	Bis(2-ethylhexyl)phthalate	SVOC	56	100,000	CW Ceiling
7440-42-8	Boron And Borates Only	METAL	4,000	100,000	CW Ceiling
108-86-1	Bromobenzene	VOC	62	1,200	
74-97-5	Bromochloromethane	VOC	83	600	
75-27-4	Bromodichloromethane	VOC	1.3	130	
75-25-2	Bromoform	VOC	33	5,500	
74-83-9	Bromomethane	VOC	7.6	490	
106-94-5	Bromopropane, 1-	VOC	210	2,800	
106-99-0	Butadiene, 1,3-	VOC	0.71	7.4	
85-68-7	Butyl Benzyl Phthalate	SVOC	160	100,000	CW Ceiling
104-51-8	Butylbenzene, n-	VOC	1,000	100,000	CW Ceiling
135-98-8	Butylbenzene, sec-	VOC	2,000	100,000	CW Ceiling

CAS	Chemical	Chemical Class	Water RAG (ppb or ug/L) Residential	Water RAG (ppb or ug/L) Construction Worker	Notes
98-06-6	Butylbenzene, tert-	VOC	690	25,000	
DEP2041	C11-C22 Aromatics	FUEL	600	100,000	CW Ceiling
DEP2042	C19-C36 Aliphatics	FUEL	40,000	100,000	CW Ceiling
DEP2038	C5-C8 Aliphatics	FUEL	180	960	
DEP2040	C9-C10 Aromatics	FUEL	71	2,700	
DEP2039	C9-C12 Aliphatics	FUEL	350	3,700	
DEP2043	C9-C18 Aliphatics	FUEL	350	3,900	
7440-43-9	Cadmium (Water)	METAL	9.2	940	
86-74-8	Carbazole	SVOC	15	13,000	
75-15-0	Carbon Disulfide	VOC	810	3,100	
56-23-5	Carbon Tetrachloride	VOC	4.6	700	
12789-03-6	Chlordane	PESTICIDE	0.20	3.7	
115-28-6	Chlorendic acid	SVOC	8.4	100,000	CW Ceiling
75-68-3	Chloro-1,1-difluoroethane, 1-	VOC	100,000	100,000	CW Ceiling
106-47-8	Chloroaniline, p-	SVOC	3.7	2,700	
108-90-7	Chlorobenzene	VOC	78	2,600	
67-66-3	Chloroform	VOC	2.2	170	
74-87-3	Chloromethane	VOC	190	11,000	
91-58-7	Chloronaphthalene, Beta-	SVOC	750	81,000	
95-57-8	Chlorophenol, 2-	SVOC	91	29,000	
76-06-2	Chloropicrin	VOC	0.83	2.6	
95-49-8	Chlorotoluene, o-	VOC	240	3,300	
106-43-4	Chlorotoluene, p-	VOC	250	100,000	CW Ceiling
16065-83-1	Chromium(III), Insoluble Salts	METAL	23,000	100,000	CW Ceiling
18540-29-9	Chromium(VI)	INORGANIC	0.35	690	
218-01-9	Chrysene	SVOC	250	100,000	CW Ceiling
7440-48-4	Cobalt	METAL	6.0	81,000	
7440-50-8	Copper	METAL	800	100,000	CW Ceiling
108-39-4	Cresol, m-	SVOC	930	100,000	CW Ceiling
95-48-7	Cresol, o-	SVOC	930	100,000	CW Ceiling
106-44-5	Cresol, p-	SVOC	1,900	79,000	
59-50-7	Cresol, p-chloro-m-	SVOC	1,500	100,000	CW Ceiling
98-82-8	Cumene	VOC	450	500	
57-12-5	Cyanide (CN-)	INORGANIC	1.5	3.6	
110-82-7	Cyclohexane	VOC	13,000	83,000	
75-99-0	Dalapon	HERBICIDE	600	100,000	CW Ceiling
72-54-8	DDD, p,p`- (DDD)	PESTICIDE	0.063	1.7	
72-55-9	DDE, p,p'-	PESTICIDE	0.46	140	
50-29-3	DDT	PESTICIDE	2.3	19,000	
124-18-5	Decane	VOC	NC	100,000	No chronic tox info / CW Ceiling
53-70-3	Dibenz(a,h)anthracene	SVOC	0.25	26,000	
132-64-9	Dibenzofuran	SVOC	7.9	1,200	

CAS	Chemical	Chemical Class	Water RAG (ppb or ug/L) Residential	Water RAG (ppb or ug/L) Construction Worker	Notes
96-12-8	Dibromo-3-chloropropane, 1,2-	PESTICIDE	0.0033	1.2	
124-48-1	Dibromochloromethane	VOC	8.7	53,000	
106-93-4	Dibromoethane, 1,2-	VOC	0.075	8.7	
74-95-3	Dibromomethane (Methylene Bromide)	VOC	8.3	280	
84-74-2	Dibutyl Phthalate	SVOC	900	100,000	CW Ceiling
110-57-6	Dichloro-2-butene, trans-1,4-	VOC	0.013	1.0	
95-50-1	Dichlorobenzene, 1,2-	SVOC	300	12,000	
541-73-1	Dichlorobenzene, 1,3-	SVOC	300	6,200	
106-46-7	Dichlorobenzene, 1,4-	VOC	4.8	400	
91-94-1	Dichlorobenzidine, 3,3'-	SVOC	1.3	2,000	
75-71-8	Dichlorodifluoromethane	VOC	200	5,400	
107-06-2	Dichloroethane, 1,2-	VOC	1.7	140	
75-34-3	Dichloroethane,1,1-	VOC	28	2,200	
75-35-4	Dichloroethylene, 1,1-	VOC	290	960	
156-59-2	Dichloroethylene, 1,2-cis-	VOC**	35	3,700	
156-60-5	Dichloroethylene, 1,2-trans-	VOC**	68	3,900	
120-83-2	Dichlorophenol, 2,4-	SVOC	46	27,000	
78-87-5	Dichloropropane, 1,2-	VOC	8.3	22	
142-28-9	Dichloropropane, 1,3-	VOC**	370	100,000	CW Ceiling
542-75-6	Dichloropropene, 1,3-	VOC	4.7	200	
60-57-1	Dieldrin	PESTICIDE	0.018	13	
84-66-2	Diethyl Phthalate	SVOC	15,000	100,000	CW Ceiling
108-20-3	Diisopropyl Ether	VOC	1,500	3,700	
105-67-9	Dimethylphenol, 2,4-	SVOC	360	100,000	CW Ceiling
576-26-1	Dimethylphenol, 2,6-	SVOC	11	15,000	
528-29-0	Dinitrobenzene, 1,2-	SVOC	1.9	8,900	
99-65-0	Dinitrobenzene, 1,3-	SVOC	2.0	5,500	
100-25-4	Dinitrobenzene, 1,4-	SVOC	2.0	11,000	
51-28-5	Dinitrophenol, 2,4-	SVOC	39	100,000	CW Ceiling
121-14-2	Dinitrotoluene, 2,4-	SVOC	2.4	15,000	
606-20-2	Dinitrotoluene, 2,6-	SVOC	0.49	2,700	
88-85-7	Dinoseb	PESTICIDE	15	1,200	
123-91-1	Dioxane, 1,4-	VOC	4.6	8,600	
115-29-7	Endosulfan	PESTICIDE	100	12,000	
72-20-8	Endrin	PESTICIDE	2.3	87	
75-00-3	Ethyl Chloride	VOC	21,000	16,000	
60-29-7	Ethyl Ether	VOC	3,900	14,000	
97-63-2	Ethyl Methacrylate	VOC	630	12,000	
100-41-4	Ethylbenzene	VOC	15	1,400	
107-21-1	Ethylene Glycol	VOC	40,000	100,000	CW Ceiling
111-76-2	Ethylene Glycol Monobutyl Ether	VOC	2,000	100,000	CW Ceiling
206-44-0	Fluoranthene	SVOC	800	100,000	CW Ceiling
86-73-7	Fluorene	SVOC	290	100,000	CW Ceiling
16984-48-8	Fluoride	ANION	800	100,000	CW Ceiling

CAS	Chemical	Chemical Class	Water RAG (ppb or ug/L) Residential	Water RAG (ppb or ug/L) Construction Worker	Notes
50-00-0	Formaldehyde	VOC	3.9	22,000	
76-44-8	Heptachlor	PESTICIDE	0.014	3.9	
1024-57-3	Heptachlor Epoxide	PESTICIDE	0.014	5.5	
118-74-1	Hexachlorobenzene	SVOC	0.098	13	
87-68-3	Hexachlorobutadiene	SVOC	1.4	230	
319-84-6	Hexachlorocyclohexane, Alpha-	PESTICIDE	0.073	80	
319-85-7	Hexachlorocyclohexane, Beta-	PESTICIDE	0.25	280	
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	PESTICIDE	0.42	7.2	
67-72-1	Hexachloroethane	SVOC	3.3	470	
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	WMD	9.7	100,000	CW Ceiling
110-54-3	Hexane, N-	VOC	1,500	8,300	
591-78-6	Hexanone, 2-	VOC	38	240	
193-39-5	Indeno(1,2,3)pyrene	SVOC	2.5	100,000	CW Ceiling
7439-89-6	Iron	METAL	14,000	100,000	CW Ceiling
78-59-1	Isophorone	SVOC	780	100,000	CW Ceiling
67-63-0	Isopropanol	ALCOHOL	410	100,000	CW Ceiling
7439-92-1	Lead	METAL	5.0	NC	IEUBK and ALM model value. No published CW GW
121-75-5	Malathion	PESTICIDE	390	100,000	CW Ceiling
7439-96-5	Manganese (Non-diet)	METAL	430	37,000	
94-74-6	MCPA	HERBICIDE	7.5	680	
93-65-2	MCPP	HERBICIDE	16	16,000	
7487-94-7	Mercuric Chloride	METAL	5.7	5,200	
7439-97-6	Mercury (elemental)	METAL	0.63	2.1	
72-43-5	Methoxychlor	PESTICIDE	37	1,400	
79-20-9	Methyl Acetate	VOC	20,000	670	
78-93-3	Methyl Ethyl Ketone (2-Butanone)	VOC	5,600	9,000	
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	VOC	6,300	5,800	
22967-92-6	Methyl Mercury	METAL	2.0	100,000	CW Ceiling
80-62-6	Methyl Methacrylate	VOC	1,400	4,200	
1634-04-4	Methyl tert-Butyl Ether (MTBE)	VOC	140	13,000	
88-19-7	Methylbenzene sulfonamide, 2-	SVOC	800	100,000	CW Ceiling
70-55-3	Methylbenzene sulfonamide, 4-	SVOC	2,300	100,000	CW Ceiling
75-09-2	Methylene Chloride	VOC	110	4,900	
90-12-0	Methylnaphthalene, 1-	SVOC	11	8,800	
91-57-6	Methylnaphthalene, 2-	SVOC	36	1,500	
7439-98-7	Molybdenum	METAL	100	100,000	CW Ceiling
91-20-3	Naphthalene	SVOC	1.2	19	
7440-02-0	Nickel Soluble Salts	METAL	390	100,000	CW Ceiling

CAS	Chemical	Chemical Class	Water RAG (ppb or ug/L) Residential	Water RAG (ppb or ug/L) Construction Worker	Notes
14797-55-8	Nitrate	NUTRIENT	32,000	100,000	CW Ceiling
14797-65-0	Nitrite	NUTRIENT	2,000	100,000	CW Ceiling
100-01-6	Nitroaniline, 4-	SVOC	38	100,000	
55-63-0	Nitroglycerin	WMD	2.0	1,300	
86-30-6	Nitrosodiphenylamine, N-	SVOC	120	100,000	CW Ceiling
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	SVOC	1,000	100,000	CW Ceiling
117-84-0	Octyl Phthalate, di-N-	SVOC	200	100,000	CW Ceiling
56-38-2	Parathion	PESTICIDE	86	10,000	
608-93-5	Pentachlorobenzene	SVOC	3.2	930	
87-86-5	Pentachlorophenol	HERBICIDE	0.41	140	
78-11-5	Pentaerythritol tetranitrate (PETN)	WMD	39	18,000	
14797-73-0	Perchlorate and Perchlorate Salts	INORGANIC	14	14,000	
375-73-5	Perfluorobutane sulfonic acid (PFBS)	PFAS*	400	100,000	CW Ceiling See section 7.5.4
1763-23-1	Perfluorooctane sulfonic acid (PFOS)	PFAS*	See Group II PFAS	750	See section 7.5.4
	Sum of Group II PFAS*	PFAS*	0.070		See section 7.5.4
335-67-1	Perfluorooctanoic acid (PFOA)	PFAS*	See Group II PFAS	750	See section 7.5.4
85-01-8	Phenanthrene	SVOC	180	58,000	
108-95-2	Phenol	SVOC	5,800	100,000	CW Ceiling
298-02-2	Phorate	PESTICIDE	3.0	280	
88-99-3	Phthalic Acid	SVOC	40,000	100,000	CW Ceiling
1336-36-3	Total Polychlorinated Biphenyls (low persistence)	PCB	0.44	67	Res and CW RAGs are PCB (low risk)
103-65-1	Propyl benzene	VOC	660	4,900	
107-98-2	Propylene Glycol Monomethyl Ether	VOC	3,200	100,000	CW Ceiling
129-00-0	Pyrene	SVOC	120	36,000	
7782-49-2	Selenium	METAL	100	96,000	
7440-22-4	Silver	METAL	94	12,000	
7440-24-6	Strontium, Stable	METAL	12,000	100,000	CW Ceiling
100-42-5	Styrene	VOC	1,200	15,000	
1746-01-6	TCDD, 2,3,7,8- Dioxin and Dioxin Like PCBs, TEQ	DIOXIN/FURAN***	0.0000012	0.00033	
95-94-3	Tetrachlorobenzene, 1,2,4,5-	SVOC	1.7	5.6	
630-20-6	Tetrachloroethane, 1,1,1,2-	VOC	5.7	620	
79-34-5	Tetrachloroethane, 1,1,2,2-	VOC	0.76	90	
127-18-4	Tetrachloroethylene	VOC	41	250	

CAS	Chemical	Chemical Class	Water RAG (ppb or ug/L)		Notes
			Residential	Construction Worker	
58-90-2	Tetrachlorophenol, 2,3,4,6-	SVOC	240	93,000	
109-99-9	Tetrahydrofuran	VOC	3,400	16,000	
479-45-8	Tetryl (Trinitrophenylmethylnitramine)	SVOC	40	100,000	CW Ceiling
7440-28-0	Thallium (Soluble Salts)	METAL	0.20	770	
7440-31-5	Tin	METAL	12,000	100,000	CW Ceiling
108-88-3	Toluene	VOC	1,100	24,000	
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	VOC	10,000	100,000	CW Ceiling
87-61-6	Trichlorobenzene, 1,2,3-	VOC	7.0	2,900	
120-82-1	Trichlorobenzene, 1,2,4-	SVOC	4.0	140	
71-55-6	Trichloroethane, 1,1,1-	VOC	8,000	29,000	
79-00-5	Trichloroethane, 1,1,2-	VOC	0.42	12	
79-01-6	Trichloroethylene	VOC	2.8	12	
75-69-4	Trichlorofluoromethane	VOC	5,200	5,900	
95-95-4	Trichlorophenol, 2,4,5-	SVOC	1,200	100,000	CW Ceiling
88-06-2	Trichlorophenol, 2,4,6-	SVOC	12	690	
93-76-5	Trichlorophenoxyacetic Acid, 2,4,5-	PESTICIDE	160	100,000	CW Ceiling
93-72-1	Trichlorophenoxypropionic acid, -2,4,5	HERBICIDE	110	8,400	
96-18-4	Trichloropropane, 1,2,3-	VOC	0.0075	2.1	
526-73-8	Trimethylbenzene, 1,2,3-	VOC	55	1,000	
95-63-6	Trimethylbenzene, 1,2,4-	VOC	56	1,000	
108-67-8	Trimethylbenzene, 1,3,5-	VOC	60	1,100	
118-96-7	Trinitrotoluene, 2,4,6-	SVOC	9.8	6,800	
7440-33-7	Tungsten	METAL	16	100,000	CW Ceiling
7440-62-2	Vanadium and Compounds	METAL	86	10,000	
108-05-4	Vinyl Acetate	VOC	410	180	
593-60-2	Vinyl Bromide	VOC	3.7	250	
75-01-4	Vinyl Chloride	VOC	0.19	0.22	
1330-20-7	Xylenes	VOC	190	2,100	
7440-66-6	Zinc and Compounds	METAL	6000	100,000	CW Ceiling

Notes: PFAS*, also see the guidelines at: https://www1.maine.gov/dep/spills/topics/pfas/index.html. For the list of Group II PFAS, see: Error! Reference source not found.

