

CSR OMNIBUS UPDATING: Proposed Amendments to Schedule 5 Human Health Protection Standards

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Date: June, 2015

Summary of Proposed Updates for 2015/2016 Stage 10 amendment to CSR

1. Repeal and revise the existing Contaminated Sites Regulation (CSR) section (1) definition of “**residential land use**” to include specific reference to two residential land types¹:
 - a. residential low density land use, and
 - b. residential high density land use.
2. Repeal CSR Schedule 5 and move existing schedule 5 substances into a proposed new single schedule of consolidated (Schedule 4, 5 and 10) soil standards further referred to as “Schedule X”.
3. For each substance currently listed in CSR Schedule 4 and 5, develop the following new high density residential land use and wildlands land use matrix soil standards for Schedule X:
 - a. Human Health Protection – Intake of contaminated soil, and
 - b. Ecological Health Protection – Toxicity to soil invertebrates and plants.
4. Develop for the existing land uses of schedule 5 modified CSST derivation equations which incorporate the new Exposure Duration Terms proposed in this Proposal paper.
5. Develop for the proposed new Wildlands (WL) and Residential High Density Residential (RL_{HDR}) land uses; defined human exposure scenarios for use in deriving new proposed WL and RL_{HDR} human health protective matrix soil quality standards.
6. Where sufficient toxicological data exists, for each substance listed in Schedule 4 and 5, derive using the proposed modified Exposure Duration Terms in the CSST equations for all land uses (i.e. WL, AL, RL_{LDR}, RL_{HDR}, UP, CL & IL) new proposed matrix soil standards to protect human health for use in Schedule X.

¹ See Appendix A of “CSR Omnibus Updating: Proposed High Density Residential Soil Standards” [1] for the proposed new CSR (1) “**residential land use**” definition, incorporating both low density and high density residential land use.

7. Where a scientifically defensible soil bioavailability factor for a Schedule 4 or 5 substance obtained from another environmental regulatory agency exists; use that bioavailability factor as the Absorption Factor_{ingestion} (AF_i) term in the CSST equations used to derive human health protective matrix soil standards for that substance.

Introduction

In November 2009, the Science Advisory Board for Contaminated Sites in British Columbia (SABCS) submitted three reports to the ministry. These reports, SABCS [2, 3, 4] provided the results and recommendations of the comprehensive review conducted from 2005 through 2009 by the Board related to how the ministry's original CSST protocol [5] and science policy related to the protocol [6] might best be updated and revised in light of advances in the science related to the derivation of soil quality standards to protect human and ecological health at contaminated sites.¹

In conducting their review the SABCS considered the derivational policy and methodology of a number of agencies charged with the development of assessment and remedial soil quality standards for contaminated sites. However, the SABCS quickly determined that the protocols and policies of the CCME [7] and US EPA [8, 9] were of primary relevance to the issue.

Legislative Review

In respect to human health, the CCME [7] and US EPA [8, 9] methodology and policies in use at the time of the SABCS review remain essentially unchanged today. Consequently, the ministry proposes to focus on the findings and recommendations of the SABCS reports for the purposes of the omnibus updating of the Schedule 5 matrix standards to protect human health.

Proposed Updates

The SABCS major recommendations and the decision/rationale of the ministry in respect to those recommendations are provided in Table 1 of Appendix A of this document. Due to time and resource constraints, many of the SABCS recommendations cannot realistically be implemented by the ministry in time for the planned Stage 10 amendment to the Contaminated Sites Regulation. Rather, many of the SABCS recommendations will have to be held over to the next cycle of future review and amendment to the Regulation's standards.

¹ The reader is referred to SABCS [2, 3, 4] for the details of the SABCS review and recommendations.

Proposed Updates – Stage 10 Amendment

1. Repeal CSR Schedule 5 and move existing Schedule 5 substances into the proposed new single schedule of consolidated (Schedule 4, 5 and 10) soil standards further referred to as “Schedule X”.
2. Develop for the existing land uses of Schedule 5 (AL, PL, RL_{LDR}, CL and IL) and the proposed new WL and RL_{HDR} land uses, modified CSST derivation equations which incorporate the new Exposure Duration Terms proposed below.