VOC** see section 7.5.1

DIOXIN/FURAN*** for Dioxins and Co-Planar PCBs see section 7.5.3

Table 8: Maine Remedial Action Guidelines for Fish Consumption – Recreational Angler

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

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

CAS	Chemical	Chemical Class	Fish Tissue RAG(mg/kg) (wet weight)
75-25-2	Bromoform	VOC	8.8
74-83-9	Bromomethane	VOC	3.6
106-94-5	Bromopropane, 1-	VOC	NC
106-99-0	Butadiene, 1,3-	VOC	0.12
85-68-7	Butyl Benzyl Phthalate	SVOC	37
104-51-8	Butylbenzene, n-	VOC	130
135-98-8	Butylbenzene, sec-	VOC	260
98-06-6	Butylbenzene, tert-	VOC	260
DEP2041	C11-C22 Aromatics	FUEL	77
DEP2042	C19-C36 Aliphatics	FUEL	5,200
DEP2038	C5-C8 Aliphatics	FUEL	100
DEP2040	C9-C10 Aromatics	FUEL	77
DEP2039	C9-C12 Aliphatics	FUEL	260
DEP2043	C9-C18 Aliphatics	FUEL	260
7440-43-9	Cadmium (Water)	METAL	2.6
86-74-8	Carbazole	SVOC	2.5
75-15-0	Carbon Disulfide	VOC	260
56-23-5	Carbon Tetrachloride	VOC	0.99
12789-03-6	Chlordane	PESTICIDE	0.20
115-28-6	Chlorendic acid	SVOC	0.76
75-68-3	Chloro-1,1-difluoroethane, 1-	VOC	NC
106-47-8	Chloroaniline, p-	SVOC	0.35
108-90-7	Chlorobenzene	VOC	52
67-66-3	Chloroform	VOC	2.2
74-87-3	Chloromethane	VOC	NC
91-58-7	Chloronaphthalene, Beta-	SVOC	210
95-57-8	Chlorophenol, 2-	SVOC	13
76-06-2	Chloropicrin	VOC	NC
95-49-8	Chlorotoluene, o-	VOC	52
106-43-4	Chlorotoluene, p-	VOC	52
16065-83-1	Chromium(III), Insoluble Salts	METAL	3,900
18540-29-9	Chromium(VI)	INORGANIC	0.14
218-01-9	Chrysene	SVOC	69
7440-48-4	Cobalt	METAL	0.77
7440-50-8	Copper	METAL	100
108-39-4	Cresol, m-	SVOC	130
95-48-7	Cresol, o-	SVOC	130
106-44-5	Cresol, p-	SVOC	260
59-50-7	Cresol, p-chloro-m-	SVOC	260
98-82-8	Cumene	VOC	260

CAS	Chemical	Chemical Class	Fish Tissue RAG(mg/kg) (wet weight)
57-12-5	Cyanide (CN-)	INORGANIC	1.5
110-82-7	Cyclohexane	VOC	NC
75-99-0	Dalapon	HERBICIDE	77
72-54-8	DDD, p,p`- (DDD)	PESTICIDE	0.077
72-55-9	DDE, p,p'-	PESTICIDE	0.20
50-29-3	DDT	PESTICIDE	0.20
124-18-5	Decane	VOC	NC
53-70-3	Dibenz(a,h)anthracene	SVOC	0.069
132-64-9	Dibenzofuran	SVOC	2.6
96-12-8	Dibromo-3-chloropropane, 1,2-	PESTICIDE	0.087
124-48-1	Dibromochloromethane	VOC	0.83
106-93-4	Dibromoethane, 1,2-	VOC	0.035
74-95-3	Dibromomethane (Methylene Bromide)	VOC	NC
84-74-2	Dibutyl Phthalate	SVOC	260
110-57-6	Dichloro-2-butene, trans-1,4-	VOC	NC
95-50-1	Dichlorobenzene, 1,2-	SVOC	230
541-73-1	Dichlorobenzene, 1,3-	SVOC	230
106-46-7	Dichlorobenzene, 1,4-	VOC	13
91-94-1	Dichlorobenzidine, 3,3'-	SVOC	0.15
75-71-8	Dichlorodifluoromethane	VOC	520
107-06-2	Dichloroethane, 1,2-	VOC	0.76
75-34-3	Dichloroethane,1,1-	VOC	12
75-35-4	Dichloroethylene, 1,1-	VOC	130
156-59-2	Dichloroethylene, 1,2-cis-	VOC**	5.2
156-60-5	Dichloroethylene, 1,2-trans-	VOC**	52
120-83-2	Dichlorophenol, 2,4-	SVOC	7.7
78-87-5	Dichloropropane, 1,2-	VOC	1.9
142-28-9	Dichloropropane, 1,3-	VOC**	52
542-75-6	Dichloropropene, 1,3-	VOC	0.69
60-57-1	Dieldrin	PESTICIDE	0.0043
84-66-2	Diethyl Phthalate	SVOC	2,100
108-20-3	Diisopropyl Ether	VOC	NC
105-67-9	Dimethylphenol, 2,4-	SVOC	52
576-26-1	Dimethylphenol, 2,6-	SVOC	1.5
528-29-0	Dinitrobenzene, 1,2-	SVOC	0.26
99-65-0	Dinitrobenzene, 1,3-	SVOC	0.26
100-25-4	Dinitrobenzene, 1,4-	SVOC	0.26
51-28-5	Dinitrophenol, 2,4-	SVOC	5.2
121-14-2	Dinitrotoluene, 2,4-	SVOC	0.22
606-20-2	Dinitrotoluene, 2,6-	SVOC	0.046

CAS	Chemical	Chemical Class	Fish Tissue RAG(mg/kg) (wet weight)
88-85-7	Dinoseb	PESTICIDE	2.6
123-91-1	Dioxane, 1,4-	VOC	0.69
115-29-7	Endosulfan	PESTICIDE	15
72-20-8	Endrin	PESTICIDE	0.77
75-00-3	Ethyl Chloride	VOC	NC
60-29-7	Ethyl Ether	VOC	520
97-63-2	Ethyl Methacrylate	VOC	NC
100-41-4	Ethylbenzene	VOC	6.3
107-21-1	Ethylene Glycol	VOC	5,200
111-76-2	Ethylene Glycol Monobutyl Ether	VOC	260
206-44-0	Fluoranthene	SVOC	100
86-73-7	Fluorene	SVOC	100
16984-48-8	Fluoride	ANION	100
50-00-0	Formaldehyde	VOC	3.3
76-44-8	Heptachlor	PESTICIDE	0.015
1024-57-3	Heptachlor Epoxide	PESTICIDE	0.0076
118-74-1	Hexachlorobenzene	SVOC	0.043
87-68-3	Hexachlorobutadiene	SVOC	0.89
319-84-6	Hexachlorocyclohexane, Alpha-	PESTICIDE	0.011
319-85-7	Hexachlorocyclohexane, Beta-	PESTICIDE	0.039
58-89-9	Hexachlorocyclohexane, Gamma- (Lindane)	PESTICIDE	0.063
67-72-1	Hexachloroethane	SVOC	1.7
121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	WMD	0.87
110-54-3	Hexane, N-	VOC	NC
591-78-6	Hexanone, 2-	VOC	13
193-39-5	Indeno(1,2,3)pyrene	SVOC	0.69
7439-89-6	Iron	METAL	1,800
78-59-1	Isophorone	SVOC	73
67-63-0	Isopropanol	ALCOHOL	5,200
121-75-5	Malathion	PESTICIDE	52
7439-96-5	Manganese (Non-diet)	METAL	360
94-74-6	MCPA	HERBICIDE	1.3
93-65-2	MCPP	HERBICIDE	2.6
7487-94-7	Mercuric Chloride	METAL	0.77
7439-97-6	Mercury (elemental)	METAL	NC
72-43-5	Methoxychlor	PESTICIDE	13
79-20-9	Methyl Acetate	VOC	2,600
78-93-3	Methyl Ethyl Ketone (2-Butanone)	VOC	1,500
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	VOC	NC

CAS	Chemical	Chemical Class	Fish Tissue RAG(mg/kg) (wet weight)
22967-92-6	Methyl Mercury	METAL	0.26
80-62-6	Methyl Methacrylate	VOC	3,600
1634-04-4	Methyl tert-Butyl Ether (MTBE)	VOC	39
88-19-7	Methylbenzene sulfonamide, 2-	SVOC	100
70-55-3	Methylbenzene sulfonamide, 4-	SVOC	290
75-09-2	Methylene Chloride	VOC	15
90-12-0	Methylnaphthalene, 1-	SVOC	2.4
91-57-6	Methylnaphthalene, 2-	SVOC	10
7439-98-7	Molybdenum	METAL	13
91-20-3	Naphthalene	SVOC	0.58
7440-02-0	Nickel Soluble Salts	METAL	52
14797-55-8	Nitrate	NUTRIENT	4,100
100-01-6	Nitroaniline, 4-	SVOC	3.5
55-63-0	Nitroglycerin	WMD	0.26
86-30-6	Nitrosodiphenylamine, N-	SVOC	14
2691-41-0	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	SVOC	130
117-84-0	Octyl Phthalate, di-N-	SVOC	26
56-38-2	Parathion	PESTICIDE	15
608-93-5	Pentachlorobenzene	SVOC	2.1
87-86-5	Pentachlorophenol	HERBICIDE	0.17
78-11-5	Pentaerythritol tetranitrate (PETN)	WMD	5.2
14797-73-0	Perchlorate and Perchlorate Salts	INORGANIC	1.8
375-73-5	Perfluorobutane sulfonic acid (PFBS)*	PFAS*	52
1763-23-1	Perfluorooctane sulfonic acid (PFOS)*	PFAS*	0.052
335-67-1	Perfluorooctanoic acid (PFOA)*	PFAS*	0.052
85-01-8	Phenanthrene	SVOC	77
108-95-2	Phenol	SVOC	770
298-02-2	Phorate	PESTICIDE	0.52
88-99-3	Phthalic Acid	SVOC	5,200
1336-36-3	Total Polychlorinated Biphenyls (high persistence)	PCB	0.035
103-65-1	Propyl benzene	VOC	260
107-98-2	Propylene Glycol Monomethyl Ether	VOC	1,800
129-00-0	Pyrene	SVOC	77
7782-49-2	Selenium	METAL	13
7440-22-4	Silver	METAL	13
7440-24-6	Strontium, Stable	METAL	1,500
100-42-5	Styrene	VOC	520
1746-01-6	TCDD, 2,3,7,8- Dioxin and Dioxin Like PCBs, TEQ	DIOXIN/FURAN***	0.00000053

CAS	Chemical	Chemical Class	Fish Tissue RAG(mg/kg) (wet weight)
95-94-3	Tetrachlorobenzene, 1,2,4,5-	SVOC	0.77
630-20-6	Tetrachloroethane, 1,1,1,2-	VOC	2.7
79-34-5	Tetrachloroethane, 1,1,2,2-	VOC	0.35
127-18-4	Tetrachloroethylene	VOC	15
58-90-2	Tetrachlorophenol, 2,3,4,6-	SVOC	77
109-99-9	Tetrahydrofuran	VOC	2,300
479-45-8	Tetryl (Trinitrophenylmethylnitramine)	SVOC	5.2
7440-28-0	Thallium (Soluble Salts)	METAL	0.026
7440-31-5	Tin	METAL	1,500
108-88-3	Toluene	VOC	210
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	VOC	77,000
87-61-6	Trichlorobenzene, 1,2,3-	VOC	2.1
120-82-1	Trichlorobenzene, 1,2,4-	SVOC	2.4
71-55-6	Trichloroethane, 1,1,1-	VOC	5,200
79-00-5	Trichloroethane, 1,1,2-	VOC	1.2
79-01-6	Trichloroethylene	VOC	1.3
75-69-4	Trichlorofluoromethane	VOC	770
95-95-4	Trichlorophenol, 2,4,5-	SVOC	260
88-06-2	Trichlorophenol, 2,4,6-	SVOC	2.6
93-76-5	Trichlorophenoxyacetic Acid, 2,4,5-	PESTICIDE	26
93-72-1	Trichlorophenoxypropionic acid, -2,4,5	HERBICIDE	21
96-18-4	Trichloropropane, 1,2,3-	VOC	0.0023
526-73-8	Trimethylbenzene, 1,2,3-	VOC	26
95-63-6	Trimethylbenzene, 1,2,4-	VOC	26
108-67-8	Trimethylbenzene, 1,3,5-	VOC	26
118-96-7	Trinitrotoluene, 2,4,6-	SVOC	1.3
7440-33-7	Tungsten	METAL	2.1
7440-62-2	Vanadium and Compounds	METAL	13
108-05-4	Vinyl Acetate	VOC	2,600
593-60-2	Vinyl Bromide	VOC	NC
75-01-4	Vinyl Chloride	VOC	0.096
1330-20-7	Xylenes	VOC	520
7440-66-6	Zinc and Compounds	METAL	770
Notes:	***** For PFAS, also see the guidelines at: https://www1.maine.gov/dep/spills/topics/pfas/index.html VOC** See section 7.5.1 DIOXIN/FURAN*** for Dioxins and Co-Planar PCBs see section 7.5.3		

- END -

Attachment A

Technical Support Document
For
2021 Remedial Action Guidelines

Effective Date May 1, 2021

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Contents

Table of Tables

1 Introduction

This document presents the technical support for the 2021 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 2021 RAG values. The document also explains the key changes from 2018 RAGs to the 2021 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. Maine's 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 contaminated sites (sites), namely: Resident (including leaching to groundwater), Park User, Commercial Worker, Construction Worker and Recreational Fish Angler. The RAGs derived for these selected scenarios and specific media (i.e., soil, groundwater, sediment, indoor air, ambient air and fish tissue) incorporate appropriate routes for potential exposure (ingestion, inhalation, and dermal contact). The RAGs target the Maine risk goal of not exceeding a 1 x 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 presented in Tables 5 to 8 of the 2021 Maine Remedial Action Guidelines (RAGs) for sites Contaminated with Hazardous Substances.

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[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 December 11, 2020, from: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part).

2 Use of RSL Calculators to Generate Maine RAGs

2.1 Use of RSL calculator

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). The Agencies use the RSL calculator because it 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.

At that time, the principle changes were:

- 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;
- 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 the Technical Support Document (TSD) for the October 19, 2018 RAGs.

2.2 Introduction to RSLs

The Tables in the RAGs were generated by 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 [December 2020]) to generate and maintain the extensive risk calculations necessary to derive the RAGs. EPA's RSL team maintains a robust risk assessment methodology for deriving chemical-specific

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[4] As of December 11, 2020 available at: https://www.epa.gov/risk/regional-screening-levels-rsls.

screening levels for various media (soil, water, air) at contaminated 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]. The home page of the EPA Regional Screening Level Generic Tables provides a convenient index with hyperlinks:

- Home Page[7]
- 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 has adopted most of EPA's default factors for risk assessment that are in the RSL calculator. This TSD focuses on the decisions the Maine agencies made in running EPA's RSL calculator, where Maine departs from standard RSL default factors and where supplemental modeling was necessary.

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 Tap-water and Groundwater Scenario

The Residential Groundwater RAGs apply to residents exposed via ingestion, dermal contact, and inhalation to contaminated groundwater from a private water supply well. The RSL calculator refers to this pathway as the Tap-water pathway. Exposure occurs from consuming the contaminated water, and during showering and bathing by inhalation and

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[5] The screening levels use EPA default parameters from various regions of the US and use several target risk levels (i.e., 1×10^{-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 webpage, "Risk Assessment: Regional Screening Levels (RSLs), (downloaded on December 11, 2020 from: https://www.epa.gov/risk/regional-screening-levels-rsls).

dermal contact. Rather than using the term "groundwater", EPA's RSL team terms this the "Tap-water" route of exposure because in other parts of the country, this exposure can also occur via contamination of surface water supplies that are then supplied to residences. Such an exposure is improbable in Maine because public water supply standards would apply. So, while the RSL Residential calculator refers to this exposure scenario as Tap-water, for the Maine RAGs the Agencies continue to refer to this exposure scenario as the Residential Groundwater scenario.

2.3.3 Composite Worker and Commercial Worker

Maine has RAGs for the Commercial Worker. 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, but also working indoors. The worker is exposed to surface soils from moderate digging and landscaping. The Composite Worker is expected to have an elevated incidental soil ingestion rate (100 milligrams per day) compared to an Indoor Commercial Worker, and is assumed to be exposed to contaminants via the following pathways: incidental ingestion of soil, dermal contact with soil, and 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 Commercial 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 current 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 RAGs also include a 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 exposure to air on the inside 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, DEP calculated Ambient Air RAGs, which are also called Maine's Ambient Air Guidelines (AAGs). The Ambient Air RAGs apply to exposure to outdoor air and assume a lifetime (70 years) of exposure. In summary, while the RSL only uses the term "ambient air", the Maine RAGs uses these procedures to calculate separate indoor and outdoor air guidelines.

2.4 RSL Calculator 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 1×10^{-5}.
>
> Step 2 involves modifying the default exposure parameters to Maine-specific values. As detailed below, the current 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.

The specific steps for running the calculator can be found in Standard Operating Procedure RWM-DR-029: Deriving and Updating the Maine Remedial Action Guidelines Using the EPA Regional Screening Levels Calculator, available at: https://www.maine.gov/dep/spills/publications/sops/index.html

3.1 Exposure Inputs

The exposure factors input into the RSL calculator to generate the current RAGs are presented in TSD Table 15 - Default Exposure Assumptions for Maine Remedial Action Guidelines and Site-Specific Risk Assessments.

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 for most of the State's population. Most importantly, a sensitivity analysis indicates that variations in climate inputs within the State do not make a significant 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. 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: Maine Precipitation Data Summary.
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)[8]. 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. This is based on professional judgement that the number of days in the fall when the air is below freezing but the ground is unfrozen, is equal to the number of days in spring when the air is above freezing but the ground is still frozen. Years with any missing data were dropped from the analysis.

The Portland station is consistent with the RME approach since for the climatological averages it has the most bare, unfrozen ground days of the areas analyzed. The ground is neither frozen nor snow covered in the Portland area for an average of 256 days per year. The Commercial Worker exposure frequency was based on the 256 days per year adjusted by 5-workdays / 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 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, as summarized in TSD Table 1.

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[8] 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: Maine Precipitation Data Summary

	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

The 2021 RAGs were updated to include 13 chemicals that have been found at contaminated sites in in Maine and for which toxicity values were available in the RSL calculator. The following sections describe the process used to determine this list and describes which chemicals were detected in Maine environmental samples that require the development of toxicity factors to develop a RAG in the future.

3.3.1 Contaminants Detected in Maine Environment That Do Not Have a RAG

DEP searched the Maine DEP Environmental and Geographic Analysis Database (EGAD) and determined the contaminants that had been detected in environmental media in the past five years that did not have an associated RAG. EGAD contains most but not all results from environmental samples obtained by DEP. The comparison identified 484 contaminants for which a RAG was not available. TSD Table 2 groups the chemicals by classes for purposes of developing risk based guidelines. TSD Table 3 shows the media that these missing guidelines fall into, ranked by the number of samples in EGAD that did not have a corresponding RAG.

As shown in TSD Table 2, most of these compounds fall into the PCB, PAH and PFAS categories so methods should be developed to include these compounds into the chemical class. For PCBs, EPA has established a system for determining the risk of Aroclors and Co-planer PCBs (see TSD section 3.4.5). An internal DEP workgroup is evaluating how to upgrade EPA’s approach to assessing risks posed by PCBs using these two approaches. EPA has also established protocols for evaluating risk posed by PAHs, and for the next RAG update the Agencies need to modify this approach to address the risk posed by the 67 additional PAHs detected. As discussed in section 3.4.7 a method needs to be established to determine the risk posed by the 46 detected PFAS compounds for which toxicity factors are not available, as well as the thousands of PFAS compounds for which detection methods have not been developed. The

EPA approaches used to address risk from dioxin like compounds, PCBs, and PAHs should be considered for establishing risk based guidelines for PFAS in the next RAGs update.

In addition to the chemical classes described above, TSD Table 2 indicates that four compounds missing RAGs are radioactive. The DHHS low-level radioactive program is consulted when radioactive compounds are detected at a site. The table also indicates that the RSL calculator has toxicity factors for 13 compounds, and RAGs were developed for these compounds in this update of the RAGs, as listed in TSD Table 3. Finally, as listed in TSD Table 5, the Agencies should develop toxicity factors for developing RAGs for these compounds. TSD Table 5 lists the number of detections of these compounds over the past 5 years, which can be used to help prioritize the development of RAGs.

TSD Table 2: Number of Compounds in EGAD without a Corresponding RAG, by toxicity groups

Category	Number of compounds
PCB compounds	278
PAH compounds	67
PFAS compounds	46
Radioactive	4
In RSL Calculator	13
Still Need Toxicity Data	76
Total identified	484

TSD Table 3: Percentage of Needed RAGs by Media Type

Media Type	**%**	**Sample Type in Media Class**
Tissue	39%	WHOLE
		HEPATOPANCREAS (TOMALLEY)
		MUSCLE
		WHOLE WITHOUT SKIN
		SKINLESS FILET
		SKIN-ON FILET
solid	22%	SOIL
		SEDIMENT
		WIPE
		BUILDING MATERIAL
		SURFACE WATER SUBSTRATE
		VEGETATION
Aqueous	36%	GROUNDWATER
		SURFACE WATER
		LEACHATE
		PORE WATER
		STORM WATER RUNOFF
		PROCESS WATER

		LEAK DETECTION FLUIDS
		WASTE WATER
gas	2%	SOIL GAS
		INDOOR AIR
		SUBSLAB GAS
		AIR
		OUTDOOR AIR
		LANDFILL GAS
Other	0.40%	NEAT SAMPLE
		WASTE
		UNKNOWN

TSD Table 4 – RAGs Developed for These Contaminants

CAS-RN	DTXSID	CONTAMINANT NAME
98-06-6	DTXSID3047138	tert-Butylbenzene
76-13-1	DTXSID6021377	1,1,2-Trichloro-1,2,2-trifluoroethane
7440-33-7	DTXSID8052481	Tungsten
67-63-0	DTXSID7020762	Isopropanol
97-63-2	DTXSID1025308	Ethyl methacrylate
16984-48-8	DTXSID9049617	Fluoride
110-54-3	DTXSID0021917	n-Hexane
124-18-5	DTXSID6024913	Decane
107-21-1	DTXSID8020597	Ethylene glycol
608-93-5	DTXSID7024247	Pentachlorobenzene
111-76-2	DTXSID1024097	2-Butoxyethanol

TSD Table 5: Compounds for which RAGs are Still Needed

CASRN or EGAD ID	**PARAMETER NAME**	**Number of Detects in past 5 years**
Various	Aroclor-PCB (89 compounds)	25,028
Various	PFAS (46 compounds)	14,478
Various	PAH (67 compounds)	5,513
24959679	BROMIDE	906
99876	P-ISOPROPYLTOLUENE	780
594207	2,2-DICHLOROPROPANE	629
563586	1,1-DICHLOROPROPENE	629
7631869	SILICA	442
18496258	SULFIDE	386
110565	1,4-DICHLOROBUTANE	249
64175	ETHANOL	223
108703	1,3,5-TRICHLOROBENZENE	186
131113	DIMETHYL PHTHALATE	173
75650	TERT-BUTYL ALCOHOL	161
142825	N-HEPTANE	157
622968	P-ETHYLTOLUENE	151
115071	PROPYLENE	150

CASRN or EGAD ID	PARAMETER NAME	Number of Detects in past 5 years
98953	NITROBENZENE	126
101553	4-BROMOPHENYL PHENYL ETHER	113
534521	4,6-DINITRO-O-CRESOL	113
108601	BIS(2-CHLOROISOPROPYL) ETHER	113
621647	N-NITROSO-DI-N-PROPYLAMINE	113
100027	4-NITROPHENOL	113
111911	BIS(2-CHLOROETHOXY) METHANE	113
88744	2-NITROANILINE	113
7005723	4-CHLOROPHENYLPHENYL ETHER	113
99092	3-NITROANILINE	113
88755	2-NITROPHENOL	113
110861	PYRIDINE	112
77474	HEXACHLOROCYCLOPENTADIENE	110
994058	T-AMYL METHYL ETHER (TAME)	101
92875	BENZIDINE	101
103333	AZOBENZENE	98
62759	N-NITROSODIMETHYLAMINE	98
DEP1103	EXCHANGEABLE ALUMINUM	96
108872	METHYLCYCLOHEXANE	89
483658	RETENE	87
637923	ETHYL T-BUTYL ETHER	87
141786	ETHYL ACETATE	84
31317187	2,4-DIMETHYLDIBENZOTHIOPHENE	75
540841	2,2,4-TRIMETHYLPENTANE	74
76017	PENTACHLOROETHANE	74
76142	1,2-DICHLOROTETRAFLUOROETHANE	57
74884	METHYL IODIDE	51
94826	2,4-DB	18
120365	DICHLOROPROP	17
1918009	DICAMBA	17
94757	2,4-D (2,4-DICHLOROPHENOXYACETIC ACID)	17
68122	N,N-DIMETHYLFORMAMIDE	15
DEP2002	PHENOL, TOTAL	15
DEP2004	TRICHLOROTRIFLUOROETHANE	13
107415	N-BUTANOIC ACID	10
79094	PROPANOIC ACID	9
7726956	BROMINE	9
872980	5,5-DIMETHYL-1,3-DIOXANE	8
593453	N-OCTADECANE	7
6117993	2,4-DIMETHYLDODECANE	6
64186	FORMIC ACID	5
110758	2-CHLOROETHYL VINYL ETHER	5
7553562	IODINE	5
109524	VALERIC ACID	4
95932	1,2,4,5-TETRAMETHYLBENZENE	4
13252136	HEXAFLUOROPROPYLENE OXIDE DIMER ACID	3
105055	1,4-DIETHYLBENZENE	3

CASRN or EGAD ID	PARAMETER NAME	Number of Detects in past 5 years
109660	N-PENTANE	3
503742	I-PENTANOIC ACID	3
111842	NONANE	3
496117	INDAN	2
142621	HEXANOIC ACID	2
7664382	PHOSPHORIC ACID	2
57556	PROPYLENE GLYCOL	1
57103	HEXADECANOIC ACID	1
634902	1,2,3,5-TETRACHLOROBENZENE	1
526750	2,3-DIMETHYLPHENOL	1
57114	STEARIC ACID	1
634662	1,2,3,4-TETRACHLOROBENZENE	1
527844	1-METHYL-2-ISOPROPYLBENZENE	1
756426581	9-CHOLOROHEXADECAFLUORO-3-OXANONANE-1-SULFONIC ACID	1
98555	ALPHA-TERPINEOL	1

3.3.2 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 typing the chemical name into the “Select Chemicals” entry box and then entering the physical-chemical properties of those contaminants. In the 2021 RAGs this was done for 17 compounds, whose input parameters are presented in TSD Table 16: Physical/Chemical Properties and Toxicity Values for Manual Entry into RSL Calculator

3.4 Toxicity Values

3.4.1 Chronic Toxicity Hierarchy

The RSL calculator uses EPA’s preferential hierarchy in selection of toxicity values. Maine first adopted EPA’s hierarchy with the 2018 RAGs after EPA put significant effort into updating its Integrated Risk Information System (IRIS), which is EPA’s primary tier for selecting toxicity factors. Further analysis is provided in the 2018 TSD for the RAGs.

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 Agencies selected toxicity values and entered them manually. For some compounds toxicity values were not available, but the Agencies applied the toxicity factor from a surrogate compound that CDC believes would have a similar toxic impact. For a summary of these decisions, see TSD Table 3 below.

TSD Table 6 - 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
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/Tap-water 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/Tap-water exposure calculations.

3.4.5 Toxicity Factors for PCBs and PCB groupings

Polychlorinated biphenyls (PCBs) are stable when heated and resist environmental degradation. They have been added to oils used in electrical transformers, light ballasts, and hydraulic fluids. They have also been added to calks, paints, and a host of other products. PCBs are a contaminant of concern at numerous Superfund and uncontrolled hazardous substance sites in Maine.

The toxicity information for PCBs that is used in the RSL calculator is based on values published in IRIS and are further described in ATSDR toxicity profiles for PCBs[9]. Section 5.8 of the RSLs User's Guide also has a an explanation of how PCBs are handled. However, Brian Davis and Michael Wade have described the problems with applying these toxicity factors to the results of environmental samples and the adjustments that EPA has made to address these problems,[10] as follows.

PCBs are sold as Aroclors and are named based on the percentage of chlorine in the mixture; An Aroclor that is 60% chlorine by weight is marketed as Aroclor 12**60**. These Aroclors are mixtures of varying amounts of 209 differing PCB congeners. PCBs are biphenyl molecules linked by a carbon-carbon bond at the 1-1' position, with 10 additional positions on the phenyl rings that a chlorine may attach to. Each of the 209 congeners is defined by where 1 to 10 of these additional chlorines attach.

The Aroclors transform in the environment, as some congeners more readily degrade, sorb to carbon, volatilize, and solubilize in water or solvents as compared to other congeners. Davis and Wade found the following:

FATE AND TRANSPORT OF PCBs

1. Variability in the physical and chemical properties of different PCB congeners results in variable behavior in the environment.
2. Volatility and mobility in the atmosphere increase with decreasing chlorination. Atmospheric transport is an important mechanism for worldwide dispersion.
3. PCBs enter water bodies from water channels and atmospheric deposition. PCBs leave water bodies by volatilization. PCBs are exchanged between the water column and sediments.
4. PCBs strongly sorb to soils, limiting mobility.
5. Rates of photochemical degradation in the atmosphere decrease with increasing chlorination. Half-lives of PCB congeners in soils and sediments are on the order of months and years.
6. Biodegradation (bacterial) results in selective dechlorination, enriching ortho-substituted congeners.

Toxicity information is only available for select, virgin Aroclors, not weathered Aroclors. The ramification is that when environmental samples are taken and analyzed for a given Aroclor, due to changes during transport and weathering, the actual make-up of the congeners within the Aroclor will be different than the mixtures upon which the toxicity studies were performed. To address this fate, transport and weathering issue, EPA's IRIS database has different slope factors and recommendations on which toxicity factor to apply to PCBs found in different media, routes of exposure, and life stage, as summarized in TSD Table 4. RSL uses the recommendations of IRIS. The toxicity information on PCBs is additionally complex because

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[9] Brian Davis and Michael Wade, Risk Assessment of Polychlorinated Biphenyls at Hazardous Waste Sites (Downloaded on December 11, 2020 from: https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/01/Risk-Assess-PCB.pdf), March 2003

[10]

non-carcinogenic Reference Doses are only available for 2 Aroclors (1016 and 1254), while slope factors (for carcinogenic effects) are available for four (1016, 1242, 1254 and 1260) and are published as ranges. However, the non-carcinogenic effects will sometimes result in an adverse impact at a lower concentration than carcinogenic effects (i.e. "drive the risk"). Therefore, Davis and Wade recommend always evaluating the non-cancer impacts. However, there is no good surrogate RfD for Low persistent PCBs, as shown in TSD Table 4.

Non-carcinogenic risk from PCBs is considered for the Construction Worker Soil exposure scenario. This is viewed as appropriate based on the shorter exposure period for this scenario. Per EPA guidance, as illustrated in Table 4, Aroclor 1254 is used as a surrogate for the evaluation of exposure risk from PCBs (high-risk), for the Construction Worker Soil scenario only. Employment of the subchronic, non-carcinogenic reference dose for Aroclor 1254 results in a lower Construction Worker Soil RAG than would be calculated using the PCBs (high-risk) default values in the RSL database.

TSD Table 7: Classification of PCB Aroclors in RAGs[11]

Persistence (resistance to weathering)	High	Low	Lowest
Non-Cancer Toxicity Based on Aroclor	1254	N/A	1016
Cancer Toxicity Based on Aroclor	1260 & 1254	1242	1016
Criteria for use	• Food chain exposure • Sediment or soil ingestion • Dust or aerosol inhalation • Dermal exposure if absorption factor applied • Dioxin-like, tumor-promoting, or persistent congeners • Early-life exposure	• Ingestion of water-soluble congeners • Inhalation of evaporated congeners • Dermal exposure, if no absorption factor has been applied	• Congeners with more than four chlorines comprise less than 0.5% of total PCBs

A more direct way to measure PCB toxicity is to analyze for individual congeners at the site, then compare results based on the toxicity of the congener. IRIS does not publish toxicity information on the congener level. However, "coplanar PCB" congeners (lacking two chlorines in the ortho position) have toxicity effects like dioxins, and at very low concentrations, so are included in the dioxin-TEQ RAG.

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[11] Adopted from Brian Davis and Michael Wade, Risk Assessment of Polychlorinated Biphenyls at Hazardous Waste Sites (Downloaded on December 11, 2020 from: https://dtsc.ca.gov/wp-content/uploads/sites/31/2018/01/Risk-Assess-PCB.pdf), March 2003.

3.4.6 Dioxins

Dioxins and dioxin like compounds are handled in accordance with the toxic equivalence approach of the World Health Organization[12]. EPA in its Chem Tox Database[13], summarizes this system as follows:

> Dioxins and dioxin-like compounds (DLCs) are compounds that are highly toxic environmental persistent organic pollutants. Dioxins have different toxicity depending on the number and position of the chlorine atoms. Because dioxins refer to such a broad class of compounds that vary widely in toxicity, the concept of toxic equivalency factor (TEF) has been developed to facilitate risk assessment and regulatory control. Toxic equivalence factors (TEFs) exist for seven congeners of dioxins, ten furans and twelve PCBs as identified in a World Health Organization Report. The reference congener is the most toxic dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) which per definition has a TEF of one. This compound is extremely stable and consequently tends to accumulate in the food chain having a half-life of 7 to 9 years in humans. This list of DLCs are those for which TEFs were reported in the WHO report."