Proposed Modified CSST Exposure Duration Terms

Based on the ministry’s review of CCME [7], SABCS [3], Health Canada [10] and US EPA [11, 12, & 13], the Exposure Duration Terms presented in Table 1 below are proposed for modification of the CSST, 1996 [5] derivation methodology.

The reader is referred to Appendix B, Table B1 of this document for respective SABCS, 2009 [3] recommended Exposure Duration terms (ETs); existing Ministry CSST, 1996 [5] ETs; and existing Health Canada, 2012 [10] ETs which were considered by the Ministry in proposing the Exposure Duration Terms presented in Table 1.

Table 1. Proposed Exposure Duration Terms (ETs) for use in Modified CSST Derivation Methodology

CSR Land Use	Proposed Modified Exposure Duration Term (ET) ¹
AL	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
UP	ET = (12hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
RL _{LDR}	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
RL _{HDR}	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
CL	ET = (12hr/24hr x 5d/7d x 48wk/52wk x 80yr/80yr)
IL	ET = (8hr/24hr x 5d/7d x 48wk/52wk x 35yr/80yr)
WL ²	ET = (24hr/24hr x 7d/7d x 26wk/52wk x 80yr/80yr)

¹ ETs applies to both non-carcinogenic and carcinogenic substances

² For subsistence users, site-specific values should be used

3. Develop for the proposed new Wildlands (WL) and Residential ^{High Density Residential} (RL_{HDR}) land uses; defined human exposure scenarios for use in deriving new proposed WL and RL_{HDR} human health protective matrix soil quality standards ².

² No change to the CSST, 1996 [5] defined human exposure scenario is proposed for the Residential_{LDR} (former RL) land use.

Proposed Defined Exposure Scenario for WL Land Use

The following human health defined exposure scenario is proposed for Wildlands land use:

Wildlands: Use of land for the primary purpose of supporting natural ecosystems, including the use of land for ecological reserves, national or provincial parks, protected wetlands or woodlands, native forests, tundra and alpine meadows, but does not include uses defined as urban parkland use.

Table 2. Human Health WL Land Use Defined Exposure Scenario

	Wildlands (WL)
Defined Land Use Scenario	<ul style="list-style-type: none"> - a seasonal wildlands camp with a family living on-site - children are present - groundwater may be used for drinking water
Critical Human Receptor	<ul style="list-style-type: none"> - child (threshold contaminants) - child physiological parameters as per CSST Protocol [5] - adult (non-threshold contaminants) - adult physiological parameters as per CSST Protocol [5]
Exposure Duration Term	- see Table 1 above
Direct Soil Exposure Pathways	- soil ingestion
Indirect Soil Exposure Pathways	- ingestion of groundwater as drinking water

Proposed Defined Exposure Scenario for RL_{HDR} Land Use

The following human health defined exposure scenario is proposed for RL_{HDR} land use:

Residential_{HDR}: Use of the land for a residential complex housing multiple persons or families in:

- (a) individual units, including boarding houses, apartments, condominiums, lodges, and townhouses, or
- (b) institutional facilities, including residential schools, hospitals, residential day care operations, retirement homes, prisons, correctional centres and community centres,

but does not include commercial hotels or motels.

Table 3. Human Health RL_{HDR} Land Use Defined Exposure Scenario

	Residential_{HDR} (RL_{HDR})	Difference from Residential_{LDR} (RL_{LDR})
Defined Land Use Scenario	<ul style="list-style-type: none"> - High Density multiple families residential housing or institutional housing complex - children are present - groundwater may be used for drinking water 	<ul style="list-style-type: none"> - RL_{LDR} assumes single family residential housing
Critical Human Receptor	<ul style="list-style-type: none"> - child (threshold contaminants) - child physiological parameters as per CSST Protocol [5] - adult (non-threshold contaminants) - adult physiological parameters as per CSST Protocol [5] 	
Exposure Duration Term	<ul style="list-style-type: none"> - see Table 1 above 	
Direct Soil Exposure Pathways	<ul style="list-style-type: none"> - soil ingestion: - adult : 10 mg/day - child : 40 mg/day 	<ul style="list-style-type: none"> - soil ingestion: - adult : 20 mg/day - child : 80 mg/day
Indirect Soil Exposure Pathways	<ul style="list-style-type: none"> - ingestion of groundwater as drinking water 	