TSD Table 8: List of Dioxin & Dioxin Like Compounds

DTXSID	PREFERRED NAME	CASRN
DTXSID2021315	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6
DTXSID5022514	3,3',4,4'-Tetrachlorobiphenyl	32598-13-3
DTXSID6023781	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	19408-74-3
DTXSID0023824	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	57653-85-7
DTXSID4025799	Octachlorodibenzo-p-dioxin	3268-87-9
DTXSID6029915	1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9
DTXSID7030066	2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4
DTXSID4032116	2,3',4,4',5-Pentachlorobiphenyl	31508-00-6
DTXSID3032179	3,3',4,4',5-Pentachlorobiphenyl	57465-28-8
DTXSID8038306	2,3,3',4,4'-Pentachlorobiphenyl	32598-14-4
DTXSID2038314	3,3',4,4',5,5'-Hexachlorobiphenyl	32774-16-6
DTXSID1052034	1,2,3,4,6,7,8-Heptachlorodibenzodioxin	35822-46-9
DTXSID3052062	Octachlorodibenzofuran	39001-02-0
DTXSID8052067	1,2,3,4,7,8-Hexachlorodibenzodioxin	39227-28-6
DTXSID7052078	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	40321-76-4
DTXSID3052147	2,3,7,8-Tetrachlorodibenzofuran	51207-31-9
DTXSID9052216	1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7

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[12] Martin Van den Berg, Linda S. Birnbaum, Michael Denison, Mike De Vito, William Farland, Mark Feeley, Heidelore Fiedler, Helen Hakansson, Annika Hanberg, Laurie Haws, Martin Rose, Stephen Safe, Dieter Schrenk, Chiharu Tohyama, Angelika Tritscher, Jouko Tuomisto, Mats Tysklind, Nigel Walker, Richard E. Peterson, "The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds", Toxicological Sciences, Volume 93, Issue 2, October 2006, Pages 223–241 (downloaded December 11, 2020 from: https://academic.oup.com/toxsci/article/93/2/223/1707690).

[13] EPA's CompTox Chemistry Dashboard (Downloaded December 11, 2020 from https://comptox.epa.gov/dashboard/chemical_lists/DIOXINS)

DTXSID	PREFERRED NAME	CASRN
DTXSID7052234	1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6
DTXSID3052276	2,3,4,6,7,8-Hexachlorodibenzo[b,d]furan	60851-34-5
DTXSID8052350	1,2,3,4,6,7,8-Heptachlorodibenzo[b,d]furan	67562-39-4
DTXSID9052470	1,2,3,7,8,9-Hexachlorodibenzo[b,d]furan	72918-21-9
DTXSID0052706	2,3,3',4,4',5-Hexachlorobiphenyl	38380-08-4
DTXSID2069155	1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9
DTXSID4074144	2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9
DTXSID7074165	2,3',4,4',5,5'-Hexachlorobiphenyl	52663-72-6
DTXSID6074205	2,3,3',4,4',5'-Hexachlorobiphenyl	69782-90-7
DTXSID6074209	3,4,4',5-Tetrachlorobiphenyl	70362-50-4
DTXSID9074226	2,3,4,4',5-Pentachlorobiphenyl	74472-37-0
DTXSID50867160	2',3,4,4',5-Pentachlorobiphenyl	65510-44-3

3.4.7 RfDs for Perfluoroalkyl Substances (PFAS)

Perfluoroalkyl Substances (PFAS) refers to family of manmade per- and polyfluorinated organic chemicals. PFAS are carbon chain atoms that are totally fluorinated (Perfluorinated) or partially fluorinated (polyfluorinated). Compared to other contaminants, PFAS physical and chemical properties are unique (for example, surfactant, oil-repelling, water-repelling), which impacts fate and transport in unique ways. PFAS present risks at low concentrations, are found in environmental media and biota worldwide, are resistant to degradation and bioaccumulate.[14] EPA's COMPTOX database lists more than 9,250 known individual PFAS by a unique identification number (DTXSID) and the traditional Chemical Abstract System Registry Number (CASRN).[15]

PFAS toxicity and mode of actions are being intensely studied and our understanding is rapidly changing. EPA's IRIS database lists a RfD of 0.00002 mg/kg/d for non-carcinogenic impacts from PFOA and PFOS (EPA PFOA RfD). In 2016, EPA Office of Water using the EPA PFOA RfD established a lifetime health advisory[16] of 0.070 µg/L (parts per

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[14] Interstate Technology Regulatory Council (ITRC), Per- and Polyfluoroalkyl Substances (PFAS) Fact Sheets. (Downloaded on December 11, 2020 from: https://pfas-1.itrcweb.org/fact-sheets/).

[15] EPA, Comptox Database website, Lists page downloaded December 11, 2020 from: https://comptox.epa.gov/dashboard/chemical_lists). Citation: The CompTox Chemistry Dashboard: a community data resource for environmental chemistry, Antony J. Williams, Christopher M. Grulke, Jeff Edwards, Andrew D. McEachran, Kamel Mansouri, Nancy C. Baker, Grace Patlewicz, Imran Shah, John F. Wambaugh, Richard S. Judson & Ann M. Richard, Journal of Cheminformatics volume 9, Article number: 61 (2017)

[16] "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

billion) for PFOA and PFOS individually or their combined concentration in drinking water (EPA HA). In 2018, after the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) reviewed the basis for the EPA PFOA RfD, ATSDR proposed lower toxicity values for PFOA and PFOS, as well as proposing toxicity values for other PFAS[17] but has not finalized these draft findings. Since then many states have established groundwater remediation thresholds well below the 70 ppt value, and lower equivalent guidelines and standards for contaminated soil based on the ATSDR draft toxicity profile and evaluation by state toxicologists.

Nonetheless, in 2019, EPA recommended that the EPA HA levels be used as Preliminary Remediation Goals (PRGs) for contaminated groundwater at federal remediation sites.[18] The EPA drinking water HA of 0.070 µg/L is based on the EPA RfD, but applies an "Relative Source Contribution" (RSC) approach to allow for possible background exposure from other sources, including diet. Although a default 20% RSC may not be needed based on currently available exposure data, use of the EPA health advisory does provide an added margin of safety that is appropriate given the possible future lowering of toxicity values. The EPA drinking water health advisory also is the threshold that would be applied to public water supplies.

After reviewing all this information, in January of 2020, the State of Maine PFAS Task Force unanimously recommended that DEP and Maine CDC's Drinking Water Program apply the EPA HA level to the sum of at least PFHxS, PFNA, PFHpA, PFOA, and PFOS"[19]. For this version of the RAGs, this group of compounds and their salts were grouped together as the "Group II PFAS" (see TSD Table 6). "Group I PFAS" are all-other PFAS.

Additionally, DEP studies and CDC risk analysis suggests that crop pathways may drive the risk for PFAS is some instances. Further the science and legal status of PFAS is rapidly changing. Therefore, this

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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 December 11, 2020.]

[17] Agency for Toxic Substances and Disease Registry (ATSDR). 2018. Toxicological profile for Perfluoroalkyls. (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Downloaded December 11, 2020 from: https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=1117&tid=237).

[18] EPA, "Interim Recommendations for Addressing Groundwater Contaminated with Perfluorooctanoic Acid and Perfluorooctanesulfonate" December 19, 2019 (downloaded April 7, 2020 from https://www.epa.gov/sites/production/files/2019-12/documents/epas_interim_recomendations_for_addressing_groundwater_contaminated_with_pfoa_and_pfos_dec_2019.pdf)

[19] Managing PFAS in Maine, Final Report from the Maine PFAS Task Force, January 2020, Pg 20 (downloaded March 27, 2020 from: https://www.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf)

version of the RAGs references the DEP website for additional exposure scenarios. This version also directs a “case-by-case” determination of potential risk from the vast majority of PFAS for which the Agencies have not developed risk-based guidelines. See section 7.1

TSD Table 9: Group II PFAS

Library Group	CASRN	PREFERRED NAME	DTXSID
PFOA	335-67-1	Perfluorooctanoic acid	DTXSID8031865
PFOA	NOCAS_893893	Perfluoroalkyl (linear) carboxylic acids	DTXSID00893893
PFOA	NOCAS_872963	Mixture of PFOS and PFOA	DTXSID20872963
PFOA	1017281-31-0	5,6,7,8-13C4-Perfluorooctanoic acid	DTXSID10892998
PFOA	3825-26-1	Ammonium perfluorooctanoate	DTXSID8037708
PFOS	45298-90-6	Perfluorooctanesulfonate	DTXSID80108992
PFOS	NOCAS_896832	Perfluoroalkyl (linear) sulfonates	DTXSID30896832
PFOS	1763-23-1	Perfluorooctanesulfonic acid	DTXSID3031864
PFOS	NOCAS_872963	Mixture of PFOS and PFOA	DTXSID20872963
PFOS	251099-16-8	N-Decyl-N,N-dimethyl-1-decanaminium perfluorooctanesulfonate	DTXSID00882964
PFOS	1379454-92-8	1-Octanesulfonic acid, 1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluoro-, ammonium salt, ion(1-) (1:1)	DTXSID501015039
PFHpA	375-85-9	Perfluoroheptanoic acid	DTXSID1037303
PFHpA	NOCAS_893893	Perfluoroalkyl (linear) carboxylic acids	DTXSID00893893
PFNA	375-95-1	Perfluorononanoic acid	DTXSID8031863
PFNA	NOCAS_893893	Perfluoroalkyl (linear) carboxylic acids	DTXSID00893893
PFHxS	108427-53-8	Perfluorohexanesulfonate	DTXSID80873012
PFHxS	NOCAS_896832	Perfluoroalkyl (linear) sulfonates	DTXSID30896832
Notes:	Library Name	As assigned in EPA’s CompTox Database	
	CASRN	Chemical Abstract System Registry Number	
	DTXSID	Chemical Identification number in EPA's web based CompTox Chemistry Dashboard	

4 Groundwater Calculations

4.1 Residential Exposure to Groundwater

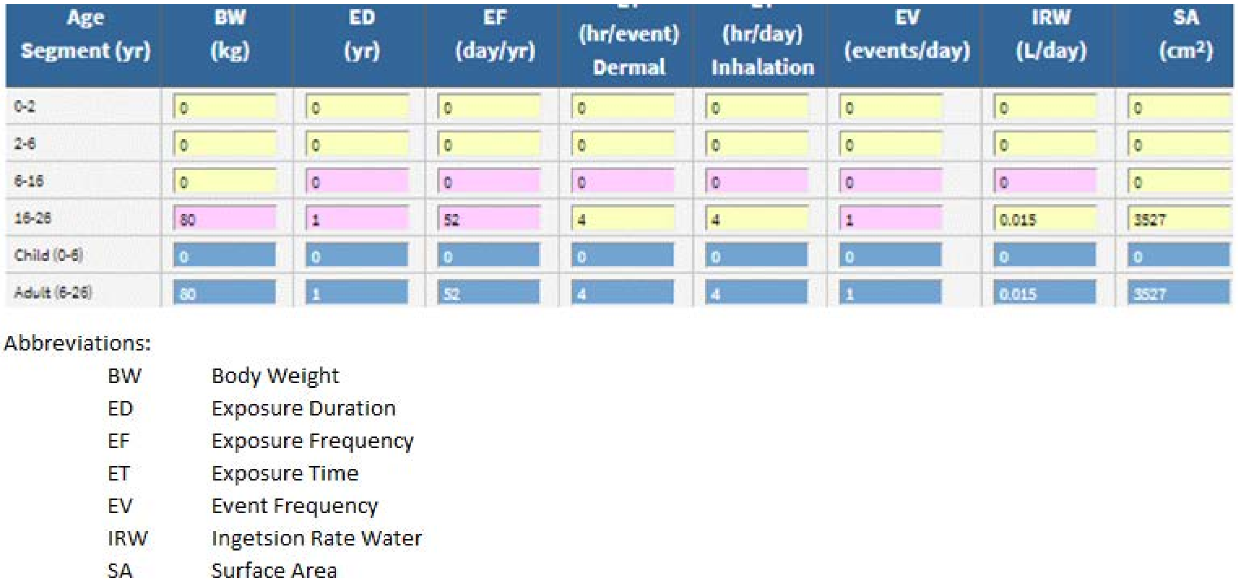
The Residential Groundwater RAGs assume that the groundwater is consumed at a residence from a well installed in the contaminated aquifer. To derive the residential groundwater RAGs, the Agencies used the RSL calculator for Tap-water and EPA default exposure parameters. A groundwater ceiling value of 100,000 µg/L was applied for contaminants exceeding 100,000 µg/L in accordance with RSL protocols.

Note that the EPA Drinking Water Program’s approach to developing risk-based guidance differs from the EPA Superfund risk assessment approach that is built into the RSL calculator. Under the drinking water methodology, only ingestion risk is calculated, then EPA applies a generic Relative Source Contribution (RSC) factor to account for all other uncalculated exposures including ingestion from other sources (e.g. soil, food), and inhalation and dermal contact during showering or bathing. In contrast, the RSL calculates ingestion risk as well as chemical specific risk from dermal contact and inhalation during showering and bathing. Further, RAGs are also developed to address exposure to contaminants from other media at the site (e.g. soil, sediment, fish tissue). This discrepancy is justifiable since the Superfund Program prevents exposure to these other sources at a site, while the Drinking Water Program does not have the regulatory ability to control exposure to these other sources. In Maine, laws like the Uncontrolled Sites Law affords the same ability to control risks from all media at a site, not just groundwater.

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 subsurface construction and utility maintenance, typically in a trench, that may be exposed to contaminated groundwater. They were derived using the EPA RSL calculator for Residential Tap-water exposure but in the site-specific mode. This calculator includes dermal, incidental 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 workday 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).

TSD Table 10: RSL Input for Construction Worker Tap Water RAG



Age Segment (yr)	BW (kg)	ED (yr)	EF (day/yr)	(hr/event) Dermal	(hr/day) Inhalation	EV (events/day)	IRW (L/day)	SA (cm²)
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

The equations used in the RSL Residential Tap-water 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 Tap-water 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[20]. The modelled VFs were applied to the Residential Tap-water 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.

5 Indoor Air and Ambient Air

Use caution with Indoor Air and Ambient Air terminology, as discussed in Section 2.3.5. The primary differences between the Residential Air RAGs, the Commercial Air RAGs and the Ambient Air RAGs are the exposure time, exposure duration and exposure frequency used to model the exposure scenarios.

The Residential and Commercial Air RAGs assume that the contamination is local to the subject residence or business. Therefore, if an individual moves to a new home or place of business, they are no longer exposed. The Residential Air RAGs use an exposure time of 24 hours/day, an exposure frequency of 350 days/year to account for the number of days that the average person would be expected to be away from their home (vacations, holidays, etc.) and an exposure duration of 26 years (the standard time period that a person might be expected to live at one location). These are the default exposure parameters for this exposure scenario in the RSL calculator.

The Commercial Worker Air RAGs use a similar scenario with an exposure time of 8 hours/day and an exposure frequency of 250 days/year and an exposure duration of 25 years, to model a typical work week of 40 hours (accounting for annual holidays) over a career.

The Ambient Air RAGs are intended to be applied to outdoor air over a broad area. If an individual lives in a town with contamination in the outdoor air, moving to another home in that town might not change their exposure. Therefore, the Ambient Air Guidelines use an exposure time of 24 hours/day, an exposure frequency of 365 days/year and an exposure duration of 70 years (lifetime). Note that, the exposure duration for exposure to chemicals with mutagenic effects was also adjusted to a total of 70 years, when calculating the Ambient Air RAGs.

6 Fish Tissue – Recreational Angler Only

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

The RAGs for Fish Consumption were calculated using the RSL calculator. Note that unlike most RAG values, fish RAGs are presented in wet-weight rather than on a dry-weight basis. For inputs to the RSL calculators, the Agencies used a 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 Introduction

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 RAGs for the Resident, Park User, Commercial Worker, Construction Worker and Recreator Sediment exposures using the inputs provided in TSD Table 15. 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.

7.1.1 Exposure Time to Residential Soil

The Agencies use the default EPA exposure time of 24-hours per day for potential exposure to volatiles from soil. This is 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, which 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 applies 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 Overview: RAGs for Petroleum Hydrocarbon 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. Note that Maine does not use the default RSL calculator for petroleum because 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.

The soil RAGs for the petroleum hydrocarbon fractions are derived with user-provided chemical information for the hydrocarbon fractions measured by the Extractable Petroleum Hydrocarbon and Volatile Petroleum Hydrocarbon (VPH) test methods (see TSD Table 8). 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 16. EPH/VPH methods report concentrations for specific petroleum target compounds. The toxicity of the ranges is calculated after the toxicity of the target compound concentrations have been subtracted.

The petroleum hydrocarbon range soil RAGs were generated using 2 volatilization models: Infinite source with no Csat substitution for the inhalation pathway and use of mass-limited volatilization with a source depth of 3 meters[21]. The three RSL results were compared and the highest value was selected as the RAG (per EPA's RSL guidance).

More details on the reasons for generating Petroleum RAGs using this approach are in the sections below.