4. Where sufficient toxicological data exists, for each substance listed in Schedule 4 and 5, derive using the proposed modified Exposure Duration Terms developed for use in the CSST equations, for all land uses (i.e. WL, AL, RL_{LDR} , RL_{HDR} , PL, CL & IL) new proposed matrix soil standards to protect human health for use in Schedule X.
5. Where a scientifically defensible Soil Bioavailability Factor for a Schedule 4 or 5 substance exists, and that factor has been approved by another recognized environmental regulatory agency; use that factor as the Absorption Factor_{ingestion} (AF_i) term in the CSST equations used to derive new matrix soil standards to protect human health for use in Schedule X.
6. Schedule X soil standards to be established under the Stage 10 amendment to the CSR will be used to revise Protocol 11 Upper Cap Concentrations for Substances

Listed in the Contaminated Sites Regulation. The revised Protocol 11 will be implemented concurrent with the Stage 10 amendment to the CSR.

Other Issues – Next Cycle Revisions

1. As a component of a future next cycle review for updating the Regulation's soil standards to protect human health, consider those additional SABCS recommended changes identified in Appendix A, Table A1 which although supported by the ministry, were deferred to future review due to time and resource constraints.
2. As a further component of a future next cycle review of the Regulation's soil standards to protect human health, consider the following options to revise human health soil standards from Schedule 4:
 - a. Repeal or substantively revise the qualitative soil standards for nonaqueous phase liquids and odorous substances, and
 - b. Repeal the existing petroleum hydrocarbon soil standards for VPHs, LEPHs and HEPHs and either:
 - i. adopt the current CCME Canada-Wide Standards for Petroleum Hydrocarbons in soil [14] as CSR petroleum hydrocarbons soil standards, or
 - ii. develop *de novo*, toxicological risk-based CSR petroleum hydrocarbon soil standards derived in accordance with the modified CSST protocol, as described above in this document.

References

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Appendix A

Science Advisory Board for Contaminated Sites in British Columbia (SABCS), 2009 [3]
Major Recommendations Relating to Updating and Revising the CSST, 1996 [5] Protocol
to Derive Matrix Soil Standards to Protect Human Health; and the Decisions of the
Ministry in Respect to the SABCS Recommendations.

Table A1. Summary of SABCS, 2009 [3] Major Recommendations to Update and Revise the CSST, 1996 [5] Protocol for Derivation of Human Health Protection Matrix Soil Standards and the Ministry’s Decisions/Rationale in Respect to the SABCS Recommendations.

Protocol Element	SABCS Recommended Revision	Ministry Decision in Respect to Recommendation	Ministry Rationale
1. Age specific apportionment of exposure for carcinogenic Substances	Adopt US EPA [8] age apportioned exposures for carcinogenic exposure	Do not adopt for Stage 10 amendment. Address as part of next cycle of updates to standards.	Age specific apportionment of carcinogenic exposure has been a contentious issue for regulatory agencies over the past 10 years. The most recent advice on this issue will be forthcoming from CCME/Health Canada over the next 1-2 years.
2. Residency Duration for AL, RL, CL and IL	CSST Residency Durations deemed overly conservative: SABCS recommends: following Residency Durations: AL: 58 years RL: 41 years CL & IL: 25 years	Do Not Adopt SABCS residency durations Develop new less conservative “interim” residency durations as part of developing new ETs for Stage 10 amendment. Develop ‘finalized’ ETs as component of next cycle of updating of CSR standards	Ministry agrees CSST residency durations may be too conservative. Ministry proposes therefore to develop new residency durations based on consideration of SABCS recommendation and current residency durations used by other agencies (CCME/Health Canada, US EPA, etc.) as a component of developing new Exposure Terms for CSR land uses. (See recommendation 9 below.)