TSD Table 11 - 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

7.3 Volatilization Modeling: Infinite Vs. Finite Source

7.3.1 Overview

The RSL soil calculators combine the 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 those that are volatilized into the air. For chemicals that are volatile, the RSL calculates a Volatilization Factor (VF) to model vapor released from soil from a wide range of

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[21] Average depth to groundwater in Maine.

contaminants. The RSLs have the option to calculates chemical-specific VFs with two different volatilization models, the Infinite Source model and the Mass-Limit model. The Infinite Source model assumes an infinite source of contamination continues to add vapors based on chemical-specific properties. The Mass-Limit model assumes a finite source fully volatilizing at a constant rate over a defined period, based on one set of generic chemical properties.

> EPA's SSL guidance recommends running both models, then, selecting the higher of the two SSLs as the final SSL for each parameter within each exposure pathway (Residential, Construction Worker, Commercial Worker, Park User and Recreational Sediment). However, the Mass-Limit model can only be run when contaminant mass can be reliably estimated, so requires site-specific inputs for source depth and area.
>
> Also note that the Infinite Source model does not account for degradation of chemicals over time, which can be significant for compounds like petroleum. This Section explains how the Agencies handled these two issues.

7.3.2 Run I: Infinite Source of Volatile Chemicals

The "Infinite Source" approach assumes a constant supply of vapors from the chemical source in the soil. This approach has the potential to derive SSLs that defy conservation of mass 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 still assumes constant replenishment. On the positive side, chemical specific parameters are used to model environmental fate.

7.3.3 Option II: Finite Source of Volatile Chemicals

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.[22] Instead the model simply volatilizes the entire mass of contamination at a constant rate, over the exposure time period until the source has been depleted. This tends to overestimate volatilization of heavy molecules with low vapor pressures[23], 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.[24]

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[22] 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 source depth, soil bulk density, exposure, and a time dispersion factor that is based on climate-specific conditions and contamination area in acres.

[23] 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.

[24] EPA 1996 Soil Screening Guidance: Technical Background Document (Downloaded December 11, 2020 from: https://nepis.epa.gov/Exe/ZyPDF.cgi/100025LM.PDF?Dockey=100025LM.PDF) and EPA RSL User's Guide (Downloaded December 11, 2020 from: https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide).

7.3.4 Use of Mass-Limit Model for Petroleum Hydrocarbon Fractions

The default, Infinite Source RSL volatilization model does not consider a chemical's degradation in soil over time. The relatively high 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-limit volatilization model for calculating soil RAGs for the six petroleum hydrocarbon fractions. Per EPA guidance, both volatilization models were run and the higher of the two resulting SLs was chosen as the RAG. Only the Construction Worker Soil scenario has petroleum hydrocarbon RAGs that are based on the Infinite Source volatilization model.

Research by DEP's petroleum program[25] indicates that the reasonable worst-case scenario is 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.

7.3.5 Hazardous Substances - Used Infinite Source Model

Following EPA guidance, the Infinite Source VF method was used as the default method to generate the RAGs for hazardous substances because the DEP could not establish generic default values for thickness of the source area and area of the release. 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, then the RSL calculator is available to run both the Infinite Source and Mass Limit models.

7.4 Soil Saturation with VOCs

7.5 Hazardous Substances - Replace SL_{inh} with C_{sat}

The RSL calculator derives a soil saturation concentration (C_{sat}) for those contaminants that are both volatile and liquid at ambient soil temperatures. 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) making RSL VF model results unreliable at concentration levels above the Csat. For most

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[25] 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), amended May 23, 2014.

contaminants, the Agencies selected the option to substitute the Csat for the inhalation-based soil screening level if the Csat was lower than the calculated risk-based inhalation screening level. This results in a lower allowable soil concentration and therefore a lower RAG. Selection of the 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 9, resulting in SLs that are between 1% and 93% of the default soil inhalation model.

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

7.5.1 Petroleum - No C_{sat} Substitution

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 7.6.3). Therefore, the Csat substitution option was not utilized for calculating the petroleum hydrocarbon fraction RAGs.

7.6 Sensitivity Analysis: Volatilization Model and Soil Saturation

The effect of not considering mass-limited VFs and substituting the Csat on the RAGs is illustrated in TSD Table 9 - Effect of Csat Substitution for Inhalation on Residential Soil Screening Levels. In the examples, the RSL calculator was used to generate soil RAGs using the default Infinite Source VF model with and without the Csat substitution (see Section 7.6, above).

TDS Table 10 evaluates the use of the Mass-Limit VF model and the omission of the Csat substitution for the petroleum hydrocarbon ranges. The first 3 data columns represent 1) calculated SLs with the infinite source VF model and the Csat substitution; 2) calculated SLs with the infinite source VF model and no Csat; 3) calculated SLs with the Mass Limit VF model and no Csat. For the C5-C8 Aliphatic hydrocarbon fraction Residential soil 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 limit VF model, the screening level is 1660 mg/kg. Particularly for petroleum hydrocarbon fractions, application of the Csat results in much lower screening levels. Four out of the six petroleum hydrocarbon fraction RAGs are based on a mass limit VF based inhalation risk SL.

TSD Table 12 - Effect of C_{sat} Substitution for Inhalation on Residential Soil Screening Levels

					2018 Residential Soil RAG with Csat		SL without Csat	
Chemical	**2018 Residential Soil RAG with Csat (mg/kg)[26]**	**SL without Csat**	**% Csat SL / default model SL**	**Csat**	**Ingestion SL (mg/kg)**	**Inhalation SL (mg/kg)**	**Ingestion SL (mg/kg)**	**Inhalation SL (mg/kg)**
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
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

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

TSD Table 13 - 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[27] (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

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[27] 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[27] (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

7.7 Construction Worker Parameters for Particulate Emission Factor

The RSL Construction Worker scenario considers inhalation of dust kicked up from truck traffic and earthwork. 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 11.

TSD Table 14 - 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

7.8 Soil Leaching to Groundwater

7.8.1 Introduction: RSL Calculator for Soil to Groundwater

Contaminated soil that does not pose a direct contract risk can still pose a health risk from contamination leaching from the soil, contaminating the underlying aquifer, and people drinking water from a well in the contaminated aquifer. 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 (aka residential groundwater RAG, see 4.1 above). 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 7.8.2.

7.8.1.1 Derivation of the Dilution Attenuation Factor (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 groundwater at the source to the receptor. In developing the 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 rounded the median value of these modeled DAFs for a DAF of 55.

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 the Agencies thought it made reasonable sense to calibrate the RSL leaching to groundwater model with the detailed 2016 RAG modeling.

7.1 Soil PFAS

In general, soil concentrations for PFAS were derived as discussed in the sections above. Note that additional PFAS guidance numbers must be consulted because, as summarized by Maine CDC[28]:

> In developing soil screening levels for the protection of human health, incidental soil ingestion for a young child is often considered the most health protective exposure pathway. Discovery of perfluorooctanesulfonic acid (PFOS) contamination in cow's milk at a small, local dairy farm in Maine suggests that soil screening levels based on direct soil contact may be inadequate to protect individuals from exposure through cow's milk at farms where PFOS is present in the soil. To better understand the exposure pathway leading to PFOS milk contamination at a dairy farm, the Maine CDC developed soil screening levels for a soil-to-fodder, fodder-to-cow's milk, milk-to-human exposure pathway. The agronomic pathway soil screening levels were developed using a modified EPA Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites (PRGR) equation. The agronomic pathway equation calculates a soil screening level to meet a prescribed PFOS milk action level based on chemical transfer from soil to plants used as dairy cow feed, dairy cow feed consumption, soil consumption while grazing and transfer from intake into milk. The soil screening levels were derived using a PFOS action level for milk of 210 ng/L. This cow's milk action level is established as guidance for determining whether a farm's milk from dairy cattle should be considered adulterated, and therefore neither sold or delivered for sale in accordance with Title 22 MRS §2155-A. Maine CDC developed the PFOS milk action

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[28] Maine CDC, Derivation of PFOS soil screening levels for a soil-to-fodder-to-cow's milk agronomic pathway, (downloaded December 28, 2020 from: https://www.maine.gov/dep/spills/topics/pfas/Agronomic-Pathway-Soil-Screening-Levels-Soil-Fodder-Cows-Milk-09.16.20.pdf) September 16, 2020.

level using the EPA reference dose for PFOS of 20 ng/kg/day, a 90th percentile milk intake level for a 1-2-year-old child, with consideration of background exposure to PFOS from other dietary and environmental sources. For the soil screening levels, PFOS-specific soil-to-hay, soil-to-corn, and milk transfer factors were selected from published peer-reviewed studies in the scientific literature and a study conducted and published by a European state agency. For soil adherence to hay, the EPA PRGR default soil plant mass loading factor for pasture plants was adjusted to a geometric mean as a central tendency estimate to account for the highly skewed range of potential values. A separate soil plant mass loading factor identified in the scientific literature was selected for corn. Soil screening levels were developed for two fodder intake scenarios: a predominantly grass-based dairy farm scenario using EPA PRGR default intakes for hay and corn silage and an average Maine dairy farm scenario using hay and corn silage estimates based on more typical Maine dairy farm practices. Terms accounting for the fraction of fodder grown on PFOS-contaminated land and the fraction of the year cattle are fed PFOS-contaminated fodder were set at EPA PRGR default values of 1. The fraction of the year spent grazing was adjusted to 0.5 to account for snow cover in Maine. These two fraction terms can be adjusted using site-specific information if appropriate. The resulting soil screening levels for a grass-based dairy farm and a more typical, average Maine dairy farm are 6,400 and 11,000 ng/kg dry weight, respectively. These agronomic exposure pathway soil screening levels are more than 150-fold lower than the current residential soil (1,700,000 ng/kg dry weight) and 2- or more fold lower than soil leaching-to-ground water (21,000 ng/kg dry weight) exposure pathways [using the traditional approaches described in this TSD].

8 Lead Modeling

8.1 Departure from RSL model

The RAGs for Lead could not be modeled with the RSL calculator because there is no toxicity value for Lead. Since there is no “safe level” of lead exposure to young children, lead does not present a classic "threshold", which is needed to develop a noncancer toxicity value. Therefore, 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. Using EPA guidance, CDC ran both the IEUBK and ALM models to establish the soil RAG at which there was a 5% or less probability that a typical child's blood lead level, or fetal blood lead level of a pregnant female worker, would not exceeding 5 micrograms per deciliter (5 µg/dL). The model inputs (TSD Table 12) were based on the most recent EPA default values, except as described below. The 5 µg/dL target blood level reflects the current US Centers for Disease Control and Prevention

USCDC) recommendation[29], Maine's statutory definition of a "Lead Poisoned" child[30], and EPA guidance[31].

8.2 Lead Residential Soil

For the Residential Soil RAG, CDC iteratively ran the IEUBK model using EPA default parameter inputs for a 12 to 72-month age range. The resultant soil concentration was 142 mg/kg, which was rounded to 140 mg/kg for the final RAG value.

8.3 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[32] whereby exposure is apportioned between the park soil and residential yard soil as presented in equation 1.

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

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:

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

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

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[29] USCDC blood lead reference level from USCDC website, Childhood Lead Poisoning Prevention (Downloaded December 11, 2020 from: https://www.cdc.gov/nceh/lead/acclpp/blood_lead_levels.htm.)

[30] 22 M.R.S. §§ 1315 (5-C)

[31] EPA Hazard Standards and Clearance Levels for Lead in Paint, Dust and Soil (TSCA Section 402 and 403): downloaded December 11, 2020 from: https://www.epa.gov/lead/hazard-standards-lead-paint-dust-and-soil-tsca-section-403 and EPA Memo Updated Scientific Considerations for Lead in Soil Cleanups (downloaded December 11, 2020 from https://semspub.epa.gov/lead/considerations.pdf) December 22, 2016.

[32] EPA, Assessing Intermittent or Variable Exposures at Lead Sites (Downloaded December 11, 2020 from: https://semspub.epa.gov/work/HQ/176288.pdf). Undated.

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.

8.4 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 CDC used the EPA recommended default exposure factors (ingestion rate and exposure frequency) for the ALM, which represent 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 soil contact during 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 during intensive work for the ALM[33].

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 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 13), 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 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.

8.5 Lead Recreational Sediment

Recreational exposure to sediment accounts for sediment exposure while wading or swimming for 3 days per week from May through October (26 weeks) based on

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[33] EPA Website, Lead at Superfund Sites: Frequent Questions from Risk Assessors on the Adult Lead Methodology, downloaded December 11, 2020 from: https://www.epa.gov/superfund/lead-superfund-sites-frequent-questions-risk-assessors-adult-lead-methodology#ingestion%20rate.

observances of Maine weather. 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.

8.6 Lead Residential Groundwater

The residential lead groundwater RAG of 5 µg/L was developed using the IEUBK model where approximately no more than 5% of children would have a blood lead level greater than 5 µg/dL. The soil lead concentration was set at the residential soil RAG of 140 mg/kg (see section 8.2) and all other parameters set at EPA defaults (TSD Table 12). Model iterations were run, gradually increase the contribution from lead in water above the EPA default value of 4 ug/kg. 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 greater than 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 less than 5% of children exceeding a 5 µg/dL blood lead level.

TSD Table 15 - IEUBK Input Parameters for 2021 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 16 **- 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.

8.7 Soil Lead Leaching to Groundwater

The RSL calculator does not provide an output for Lead in the Leaching to Groundwater calculator. It does calculate an MCL-based[34] value, for the EPA Lead MCL of 15 µg/L. The Lead Leaching to Groundwater value presented in the 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 14:

TSD Table 17: 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

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[34] Maximum Contaminant Levels (MCLs) are standards that are set by the United States Environmental Protection Agency (EPA) for drinking water quality. An MCL is the legal threshold limit on the amount of a substance that is allowed in public water systems under the Safe Drinking Water Act (SDWA). Downloaded April 22, 2020 from: https://en.wikipedia.org/wiki/Maximum_Contaminant_Level.

9 Soil Background Concentrations

9.1 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[35]. 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, which were set as the background concentrations.

9.2 PAHs

To establish the background concentration of Polycyclic Aromatic Hydrocarbons (PAHs) 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 soil. After evaluating multiple possibilities, DEP ultimately determined that a consistent, statistically valid split in PAH sample results was correlated with the definition of urban and rural areas that is used by the Department of Transportation's compact urban zones program. These zones are geographically located in GIS layers. Additional information is available in the PAH study[36].

9.3 PFAS

PFAS background concentrations likely result from air deposition. Maine DEP did not have a readily available dataset to establish background soil concentrations for per- and poly-fluoroalkyl substances. DEP assumed that Maine concentrations are similar to Vermont concentrations, so used the background concentrations established in the State of Vermont.[37]

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[35] 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, downloaded December 11, 2020 from: http://pubs.usgs.gov/of/2005/1253/), July 2005.

[36] 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.

[37] Wenyu Zhu, Roakes, Harrison, Xemba, Stephen and Badireddy, Appala Raju, University of Vermont, PFAS Background in Vermont Shallow Soils (downloaded February 16, 2021 from: https://anrweb.vt.gov/PubDocs/DEC/PFOA/Soil-Background/PFAS-Background-Vermont-Shallow-Soils-03-24-19.pdf) February 8, 2019

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 each met its 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, DEP ended their use in 2018. 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}.

TSD Table 18 - 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 nor 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 workday	RSL default
	Air	Commercial Worker (Outdoors)	8	hours/day	The workday	RSL default
	Air	Construction Worker	8	hours/day	The workday	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

References

U.S. EPA 1989. RAGs Volume I: Human health evaluation manual (Part A). Interim Final. Office of Emergency and Remedial Response. EPA/540/1-89/002. U.S. EPA 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard default exposure factors". OSWER Directive 9285.6-03.

U.S. EPA. 1996a. Soil Screening Guidance: User's Guide. Office of Emergency and Remedial Response. Washington, DC. OSWER No. 9355.4-23

U.S. EPA. 1996b. Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. Washington, DC. OSWER No. 9355.4-17A

U.S. EPA. 1997a. Exposure Factors Handbook. Office of Research and Development, Washington, DC. EPA/600/P-95/002Fa.

U.S. EPA 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December 2002.

U.S. EPA 2004. RAGs Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). OSWER 9285.7-02EP.July 2004.

U.S. EPA 2009. RAGs Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). OSWER 9285.7-82. January 2009.

U.S. EPA 2011. Exposure Factors Handbook 2011 Edition (Final). National Center for Environmental Assessment, Office of Research and Development. Washington D.C.

U.S. EPA 2018. Region 4 Human Health Risk Assessment Supplemental Guidance March 2018 available at: https://rais.ornl.gov/documents/hhra_regional_supplemental_guidance_report-march-2018_update.pdf

TSD Table 19: 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	0.02	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	0.04	-	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	-	-	-	-	-	-
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

	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 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
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

	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**
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) (Downloaded December 11, 2020 from: https://rais.ornl.gov)

The constants for 2-Methylbenzene sulfonamide and 4-Methylbenzene sulfonamide were obtained from National Institute of Health’s National Library of Medicine and the National Center for Biotechnolgy Information (Available December 11, 2020 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: May 1, 2021

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:

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

This supplemental guidance:

4. Fosters a consistent framework for conducting risk assessment at Maine sites;
5. Expedites Agency review of risk assessments;
6. Minimize revision and resubmittal of risk assessment documents; and
7. 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

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[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 February 19, 2021 from: http://www.maine.gov/dep/spills/publications/guidance/index.html)

[2] EPA Website “Risk Assessment Guidance for Superfund (RAGS): Part A” (downloaded February 19, 2021 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

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[3] ITRC, Webpage “Decision Making at Contaminated Sites: Issues and Options in Human Health Risk Assessment” (Downloaded on February 19, 2021 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 Maine RAGs Technical Support Document (TSD) Table 15 - 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.