Protocol Element	SABCS Recommended Revision	Ministry Decision in Respect to Recommendation	Ministry Rationale
3. Soil Ingestion Rate for Child	SIR _{child} : 100 mg/d	Do not adopt for Stage 10 amendment.	SIR estimates for children vary significantly in the literature. More recent US EPA radioisotope studies indicate CSST original 80 mg/d estimate is still valid.
4. Dermal Exposure parameters	Dermal exposure parameters vary between US EPA and Health Canada. Recommendation: Further study required.	Do not include in Stage 10 amendment. Consider for next cycle of updates to standards.	Dermal exposure already enabled under CSST equation. SABCS notes that soil ingestion route is major contributor to human exposure. Dermal exposure contribution is trivial by comparison.
5. Particulate (Ingestion) Exposure	Consider Use of US EPA particulate ingestion data in derivation	Do not include in Stage 10 amendment. Consider for next cycle of updates to standards.	Particulate ingestion (As Soil Inhalation Rate) exposure already enabled under CSST equation. SABCS notes that soil ingestion route is major contributor to human exposure. Particulate ingestion contribution is trivial by comparison.

Protocol Element	SABCS Recommended Revision	Ministry Decision in Respect to Recommendation	Ministry Rationale
6. Critical Receptor for CL and WL	Use adult as critical receptor at CL and toddler as critical receptor at WL sites	Do not adopt adult as critical receptor for CL land use. Adopt toddler as critical receptor for WL land use.	CSR legal definition for CL specifically includes hotels and motels. Therefore Ministry believes that children cannot reasonably be excluded from either CL or WL.
7. New “Institutional” Land use	Create new institutional land use for daycares, schools, community centres, etc.	Redundant recommendation	Current CSR specifies institutional use as RL
8. Life expectancy	80 years (Health Canada)	Adopt	Basis is Health Canada PQRA guidance and CSR TG 7
9. Exposure Terms	CSST ETs are overly conservative SABCS recommends new ETs. See Appendix B below.	Do Not Adopt SABCS Table 2 ETs Develop new less conservative “interim” ETs for Stage 10 amendment. Develop “finalized” ETs as component of next cycle of std updating	Ministry agrees CSST ETs may be too conservative. However, SABCS ETs are age specific apportioned for some land uses or ignore residual adult exposure (AL, RL _{LDR} , RL _{HDR} , UP, & WL) or ignore residual child exposure (CL & IL).
10. Receptor Physiological Parameters	Recommended adoption of Health Canada 2004 parameters	Do not adopt Health Canada 2004 parameters for stage 10 amendment. Adopt most current HC parameters in next cycle of updates to standards.	CSST parameters are only slightly more conservative than Health Canada’s current parameters. Retain CSST parameters for stage 10 amendment.

Protocol Element	SABCS Recommended Revision	Ministry Decision in Respect to Recommendation	Ministry Rationale
11. Soil Allocation Factor	replace SAF with EDI	Redundant recommendation	Substitution of SAF with EDI already enabled in CSST protocol. However, ministry does propose to allow, where data is available, proportional adjustment to the SAF (20%) based on contaminant concentration in the five environmental media (soil, water, air, food & consumer products).
12. Consider both carcinogenic and non-carcinogenic end-points	Set std based on most stringent of carcinogenic or non-carcinogenic end-points for the substance	Do not include in Stage 10 amendment. Consider for next cycle of updates to standards.	Ministry's preference would be to develop discrete Ca. and non-Ca. soil standards for the substance. Also ministry time/resource limitations preclude adoption of recommendation.
13. Bioavailability	Allow modification of assumed $AF_T = 1.0$ (i.e. 100% bio-available) based on other agencies bioavailability factors	Redundant recommendation	Adjustment of AF_T term is enabled in CSST protocol. (Actual issue is that very few agency endorsed bioavailability factors exist. See Appendix C).

Appendix B

Table B1. Science Advisory Board for Contaminated Sites in British Columbia (SABCS), 2009 [3] Recommended New Exposure Duration Terms (ETs) Related to Updating and Revising the CSST, 1996 [5] Protocol to Derive Matrix Soil Standards to Protect Human Health; Existing Ministry CSST, 1996 [5] ETs; and Health Canada, 2012 [10] existing ETs.

Table B1. SABCS, 2009 [3] Recommended Exposure Duration Terms (ETs); Ministry Existing CSST, 1996 [5] ETs; and Health Canada, 2012 [10] Existing ETs.

Land Use	SABCS, 2009 [3] ET Recommendations	Existing Ministry CCST, 1996 [5] ETs	Existing Health Canada, 2012 [10] ETs
Carcinogens			
AL	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 58yr/80yr) ¹	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 70yr/70yr)	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
UP	ET = (12hr/24hr x 7d/7d x 52wk/52wk x 41yr/80yr) ²	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 70yr/70yr)	ET = (2hr/24hr x 2d/7d x 35wk/52wk x 80yr/80yr)
RL _{LDR}	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 41yr/80yr) ²	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 70yr/70yr)	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
RL _{HDR}	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 41yr/80yr) ²		
CL	ET = (12hr/24hr x 5d/7d x 48wk/52wk x 25yr/80yr) ³	ET = (12hr/24hr x 5d/7d x 48wk/52wk x 70yr/70yr)	ET = (8hr/24hr x 5d/7d x 52wk/52wk x 35yr/80yr) ⁴
IL	ET = (12hr/24hr x 5d/7d x 48wk/52wk x 25yr/80yr) ^{3,5}	ET = (8hr/24hr x 5d/7d x 48wk/52wk x 35yr/70yr)	ET = (10hr/24hr x 5d/7d x 48wk/52wk x 35yr/80yr) ⁴
WL	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 41yr/80yr) ²		ET = (24hr/24hr x 7d/7d x 13wk/52wk x 80yr/80yr) ⁶
Non-Carcinogens			
AL	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 4.5yr/80yr) ⁷	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 70yr/70yr)	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
UP	ET = (12hr/24hr x 7d/7d x 52wk/52wk x 4.5yr/80yr) ⁷	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 70yr/70yr)	ET = (2hr/24hr x 2d/7d x 35wk/52wk x 80yr/80yr)
RL _{LDR}	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 4.5yr/80yr) ⁷	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 70yr/70yr)	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 80yr/80yr)
RL _{HDR}	ET = (24hr/24hr x 7d/7d x 52wk/52wk x 4.5yr/80yr) ⁷		
CL	ET = (12hr/24hr x 5d/7d x 48wk/52wk x 25yr/80yr) ³	ET = (12hr/24hr x 5d/7d x 48wk/52wk x 70yr/70yr)	ET = (8hr/24hr x 5d/7d x 52wk/52wk x 35yr/80yr) ⁴
IL	ET = (12hr/24hr x 5d/7d x 48wk/52wk x 25yr/80yr) ^{3,5}	ET = (8hr/24hr x 5d/7d x 48wk/52wk x 35yr/70yr)	ET = (10hr/24hr x 5d/7d x 48wk/52wk x 35yr/80yr) ⁴
WL	ET = (12hr/24hr x 7d/7d x 52wk/12wk x 4.5yr/80yr) ⁷		ET = (24hr/24hr x 7d/7d x 13wk/52wk x 80yr/80yr) ⁶

¹ 58 years = Sum of child 6 years exposure + adult 52 years exposure

² 41 years = Sum of child 6 years exposure + adult 35 years exposure

³ 25 years ignores any additional exposure as a child

⁴ 35 years based on employee, rather than a member of the general public

⁵ SAB modified daily exposure term to 8hr/24hr in 2009 finalized report

⁶ Scenario considered most relevant to First Nations and Aboriginal communities in remote areas where harvesting of natural resources is a life-long cultural activity.

⁷ 4.5 years ignores any additional exposure as an adult

Appendix C

The Incorporation of Bioavailability in Environmental Standards:
A Jurisdictional Review

The incorporation of bioavailability in soil standards: a jurisdictional review

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June 19 2015

Background

The Land Remediation Section is proposing to review and update environmental standards of the Contaminated Sites Regulation. Part of this review includes updating standards according to current best practices in science. Incorporating the biological availability (bioavailability) of substances is one component of environmental standards under review. The purpose of this paper is to provide a general review of the current use of bioavailability in environmental standards in Canada, the USA, Europe, and Australia. Although many jurisdictions do not include bioavailability for soil standards, this review also highlights how bioavailability is incorporated in water and sediment standards.

Canada

Federally and provincially, bioavailability is rarely used in environmental standard derivation for soil. In water, according to the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic life, two environmental quality guidelines should be derived for specific substances that exhibit a complex environmental chemistry and toxicology. The first, called the total guideline, does not account for bioavailability and is based on the total concentration of a substance. The second, called the bioavailable guideline, is based on relevant chemical speciation-specific fractions and should focus on the bioavailable forms of substances. The bioavailable guideline is not yet derived or available (CCME).