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[4] EPA webpage, "Risk Assessment: Regional Screening Levels (RSLs)" (downloaded February 19, 2021 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:

8. 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").
9. 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 Party representatives will have a 14 (fourteen) day Negotiation Period from receipt of the written objection(s) to resolve the dispute.
10. 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 the DEP 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.
11. 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 the Risk Assessment.
12. 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.
13. 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 to be conducted, generally DEP Programs will 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:

1. Conceptual Site Model (CSM) identifying the media, exposure points, receptors, and exposure pathways of concern (see Figure C-1);[6]
2. Selection of chemicals of potential concern (COPCs);
3. Receptor-specific exposure assumptions;
4. Exposure Units (see section 3.2);
5. Modeling reports when models are used to estimate risks or hazards, including any statistical programs, and fate and transport models;
6. Exposure point concentration (EPC) calculations (Section 5.4); and
7. 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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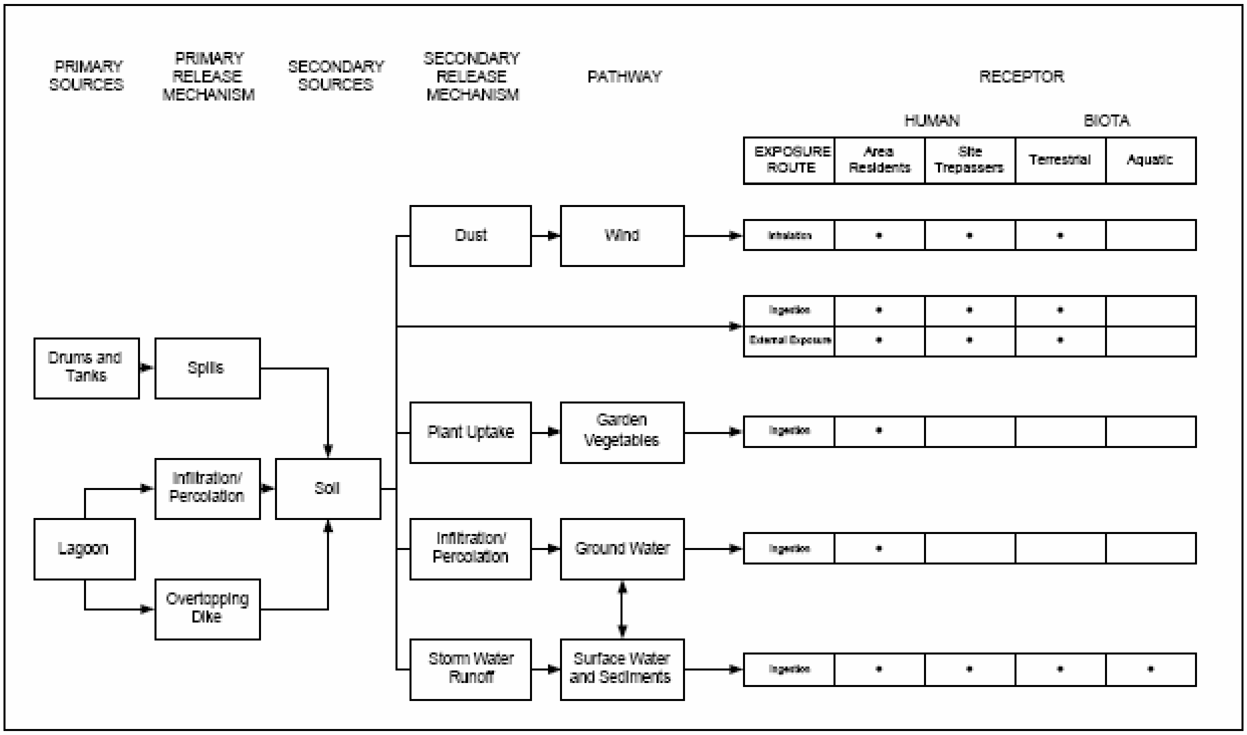
[5] EPA webpage, "Risk Assessment: Risk Assessment Guidance for Superfund (RAGS): Part D" (downloaded February 19, 2021 from: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-d).

[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 February 19, 2021 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 where a Reasonably Maximum Exposed (RME) individual may be exposed to site contaminants. Exposure units are identified based on typical human activities, and the CSM’s current and future site use. They are described by location, size and environmental media (e.g. soil, groundwater, etc.). In the quantitative risk assessment, data are grouped by exposure units to calculate exposure point concentrations. An example of an exposure unit is surficial soil over a proposed ¼ acre residential house lot. Typically, separate operable units or areas of concern 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 ”hot-spots” 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 an identified 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 determine site-specific background conditions, 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). 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:

1. There is sufficient analytical data to characterize the site;
2. Data collection methods are consistent with DEP and EPA guidance and an approved SAP that includes a Quality Assurance Project Plan QAPP);
3. Sampling and analytical procedures give accurate, chemical-specific concentrations;
4. The data has been validated and found to meet project data quality objectives (DQOs) for the risk assessment; and
5. Method detection limits and sample quantitation limits, to the extent practicable, are 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 the media-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 the analytical 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 of the risk assessment report (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 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 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 should 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.

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[7] EPA, Data Quality Objectives Process for Hazardous Waste Site Investigations (QA/G-4HW), January 2000, (downloaded February 19, 2021 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 (EPA QA/G-4), February 2006, (downloaded February 19, 2021 at: https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4)

And

EPA, EPA Guidance for Quality Assurance Project Plans, February 1998 (downloaded February 19, 2021 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). COPCs are selected by comparing maximum measured concentrations in a given media to the current media specific RSL values set at a HQ=0.1 and an ILCR of 10^{-6}. Compounds that exceed the screening table values are COPCs. 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 eliminate 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 corresponding 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 value to be used. Additionally, retain lead as a COPC when a maximum exposure concentration exceeds its respective Maine RAG value.

In accordance with EPA Guidance, 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 media (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.

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

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 15.

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:

1. Ingestion of homegrown meat and dairy products for a home farm scenario;
2. Ingestion of game and waterfowl for hunters and their families;
3. Inhalation of volatiles from surface water;
4. Inhalation of particulates by dirt biking trespassers, residents, or recreational users; and/or
5. 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 be 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 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 15. 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 site 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 modeling, 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 media-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 these evaluations. When direct measurement is not possible, consult DEP on the value of modeling, and whether pre-emptive remedies

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[9] EPA webpage ExpoBox (A Toolbox for Exposure Assessors), which provides models and other tools by media (Downloaded February 19, 2021 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" January, 2015. (downloaded on February 19, 2021 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. (Downloaded February 19, 2021)

will be more cost-effective. The EPA Vapor Intrusion Screening level calculator (VISL) identifies chemicals that are considered to be sufficiently volatile and toxic to warrant an investigation of the soil gas intrusion pathway when they are present as subsurface contaminants..

5.3.2 Shower Model

The RSL calculator residential tapwater scenrio includes exposure to contaminants from volatilization 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 or 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 software to calculate the 95% UCL. 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 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 the calculated 95% UCL 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.

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[12] Virginia Department of Environmental Quality, Virginia Unified Risk Assessment Model – VURAM Users Guide for Risk Assessors (downloaded February 19, 2021 from: https://www.deq.virginia.gov/home/showpublisheddocument?id=4068) Updated October 2018

[13] EPA, Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (Downloaded February 19, 2021 from: https://www.epa.gov/sites/production/files/2016-03/documents/upper-conf-limits.pdf). December 2002.

In the case of Multi-Incremental Sampling or Incremental Sampling Methodology, the Decision Unit may represent the EPC. If an EPC is represented by multiple Decision Units, then the 95% UCL 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 residents or contacted by construction workers. Prior to EPC estimation, duplicate sample results should be averaged. Estimated values (e.g., “J” qualified

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[14] EPA, Exposure Point Concentrations in Groundwater. (downloaded February 19, 2021 from: https://www.epa.gov/risk/exposure-point-concentrations-groundwater), 2014

results) should be used without adjustment. Non-detects in the dataset should be treated as recommended in the ProUCL User's Guide.

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). Maine RAGs, Section 6.5.3-Dioxins and Co-Planar PCBs, provides guidance on how to evaluate dioxin and dioxin-like compound data, including a table of TEFs (Table 2). 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] Table 16: Physical/Chemical Properties and Toxicity Values for Manual Entry into RSL Calculator, of the Maine RAGs TSD, includes default toxicity values to be used for assessing VPH, EPH and APH exposure risk.

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:

1. Compare the sum of all xylene isomers to the total xylenes RAG.

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[15] EPA, Memorandum for Human Health Toxicity Values in Superfund Risk Assessments (OSWER Directive 9285.7-53, downloaded February 19, 2021 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- (Downloaded February 19, 2021)

2. Compare 1,2 dichloroethylene results to the cis-1,2-dichloroethylene RAG.
3. Compare the sum of cis and trans 1,3-dichloropropane to the 1,3-dichloropropane RAG.

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 media, 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]. Several other States have developed toxicity factors for several PFAS compounds, and Maine CDC is assessing this information. 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, site-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

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[17] EPA webpage, “Assessing and Managing Chemicals under TSCA: Risk Management for Per- and Polyfluoroalkyl Substances (PFASs) under TSCA (downloaded February 19, 2021 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 February 19, 2021 from: https://www.epa.gov/expobox/exposure-assessment-tools-chemical-classes-nanomaterials).

[19] U.S. Centers for Disease Control and Prevention website, “Blood Lead Levels in Children”, downloaded February 19, 2021 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 equal to or exceeds 5 micrograms per deciliter” (downloaded February 19, 2021 from: http://legislature.maine.gov/statutes/22/title22sec1315.html).

ALM estimates the soil lead concentration at which the probability of blood lead 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:

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

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[21] EPA Website, "Lead at Superfund Sites: Software and Users' Manuals" downloaded February 19, 2021 from: https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals

[22] EPA website, "Lead at Superfund Sites: Guidance" downloaded February 19, 2021 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 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 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 action 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.

When conducting risk assessments for petroleum compounds, be careful to avoid double counting risks from target analytes and petroleum ranges. For example, analyzing for both VOCs and VPH/APH will cause reporting of the substituted benzenes (trimethylbenzene, butylbenzenes) twice, once as the pure compounds and a second time as part of the C9-C10 mixture of compounds. The risks from these two analyses should not be added together. The risks from the VPH/APH will be the most accurate because they account for the risk posed by the full mixture, rather than the small number of individual compounds that fall within that range that are picked up by the VOC analysis.

The toxicity values for the petroleum ranges were developed to best represent the toxicity of each ranges' mixture overall, based on the toxicity of the most toxic individual compound or on mixtures studies. So, while the range's RfD and CPF may not be as conservative as those for some of the individual non-BTEX substituted benzene compounds, they capture the risk of the entire range. If a site was sampled for VOCs only (and not VPH/APH) and the results show the benzene substitutes to be present, then the site will need to be resampled for VPH/APH to determine the actual risk posed by petroleum.

8 Acute Toxicity Values

When the risk assessment indicates that there is a significant 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

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[23] ATSDR Webpage: Toxic Substances Portal, Minimal Risk Levels (MRLs) – For Professionals, downloaded February 19, 2021 from: http://www.atsdr.cdc.gov/mrls/index.html.

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]

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[24] EPA webpage "Dose-Response Assessment for Assessing Health Risks Associated With Exposure to Hazardous Air Pollutants" downloaded February 19, 2021 from: https://www.epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants.

[25] EPA, "Calculating Preliminary Remediation Goals (PRGs)" downloaded February 19, 2021 from: https://www.epa.gov/risk/calculating-preliminary-remediation-goals-prgs.

Attachment C: Maine 2021 Remedial Action Guidelines Addendum for Petroleum Remediation

Effective Date: May 1, 2021

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Contents

1 Introduction and Disclaimer

This document presents the 2021 Maine Remedial Action Guidelines (RAGs) for sites Contaminated with Hazardous Substances and Petroleum, Addendum for Petroleum Remediation (petroleum addendum). Together, the petroleum addendum and the RAGs provide a DEP-accepted approach for determining human health risk and clean-up goals at petroleum remediation sites.

The petroleum addendum and RAGs are guidelines not rules and are not intended to have the force of law. This addendum 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. Specifically, applicable standards in *Rules for Underground Oil Storage Facilities*, 06-096 C.M.R. ch. 691 (effective date September 16, 1991, amended September 26, 2018-filing 2018-205), *Identification of Hazardous Matter*, 06-096 C.M.R. ch. 800 (effective date February 3, 1981, amended September 3, 2013-filing 2013-215) and *Beneficial Use of Solid Wastes*, 06-096 C.M.R. ch. 418 (last revised July 8, 2018) supersede any conflict with this guidance.

The petroleum addendum is specific to the investigation and remediation of petroleum only sites directly related to petrogenic hydrocarbons with the exception of the Marine Terminal Facilities, which have their own cleanup criteria established in *Oil Discharge Prevention and Pollution Control*, 38 M.R.S. §542 (4-B)(E) (1/1/2021). Section 3 below provides additional details on the applicability of the petroleum addendum.

The petroleum addendum identifies specific sections where petroleum remediation guidelines require clarification on how the RAGs are applied to petroleum remediation (e.g. Section 3.2, Applicable Pollutants) and sections that don't align with the RAGs (e.g. Section 3.3, Applicable Media, Scenarios, and Routes of Exposure). The petroleum addendum defaults to the RAGs when there are no specific details provided in this addendum (e.g. Section 3.5 of the RAGs, Not Applicable to Selection of COPCs for Full Risk Assessment, Section 8, Technical Help & Technical Basis for the RAGs, and Section 9, RAG Tables).

This addendum utilizes the same risk-based criteria supported by the Maine Center for Disease Control and Prevention (CDC). Section 4 of the RAGs provides the risk protocols used to develop the petroleum addendum. This addendum is supported by Attachment A and Attachment B of the RAGs and is included as Attachment C to the RAGs.

As discussed in section 6.2 of the RAGs, the RAGs apply only after emergency removal actions have been completed. Many petroleum release sites involve a recent discharge of petroleum. DEP's Division of Response Services is responsible for emergency actions to resolve imminent threats to human health and the environment. Emergency actions include stopping the discharge, mitigating the spread of the discharge to receptors, and removing the discharge at the receptor (residential home, commercial building, wetland, marsh, surface waters, and marine environment). Prompt emergency response actions to eliminate the discharge condition and control the released petroleum from migrating to a receptor, into the environment, or soaking further into building materials is the top priority for emergency response action.

This addendum applies to the following programs within BRWM including Uncontrolled Sites (RAGs Section 3.1.1), VRAP (RAGs Section 3.1.2), Brownfields (RAGs Section 3.1.3), Superfund/CERCLA (RAGs Section 3.1.4), RCRA subpart I (RAGs Section 3.1.5), and Beneficial Reuse of Remediation Debris (RAGs Section 3.1.8).

Standard Operating Procedures (SOPs) for implementation of the RAGs Petroleum Addendum are provided on the DEP website at: https://www.maine.gov/dep/spills/petroleum/index.html.

Remedial actions completed or overseen by DEP staff must follow required funding approval requirements and supervisor notifications.

When petroleum remediation sites need state liability protections as defined in law (*Voluntary Response Action Program*, 38 M.R.S §343-E), application should be made to the Voluntary Response Action Program (VRAP) at : https://www.maine.gov/dep/spills/vrap/index.html.

Petroleum Remediation sites that do not require VRAP liability protections but need an opinion from the DEP related to contamination present (i.e. comfort letter) should contact the Technical Services Director for assistance. Contact information is available on the DEP website: https://www.maine.gov/dep/spills/petroleum/index.html

1.1 DEP Petroleum Program

Widespread use, storage, and transportation of petroleum products, and their frequent discharges to the environment in Maine (averaging 2 per day) make the petroleum program a diverse program. The scope of the petroleum remediation program includes, but is not limited to, operating and former gas stations, home and commercial heating oil tanks, transportation accidents (trucks, cars, and boats), bulk oil storage facilities, unlicensed and/or illegal storage of petroleum, above ground tanks, underground storage tanks, piping, and dispensers.

The majority of petroleum remediation cases come through a report of a discharge to the Division of Response Services and are assigned a Spill Number. However, there are many other petroleum remediation sites that get reported to the Maine DEP through various other sources, including assessment reporting required under 06-096 C.M.R. ch. 691, through other BRWM programs, and through other points of contact within the Department. The petroleum addendum addresses the applicability of the RAGs to oil discharges.