Bioavailability is used in contaminated sites human health and ecological risk assessments.

USA

Similar to Canada, the United States does not yet incorporate bioavailability into soil standards. However, at the state level, Washington State includes gastrointestinal (GI) and dermal absorption by use of conversion factors in soil cleanup levels. The factors are unitless, chemical specific, and when used together indicate the proportion of analyte absorbed into the body (Ecology, 2001).

In water, the United States Environmental Protection Agency (US EPA) includes bioavailability in environmental screening levels for select substances such as copper and arsenic. The metals criteria include dissolved metal as an improved approximation for metal bioavailability than total metal. The dissolved metal approach accounts for the low bioavailability of metals on suspended particles but does not address the major effects of various dissolved species on bioavailability (Copper Criteria).

Appendix 1.1 contains a selection from the Arsenic User Guide, a document that describes the screening level derivation from US EPA Regions 3, 6, and 9 Screening

Levels. According to communication with Fred Dolislager, a researcher at the University of Tennessee who conducts Regional Screening Level development for Superfund, the US EPA may be using relative bioavailability for other substances in the near future but this has not yet occurred. If the relative bioavailability information is available for each analyte, the site specific screening tool calculator can be used to determine site-specific screening levels that incorporate bioavailability. You can find the calculator [here](#).

Europe

The European commission discusses the use of bioavailability in standards derivation, however few values are published for any environmental media. Most recently, SETAC Barcelona 2015 featured several abstracts about incorporating bioavailability into standards development; overall, the bioavailability incorporation into standards remains “in development” and most jurisdictions have not yet published values (SETAC Barcelona, 2015). The EU does, however, include bioavailability in water standards development in the form of biotic ligand models for certain metals. Below is a list of substances for which bioavailability was incorporated into the draft environmental standards. Whether or not these drafts were approved and brought into legislation remains unclear.

- [Zinc](#) (Ackermann-Liebrich, Autrup, Bard, Calow, & Michaelidou, 2012)
- [Lead](#) (Ackerman-Liebrich, Autrup, Bard, Calow, & Michaelidou, 2011)

Australia

Australia soil standards have considerable discussion of bioavailability (Diane Heemsbergen, 2009). The guideline for derivation is complex and in discussion about Australian standards with Chris Allaway of Environment Canada last month, he pointed out that Australia has not yet officially released the derived standards despite the protocol being published

When sediment concentrations exceed the ISQG-low or ISQG-high levels, an assessment of contaminant bioavailability should be conducted in Western Australia as part of the site screening process.. If the bioavailable concentration still exceeds the guideline, toxicity assessment is to be completed. If the bioavailable concentration no longer exceeds the guideline, no further action for the substance needs to be taken. Sediment guidelines are normalized to 1% organic carbon however if the sediment organic carbon is markedly higher, the guideline value should be increased accordingly since additional carbon bonding sites reduce the contaminant bioavailability (Series, 2010).

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Appendix 1.1

Arsenic (USEPA User's Guide, 2014)

Arsenic screening levels for ingestion of soil are now calculated with the [relative bioavailability factor](#) (RBA) of 0.6. The RBA can be adjusted using the calculator in site-specific/user-provided mode the same way toxicity values can be changed. The RBA for soil ingestion is shown in the calculator output. The 2012 document, [Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil](#) provides supporting information.

Absolute bioavailability can be thought of as the [absorption fraction](#). Relative bioavailability accounts for differences in the bioavailability of a contaminant between the medium of exposure (e.g., soil) and the media associated with the toxicity value (e.g., the arsenic RfD and CSF are derived from drinking water studies). The 60% oral RBA for arsenic in soil is empirically-based. It represents an upper-bound estimate from numerous studies where the oral RBA of soil-borne arsenic in samples collected from across the U.S. was experimentally determined against the water-soluble form. This RBA does not apply to dermal exposures to arsenic in soil for which the absorbed dose is calculated using a dermal absorption fraction (ABSd) of 0.03 (Exhibit 3-4 of USEPA, 2004).

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