The Maine petroleum program includes staff from:

- Maine Department of Public Safety, Office of the State Fire Marshal
- Office of Commissioner, Collections, Claims, and Recovery Unit
- Bureau of Remediation and Waste Management
- Bureau of Air Quality, Division of Licensing and Compliance

The DEP petroleum program includes, but is not limited to:

- UST Management and Compliance
- Oil Compliance
- Bulk Oil Storage
- Petroleum Remediation

Federal and state laws, statues, and rules that provide the foundation to the Remedial Action Guideline Addendum for Petroleum Remediation are outlined below.

The USEPA RCRA Subtitle I (RCRA §§9001-9010) includes requirements for the Underground Storage Tank (UST) Program for storing petroleum including:

- Protecting groundwater from leaking underground storage tanks
- Requiring owners and operators to prevent, detect, and cleanup releases
- Bans the installation of unprotected steel tanks and piping
- Considerations for UST cleanup include:
    - Protect human health and the environment
    - Ensure that wastes are managed in an environmentally sound manner

Protection and Improvement of Waters, 38 M.R.S , §§361 - 571 includes two subchapters that set the foundation for the petroleum program and establish differences between it and the other programs in BRWM. The two subchapters are:

- Oil Discharge Prevention and Pollution Control, 38 M.R.S. §§541-560
- Oil Storage Facilities and Ground Water Protection, 38 M.R.S.§§561-570-N

Four sections of Title 38 establish the petroleum remediation program including:

- Pollution and Corruption of Waters and Lands of the State Prohibited, 38 M.R.S. §543
- Removal of Prohibited Discharges, 38 M.R.S. §548
- Maine Ground and Surface Clean-up and Response Fund, 38 M.R.S. §551
- Cleanup and Removal of Prohibited Discharges, 38 M.R.S. §568

38 M.R.S. §551 satisfies the EPA requirement for financial assurance for UST facility owners and provides funding for required cleanup.

There are several rule chapters for the Board of Underground Storage Tank Installers (06-481) and DEP (06-096) related to different aspects of the petroleum program (https://www.maine.gov/sos/cec/rules/06/chaps06.htm). Rules specifically related to this Petroleum Addendum to the RAGs include:

- *Rules for Underground Oil Storage Facilities*, 06-096 C.M.R. ch. 691 (effective date September 16, 1991, amended September 26, 2018-filing 2018-205)
- *Siting of Oil Storage Facilities*, 06-096 C.M.R. ch. 692 (effective date August 7, 2019-filing 2019-116)

38 M.R.S. §543 states that any person who causes or is responsible for a discharge in violation of §543 is not subject to any fines or civil penalties if that person reports

the discharge within 2 hours and promptly removes the discharge in accordance with the rules and orders of the Board of Environmental Protection or Commissioner of the DEP (38 M.R.S. §550). There is no minimum quantity stated in the law or in any DEP rules.

1.2 DEP Petroleum Remediation

Petroleum remediation is one of several components of the DEP Petroleum Program. The remediation program focuses on releases associated with home and commercial heating oil spills, that result in a direct human health risk, at the same time the remediation program continues to address releases at UST, AST, and transportation related releases that are attributable to equipment failure, human error, and accidents. Threats to environmental resources and human health have been significantly reduced at UST and bulk oil AST facilities due to advancements in technology, reporting requirements, and siting criteria. However, continual releases from home and commercial heating oil tanks have not been reduced over the same time period and often result in completed exposure pathways to human occupants and adjacent properties. This document and associated Standard Operating Procedures (SOPs) are based on more than 40 years of DEP staff experience in successfully remediating petroleum contamination in Maine.

The petroleum program successfully opens and closes petroleum remediation cases based on the Conceptual Site Model (CSM) for the site that includes evaluation of human health risks and risks to surface water bodies. Several factors have contributed to the success of the petroleum program that are unique to the program, including:

1. The establishment of the Maine Ground and Surface Waters Clean-up and Response Fund for petroleum releases makes the petroleum program function differently than all other programs by establishing cleanup funding and rules related to fund expenditures and reimbursements (38 M.R.S. Section 551 and Section 568-A).

2. Technology advancements in leak detection and facility design has reduced legacy releases that were the focus of remedial resources in the 1990’s.

3. Siting criteria for oil storage facilities has reduced the risk to water supplies and groundwater resources.

4. Improved reporting of petroleum releases has allowed DEP staff to focus on source reduction in a timely fashion, which reduces the length of a project.

5. Resources to remediate contaminated soil and water and eliminate vapor risks in a timely manner, which facilitates site closure within months of a release.

6. Funding and resources to monitor the effects of source reduction and evaluate human health risks. Follow-on monitoring facilitates the ability to leave remaining contamination in place after the source reduction activities are complete and to make sure human health is protected.

7. Understanding unique physical properties affecting the fate and transport of petroleum in the environment. Specifically, the ability of petroleum to biodegrade, attenuate, and float on water, in most instances, allows DEP staff to make risk management decisions that are not possible with other contaminant types.

8. The ability to close sites, in accordance with the CSM and follow-on monitoring, even when remaining contamination is present and institutional controls are not established.

2 Purpose

The purpose of this addendum is to specify unique aspects of the petroleum remediation guidelines that are different from the hazardous substance sites and mixed substance (petroleum and hazardous substance) sites as presented in Section 3.1 of the RAGs. The differences between petroleum and hazardous substances provide the basis for this addendum and set the basis for how the RAGs are applied to petroleum sites. This addendum prioritizes long-term remediation resources in the following order of importance, in accordance with the site-specific CSM:

1. Sites where the human health pathway is complete from the source to receptor;
2. Removal of petroleum product from the environment before it partitions into air and water and migrates away from the area of release in the vapor phase, dissolved phase or light non-aqueous phase liquid (LNAPL) phase.
3. Sites where the Conceptual Site Model (CSM) demonstrates that human health is at-risk because the migration pathway between the source and the receptor is contaminated;
4. Sites where the environmental resource pathway is complete from the source to the receptor (i.e. surface water.)
5. Sites where the CSM demonstrates that the surface water receptor is at-risk because the migration pathway between the source and the surface water receptor is contaminated.

The CSM is the tool used to determine if a risk pathway is complete or at-risk. For sites covered under items 3 through 5 above, where the existing contamination has been in place for sufficient time (relative to the fate and transport of petroleum contamination along the migration pathway) to reach a receptor and the receptor is not impacted above an applicable guideline (as determined by the CSM), the Environmental Professional, in consultation with DEP staff and the Director of Technical Services, must consider the environmental footprint (Section 4 below) of the cleanup as part of the remedy selection process. The environmental footprint includes but is not limited to the presence and function of wetlands and natural stream and river embankments as well as consideration of the carbon footprint of the selected remedy. The evaluation will be consistent with the ITRC Green and Sustainable Remediation work group (https://www.itrcweb.org/Team/Public?teamID=7). The determination of sufficient time is based on site specific measurements of travel times and attenuation rates between the source and the receptor.

For short-term emergency response cases, such as those administered by the Division of Response Services, the priority of actions is to eliminate the discharge condition and control the released petroleum from migrating to a receptor, into the environment, or soaking further into building materials as explained in Section 1 above.

The petroleum remediation program does not use institutional controls in the form of a declaration of environmental covenant to control exposures. Therefore, clean-up of petroleum sites should meet the ASTM definition of a historic recognized environmental condition (Section 4 below) that allows for unrestricted site use without subjecting the property to any required activity and use limitations (AUL). AULs in the form of a Declaration of Environmental Covenant in compliance with the *Uniform Environmental Covenants Act*, 38 M.R.S.A. §§ 3001-3013 (UECA) are permitted and may be used as part of a risk-based decision that is protective of human health and the environment where remediation is not practicable.

2.1 Consistency

This addendum is consistent with 06-096 C.M.R. ch. 691, 06-096 C.M.R. ch. 800, and 06-096 C.M.R. ch. 418 §3(O) and §3(R).

2.2 Site Specific Risk Assessment

This addendum is administered by the Technical Services Director in BRWM. Therefore, any petroleum only site administered under the petroleum program must have written approval from the Technical Services Director to develop and implement a site-specific risk assessment.

3 Applicability

This addendum is applicable to staff in the DEP’s petroleum program and other Environmental Professionals (EP) completing investigation, remediation, or mitigation in accordance with the commissioner’s satisfaction. This includes:

- Petroleum sites requiring DEP approval under 06-096 C.M.R. ch. 691,
- Reimbursement for eligible expenses under 38 M.R.S.§562-A,
- Fund coverage under 38 M.R.S.§568-A and 38 M.R.S.§569-A.

The following summarize the applicability of this addendum:

- Applicable to petroleum only
- Applicable to pure motor oil
- Applicable to pure hydraulic oil
- Applicable to hydrocarbons with petrogenic origin
- Not Applicable to hydrocarbons with pyrogenic origin
- Not Applicable to waste oil discharge

- Not Applicable to DEP Licensed Marine Oil Terminals, 38 M.R.S. §542 (4-B)(E) (1/1/2021)
- Not Applicable to mixtures

3.1 Applicable Programs

This addendum applies to all programs within BRWM including Uncontrolled Sites (RAGs Section 3.1.1), VRAP (RAGs Section 3.1.2), Brownfields (RAGs Section 3.1.3), Superfund/CERCLA (RAGs Section 3.1.4), RCRA subpart I (RAGs Section 3.1.5), and Beneficial Reuse of Remediation Debris (RAGs Section 3.1.8). As stated previously, this addendum does not apply to DEP licensed Marine Oil Terminal Facilities, which have their own defined cleanup criteria, 38 M.R.S. §542 (4-B)(E) (1/1/2021). Additionally, Chapter 691, notification levels, rather than the RAGs, determine when the Department must be notified of a petroleum discharge. The current laws, rules, and policies for Underground Oil Storage Tanks can be found at https://www.maine.gov/dep/waste/ust/lawsrules.html.

This addendum may be applicable to portions of an Uncontrolled Site, VRAP, Brownfield, Superfund/CERCLA, or RCRA, sites where the petrogenic hydrocarbon contamination is directly related to a tank (UST or AST) that contained heating oil or petrogenic hydrocarbon contamination that is not co-mingled with hazardous substances including waste oil, stoddard solvents, lubricants, or coatings.

Remediated soils or other debris may qualify for a subsequent reuse, such as construction fill, even though pollutants in the material may exceed normal background concentrations. The beneficial reuse of petroleum 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 other purpose, such as construction fill or a building material, that activity would be subject to *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, as defined in 06-096 C.M.R. ch. 418 (last revised July 8, 2018), §3(O) and §3(R). See the rules and discuss with the DEP's solid waste staff (aka Division of 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 06-096 C.M.R. ch. 418 or 06-096 C.M.R. ch. 419. When DEP is the Project Lead, surplus soils excavated during a UST replacement can be managed in accordance with SOP-PP-012 per 06-096 C.M.R. ch. 418§3(O) and §3(R).

3.2 Applicable Pollutants

This addendum is applicable to media that are contaminated with petroleum only such as motor fuel, jet fuel, heating oil (including kerosene), or their additives (i.e. MTBE).

MTBE is a gasoline additive used in Maine as part of the reformulated gasoline formula to replace lead and lead scavengers. The State of Maine, Department of Health and Human Services, Maine Center for Disease Control and Prevention, Division of Environmental Health, Drinking Water Program has set an enforceable drinking water standard (MCL) for MTBE of 35 ug/L (10-144 C.M.R., ch. 231, §7(D)(2)(b)). The RAG for residential groundwater exposure is 140 ug/L based on the USEPA RSL Calculator. This addendum for petroleum remediation will default to the MCL of 35 ug/L for all drinking water supplies. The groundwater RAG values for MTBE are appropriate for groundwater that is not associated with drinking water supplies within the context of an approved CSM (RWM-PP-006). Site specific risk assessments may be used in accordance with The RAGs, Attachment B which are reviewed by the DEP and Maine CDC to determine site specific health risks associated with the presence of MTBE in private drinking water supplies.

Where historic use of the site includes potential storage of leaded gasoline, this procedure applies and includes the evaluation of the presence of lead, and lead scavengers; including, 1,2-dichloroethane (1,2-DCA) and 1,2 dibromoethane (i.e. ethylene dibromide or EDB), in accordance with 06-096 C.M.R. ch. 691.

This addendum is applicable where fire-fighting foam, including fire-fighting foam with PFAS, was used to extinguish or prevent a petroleum-based fire and there is documented evidence of a petroleum release. Therefore, this addendum applies to PFAS compounds associated with the fire-fighting foam.

3.3 Applicable Media, Scenarios, and Routes of Exposure

This addendum does not apply to establishing clean-up guidelines for public drinking water supplies, or any other media/scenarios/routes-of-exposure that are not included in Table 1 of the RAGs, except for surface water.

In accordance with 06-096 C.M.R. ch. 691, this addendum does apply to surface water as defined in Section 3 above. For surface water, petroleum hydrocarbons and additives related to leaded gasoline analytical results should be compared to Surface Water Quality Criteria for Toxic Pollutants, 06-096 C.M.R. ch.584 (effective date July 29, 2012-filing 2012-211), MCLs, MEGs, Health Advisories, and Drinking Water Equivalent Levels to determine if an ongoing discharge is adversely affecting surface water quality.

4 Definitions

In addition to the definitions presented in the RAGs, Section 4.2, the following definitions are unique to Petroleum Remediation:

4.1 Contamination

Contamination means a site with any of the following conditions:

1) The presence of LNAPL.
2) The presence of petroleum hydrocarbon constituents at concentrations exceeding the RAGs or MCLs adopted by the Maine Department of Health and Human Services under 22 M.R.S. §2611.
3) A statistically significant increase in the concentration of measured parameters at on-site or down-gradient locations by comparison with representative background values, as demonstrated by statistical methods and procedures using a 95 percent level of confidence, approved by the Commissioner and consistent with the provisions of Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 40 C.F.R. §264.97 as amended up to July 1, 2018 (except that where the "Regional Administrator" is referred to, the "Commissioner" is meant);
4) Contamination includes soil and water where petroleum hydrocarbons are detected above the laboratory practical quantitation level using the MADEP VPH or EPH analyses.
5) Contamination includes soil and water where motor fuel additives are detected above the laboratory practical quantitation level using the appropriate laboratory methods to detect the additives at levels consistent with the appropriate RAGs and are associated with the presence of motor fuels.
6) Soils visibly stained or discolored by the presence of heavy oil or present above a notification level (06-096 C.M.R. ch. 691, Appendix Q).

4.2 Discharge

Discharge means any spilling, leaking, pumping, pouring, emitting, escaping, emptying, or dumping of oil (38 M.R.S. §562-A).

4.3 Environmental Footprint

The term is broad and includes all impacts to the natural environment. Specifically, the effect that an activity has on the environment, which includes the amount of natural resources impacted by the action (excavation, investigation) and the amount of harmful gases that the activity produces (excavation, trucking, treatment, etc.). The term includes but is not limited to the carbon footprint of an activity.

4.4 Environmental Professional

An Environmental Professional (EP) is person meeting the educational, training, and experience requirements as set forth in 40 CFR Section 312.10(b). 40 CFR Section 312.10(b) includes (1) a person who possesses sufficient specific education, training, and experience necessary to exercise professional judgment to develop opinions and conclusions regarding conditions indicative of releases or threatened releases on, at, in, or to a property, sufficient to meet the objectives and performance factors in Section 312.20(e) and (f). (2) Such a person must: (i) hold a current Professional Engineer’s or Professional Geologist’s license or registration from a state, tribe, or US territory and have the equivalent of three (3) years of full-time relevant experience; or (ii) be licensed or certified by the federal government, a state, tribe, or U.S. territory to perform environmental inquiries territory and have the equivalent of three (3) years of full-time relevant experience; or (iii) have a Baccalaureate or higher degree from an accredited institution of higher education in a discipline of engineering or science and the equivalent of five (5) years of full-time relevant experience; or (iv) have the equivalent of ten (10) years of full-time relevant experience. (3) An EP should remain current in his or her field through participation in continuing education or other activities

4.5 Fund Insurance Program

The Fund Insurance Program is the State program established under 38MRS, §568-A, to cover eligible costs associated with the clean-up of discharges from oil storage facilities. The program uses public funds from the Maine Ground and Surface Water Clean-up and Response Fund to cover eligible clean- up costs and third-party damages

4.6 Gross Contamination

Presence of Free Product LNAPL, heavily contaminated soil, heavily contaminated groundwater, heavily contaminated surface water, or heavily contaminated indoor air. Petroleum is readily apparent through visual or olfactory senses.

4.7 Historic Recognized Environmental Condition

As defined in the ASTM Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, ASTM E- 1527-13,. a A past release of any hazardous substances or petroleum products is one that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authority or meeting unrestricted use criteria established by a regulatory authority, without subjecting the property to any required controls. (For example, property use restrictions, activity and use limitations, institutional controls, or engineering controls). Before calling the past release a historic recognized environmental condition, the environmental professional must determine whether the past release is a recognized environmental condition at the time the Phase I Environmental Site Assessment is conducted (for example, if there has been a change in regulatory criteria). If the EP considers the past release to be a recognized environmental condition at the time the Phase I ESA is conducted, the condition should be included in the conclusions section of the (Phase I ESA) report as a recognized environmental condition.

4.8 LNAPL Light Non-Aqueous Phase Liquid

A liquid having a specific gravity less than one and is composed of one or more organic compounds that are immiscible or sparingly soluble in water and is observable to be separate from water. The term encompasses all potential occurrences of LNAPL including free, residual, mobile, entrapped, and visible petroleum sheen.

4.9 Oil

As defined in statue, 38 MRS, §562-A, means oil, additives, petroleum products, and their by-products of any kind and in any form including, but not limited to: petroleum, fuel oil, sludge, oil refuse, oil mixed with other non-hazardous waste, crude oils, and other liquid hydrocarbons regardless of specific gravity.

4.10 Oil Storage Facility

As defined in 38 MRS, § 562-A, and oil storage facility means tanks together with associated piping, transfer and dispensing facilities, used to store or supply oil at a fixed location for more than 4 consecutive months per year. If less than 10% of the facility capacity is beneath the surface of the ground, the facility is an above ground oil storage facility, or AST. All other storage facilities are underground storage tanks (UST) facilities, including facilities with tanks located wholly above the ground surface if associated underground piping contains 10% or more of the facility's total capacity.

4.11 Petrogenic Hydrocarbons

Hydrocarbons produced from pure petroleum sources including refined and unrefined petroleum products like crude oil, gasoline, heating oil, and pure petroleum based asphalt coatings.

4.12 Pyrogenic Hydrocarbons

Hydrocarbons produced by incomplete combustion of organic material and is not directly related to pure petroleum sources. Pyrogenic hydrocarbons may be found in ash, coal ash, rubber products (tires), asphalt, coal tar, and coal tar based products (some asphalt coatings).

4.13 Surface Water

The State of Maine classifies three types of surface water: Fresh Surface Water, Lakes and Ponds, and Estuarine and Marine Waters. Fresh Surface Water has four classifications: AA, A, B and C. Lakes and Ponds has one GPA. Estuarine and Marine Waters has three classifications SA, SB, and SC.

Additionally, the State of Maine designates Surface Water of Special Considerations including waters that are classified as sustenance fishing including sections of the Penobscot River Basin, St. Croix River Basin, and St. John River Basin and some lakes and ponds including, Conroy Lake in Monticello; Grand Lake Metagaming in Trout Brook Township and T6R8 W.E.L.S; Mattamiscontis

Lake in T3R9 N.W.P. and T2R9 N.W.P; Grand Falls Flowage, Berry Brook Flowage, George Brook Flowage, Huntley Brook Flowage, Lewey Lake, The Basin, The Narrows, Long Lake and Big Lake, adjacent to Indian Township; and Sysladobsis Lake in T5 N.D.

An updated map of the Classification of Maine Waters is found on the Maine DEP GIS website for GIS Maps and Other Data Files at www.maine.gov/dep/gis/datamaps.
A link to the ArcGIS Online map is:
https://maine.maps.arcgis.com/apps/webappviewer/index.html?id=397738f1d21d42589ab7ac989e2db568

4.14 Waste Oil

A petroleum or synthetic oil that, through use or handling, has become unsuitable for its original purpose due to the presence of hazardous substances or other impurities, or loss of its original properties (38 MRS, §1301-C).

4.15 Water Shake Test

A field method for determining the presence of LNAPL in soils or sediments. The method is described in DEP SOP TS004, and it includes placing soil into a clear glass jar and pouring clean water into the jar to cover the soil in water. Securing the water tight lid and shaking the soil and water sufficiently to break-up the soil particles and liberate any LNAPL present in the soil pores. The presence of LNAPL is observed as a layer on the water surface after shaking is stopped and the lid is removed.

4.16 Water Supply Well

A well that supplies potable water for human consumption. This may be a private well, or a public water supply. It could be a drilled bedrock well, a driven point overburden well, a dug well, or a spring that supplies water.

5 Responsibilities

5.1 Project Leader

The project leader of a petroleum remediation site should develop media specific remediation goals for DEP's consideration that are consistent with the RAGs, including this petroleum supplemental guidance or the site-specific risk assessment guidance provided in the RAGs Attachment B.

The project leader shall have the responsibility of establishing and maintaining communications with the Project Team and all parties involved with and affected by the release of petroleum including:

- Property Owner
- Tenant/Occupant
- Potential Responsible Party and their representatives

The Project Leader must communicate to their supervisor (DEP-lead case) or to the Director of the Division of Technical Services, or their designee (non-DEP lead case) who will complete the tasks necessary to remediate/mitigate the petroleum release, accurately document the progress, document decisions made, track costs, and provide updates all parties involved with and affected by the release of petroleum (see above).

5.2 BRWM Staff

DEP program staff should encourage adherence to the RAGs through the development of a Conceptual Site Model 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 unit-specific standard operating procedures or protocols. Unit supervisors must receive pre-approval from the Division or Bureau Director before recommending any remediation approvals that vary from this addendum.

5.4 BRWM Division Directors

Division Directors are responsible for ensuring that the staff in their division are trained in how to apply this addendum and that the RAGs 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 Petroleum Program Site Assessment and Remediation Process

6.1 Introduction

Section 6 of the RAGs provides a summary of where the RAGs fit into the site assessment and remediation process. The Petroleum Program SOPs provide guidance for site assessment and remediation that together with this addendum define the Commissioner’s satisfaction. As stated above the Petroleum Program SOPs are provided on the DEP website at: https://www.maine.gov/dep/spills/petroleum/index.html

Determination of risks at petroleum release sites require laboratory analyses that quantify the mass of petroleum mixture present and individual target compounds for the more toxic compounds present within the petroleum mixture. The Massachusetts Department of Environmental Protection petroleum hydrocarbon fraction analytical methods for Volatile Petroleum Hydrocarbons (VPH) and Extractable Petroleum Hydrocarbons (EPH) are needed to determine the risks at a petroleum release site. The VPH and EPH analyses, including the target compounds are needed to apply the RAGs to petroleum release sites. VPH and EPH analyses are needed when individual petroleum compounds are detected by compound specific analytical methods, such as EPA methods 524.4, 8260, and 8270 in order to quantify the risks of the total petroleum mass present.

6.2 Conceptual Site Model

The project lead will be responsible for development of the CSM for DEP review and approval at non-DEP lead sites. The CSM can be submitted to the DEP Project Manager, Hydrogeologist, or Engineer. If none of these are assigned, the CSM can be submitted to the Director of the Technical Services Division. The CSM should follow Section 6.3 of the RAGs, DEP SOP RWM-PP-006, and applicable guidance such as ASTM Standard Guide for Developing Conceptual Site Models for Contaminated Sites, and Standard Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids Released to the Subsurface.

6.3 Groundwater Resource and Drinking Water Protection

The supplemental petroleum guidance is protective of groundwater supplies and groundwater resources for public and private water supplies by applying the Residential Groundwater Exposure RAGs, MCLs, and MEGs to groundwater remediation sites where groundwater or surface water is the primary drinking water resource within the migration pathway of the petroleum plume. SOP RWM-PP-010 provides procedures to be used to meet the Commissioners satisfaction when groundwater is contaminated at a petroleum site.

6.4 Sampling Investigation and Remediation

The supplemental petroleum guidance encourages simultaneous sampling, investigation, and remediation to take place, especially during the early stages of a remediation project when some risk pathways are complete (i.e. soil and air), while others require additional information (i.e. groundwater, surface water). All steps taken must be supported by the CSM. A site sampling plan is needed when investigations and sampling involve laboratory analysis to assure appropriate detection levels and data quality objectives are met. When remedial actions are finished, appropriate documentation of the completeness of the remedial actions and remaining contamination must be documented in accordance with SOP RWM-PP-017.

6.5 Field Instrument Calibration

Investigations and remedial actions must use and document the use of calibrated field instrumentation. SOP RWM-PP-007 and RWM-PP-008 provide additional guidance.

6.6 Site-Specific Sampling Plan and Site Safety Plan

Investigations and remedial actions must follow a site-specific sampling and analysis plan and a site safety plan. SOP RWM-PP-007 (Development of a

Sampling and Analysis Plan), RWM-PP-014 (Water Sampling at Petroleum Sites), and RWM-PP-071 (Site Safety Plan) provide additional guidance.

6.7 Detection Levels & Data Quality Objectives

It is important to consider the site's clean-up goals when establishing the Data Quality Objectives (DQOs) for a site sampling plan (see Section 6.4.1 of RAGs). For example, ethylene dibromide (EDB, 1,2 dibromoethane) must be analyzed using EPA method 504.1 to meet the appropriate detection limit for the groundwater RAG for residential exposure.

6.8 Assessing Petroleum Vapor Intrusion

Petroleum vapor intrusion (VI) is the volatilization of petroleum related substances from NAPL, contaminated soil, or groundwater into buildings. DEP has adopted the EPA Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites, June 2015. SOP RWM-PP-009 provides additional information.

DEP Technical Services notification is required under the following conditions:

a. Vapors are detected within 100-feet of an occupied building
b. When a sensitive receptor (i.e. school, day care, or elderly housing) is at risk of vapor intrusion. DEP Technical Services staff are required to notify Technical Services Division Director to determine if CDC assistance is warranted.

6.9 Lead and Lead Scavengers

Lead continues to be used in high octane fuels and certain aviation fuels. However, lead was prohibited in gasoline as of January 1, 1996. According to public testimony given by DEP Commissioner Sullivan dated September 16, 1998, leaded gasoline in Maine was replaced by reformulated gasoline with MTBE by January 1, 1995. DEP detected MTBE in Maine groundwater as early as 1985, indicating that reformulated gasoline was used at least 11-years before the lead prohibition.

Where historic use of leaded gasoline was potentially stored prior to the prohibition of leaded gasoline, lead scavengers; including, 1,2-dichloroethane (1,2-DCA) and 1,2 dibromoethane (i.e. ethylene dibromide or EDB) should be considered potential contaminants of concern, in accordance with Chapter 691. EDB in water should be analyzed using EPA method 504.1 to meet the appropriate DQOs.

6.10 Soil Sampling Depths

Appropriate soil depths at a petroleum site will be based on the CSM and in accordance with any institutional controls that may or may not be used to manage the risks.

6.11 Exposure Point Concentrations

See RAGs, Section 6.5 and Section 7.5.1 for handling of chemical isomers of xylene.

7 Determining Target Clean-up Levels Using RAGs

The six steps outlined in Section 7.1 of the RAGs (provided below) are potentially applicable to large historic petroleum releases where decades have passed since the petroleum release occurred. This was the type of site that the petroleum program remediated in the 1980's and 1990's. There are large historic release sites that DEP handles on occasion that could benefit from following the six-step process.

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. The lowest applicable value in the column of the table that you are using is the applicable RAG;
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.

Oftentimes Step 6 of the six-step process can be achieved within days of the reported release and the petroleum program can begin the collection of confirmation sampling to confirm that the remedial actions have addressed the risk to human health and the environment. Using this approach, sites can be successfully closed after monitoring a site (i.e. vapor and groundwater) for an appropriate amount of time (i.e. 4 quarters) based on the 40-year program experience. With supervisor approval or approval from the Technical Services Division Director, this can be done, even when contamination remains on-site that exceeds the RAGs as explained in Section 1.2 above.

As explained in Section 1.2 of this addendum, several factors facilitate more efficient remedial actions when spill volumes are small, reporting times are short relative to the fate and transport of petroleum contamination along the migration pathway, and aggressive source removal is completed before sensitive resources are impacted. Therefore, the CSM is a vital tool to making appropriate remedial decisions and establishing clean-up goals.

In situations where contamination has been present for sufficient time relative to the fate and transport of petroleum contamination along the migration pathway and no receptors (human or surface water) have been impacted above a guideline or criteria, an evaluation of the environmental footprint should be completed to evaluate the benefit of completing remedial actions.

7.1 Application of Exposure Pathways and Scenarios

7.1.1 Groundwater

Groundwater remediation goals using residential exposure criteria and soil remediation goals using the leaching to groundwater criteria will be followed at sites where public water is not provided and where the site meets the definition of a sensitive geologic area defined in 06-096 C.M.R. ch. 691. This includes mapped (1) Significant Sand and Gravel Aquifers; (2) locations within 1,000 feet of a public drinking water supply; (3) locations within 300-feet of a private drinking water supply; (4) surface water bodies within 1000-feet of the intake point of a public water system, except on rivers and streams where it will only include the upstream side on both shores. See 06-096 C.M.R. ch. 691, §3 (EEE and FFF) for additional details. The Department may allow for site specific data to be used to modify the use of the leaching to groundwater criteria that is supported by the Conceptual Site Model. All modifications need to be approved by the Director of the Technical Services Division or their designee.

Groundwater remediation goals using the Construction Worker scenario should not be used as a groundwater cleanup guideline. The groundwater Construction Worker scenario should be used as a risk management tool to protect Construction Workers as part of a groundwater management plan during remedial actions, UST replacement, or property redevelopment. DEP SOP RWM-PP-012, Managing Non-Hazardous Petroleum Contaminated Groundwater and Soil at UST Sites, provides guidance for managing contaminated groundwater.

The Ground Water Resource and Drinking Water Protection SOP (RWM-PP-010) provides procedures for notification of the Department of Health and Human Services, Drinking Water Program when appropriate in accordance with a DWP/DEP Memorandum of Agreement.

7.1.2 Surface Water

To be consistent with 06-096 C.M.R. ch. 691, the petroleum addendum includes criteria for surface water, as defined in Section 3 above. For petroleum sites, the contaminants of concern in the dissolved phase must be protective of human health and the aquatic environment of the surface water body. However, it is beyond the scope of this addendum to include a full ecological risk assessment. Based on DEP experience, leaded and unleaded motor fuel facilities within 300-feet of a water body have the potential to impact surface water and pore water quality above acceptable levels. Beyond 300-feet the potential for impact declines below measurable levels due to the ability of petroleum to attenuate.

Water Classification Program, 38 M.R.S. §464 (1 and 2) specify that Class AA and Class A surface waters must be of such quality that they are suitable for designated uses of drinking water after disinfection. Subsections 3 and 4 specify that Class B and C surface waters must be of such quality that they are suitable for the designated uses of drinking water after standard treatment required under the Safe Drinking Water Act (and not more advanced treatment that might be necessary to meet the ‘water and organisms’ or ‘organisms only’ criteria of Maine’s Surface Water Quality Criteria).

For risks to the aquatic environment, the discharge of the plume must not degrade the water quality below the designated uses as stated in Water Classification Program, 38 M.R.S. §465. This can be evaluated by comparing the porewater concentrations to the 06-096 C.M.R Ch. 584, Appendix A, Criterion Continuous Concentration (CCC) as a screening criterion. Surface water samples should be evaluated against the applicable drinking water criteria (MCL, MEG, RAG).

7.1.3 Lead in Soil

06-096 C.M.R. ch. 691requires total lead concentrations exceeding 100 mg/kg to be analyzed by TCLP. Therefore, all soils with lead concentrations directly related to leaded gasoline must be analyzed for lead and if the total lead concentration exceeds 100 mg/kg, the soil needs to be analyzed for TCLP lead. Soil cleanup actions will be based on the presence of petroleum hydrocarbon contamination, not the extent of lead contamination in the soil.

7.1.4 MTBE in Drinking Water

MTBE is a gasoline additive used in Maine as part of the reformulated gasoline formula to replace lead and lead scavengers. The State of Maine, Department of Health and Human Services, Maine Center for Disease Control and Prevention, Division of Environmental Health, Drinking Water Program has set an enforceable drinking water standard (MCL) for MTBE of 35 ug/L (10-144 CMR, Chapter 231, Section 7(D)(2)(b)). The RAG for residential groundwater exposure is 140 ug/L based on the USEPA RSL Calculator. This addendum for petroleum remediation will default to the MCL of 35 ug/L for all drinking water supplies. The groundwater RAG values for MTBE are appropriate for groundwater that is not associated with drinking water supplies within the context of an approved CSM (RWM-PP-006). Site specific risk assessments may be used in accordance with The RAGs, Attachment B which are reviewed by the DEP and Maine CDC to determine site specific health risks associated with the presence of MTBE in private drinking water supplies.

7.2 Assessing Risk Contribution from Background Contaminants

Section 7.2 of the RAGs addresses the Background Concentrations Policy (Section 7.2.1), Determining Background Concentrations (Section 7.2.2) Arsenic Background Concentrations vs. Man-made Sources (Section 7.2.3), Background Concentration of Polycyclic Aromatic Hydrocarbons (Section 7.2.4), and Addressing Risk Due to Background (Section 7.2.6), At many UST sites the background concentrations of PAHs at a site are elevated due to the presence of pyrogenic PAHs present in the pavement. Therefore, the CSM needs to address the background concentrations of pyrogenic hydrocarbons and the sampling and analysis plan should include provision for distinguishing between PAHs related to petrogenic hydrocarbons and PAHs related to background pyrogenic hydrocarbon sources.