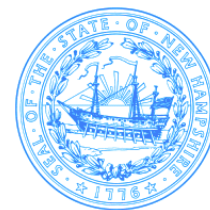




The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES



Robert R. Scott, Commissioner

To: Jeffrey Marts, P.G., NHDES-HWRB Administrator
From: David B. Larson, M.P.H., Environmental Health Program
RE: Recommended Direct Contact Risk-Based Soil Concentrations
(milligrams per kilogram [mg/kg] = parts per million [ppm]):

Perfluorooctanoic acid (PFOA)	(S-1 = 0.2)	(S-2 = 1.4)	(S-3 = 1.4)
Perfluorooctane sulfonic acid (PFOS)	(S-1 = 0.1)	(S-2 = 0.7)	(S-3 = 0.7)
Perfluorohexane sulfonic acid (PFHxS)	(S-1 = 0.1)	(S-2 = 0.9)	(S-3 = 0.9)
Perfluorononanoic acid (PFNA)	(S-1 = 0.1)	(S-2 = 1.0)	(S-3 = 1.0)

Date: October 6, 2023

The Environmental Health Program (EHP) has developed revised recommendations for direct contact risk-based (DCRB) soil concentrations for four (4) per- and polyfluoroalkyl substances (PFAS) considered protective of potential human exposure in S-1, S-2, and S-3 scenarios. The designation of an “S” category is dependent on the accessibility of the soil and the receptor characteristics. In general, S-1 represents a residential scenario, S-2 an outdoor maintenance worker/passive recreator scenario and S-3 is for a construction/utility worker scenario. This revision of the recommended DCRB soil concentrations incorporates an adult body weight of eighty (80) kg to be consistent with the assumed adult body weight incorporated into the development of the maximum contaminant levels (MCL) for the four PFAS compounds; and the corresponding increase in the adult skin surface area available for soil contact. All other exposure assumptions are consistent with those assumed in the December 11, 2019, document.^a The S-3 (construction/utility worker) scenario concentrations were also added to be consistent with the approach described in the NHDES Contaminated Sites Risk Characterization and Management Policy (RCMP).^b

The recommended DCRB soil concentrations are not anticipated to present an appreciable increased health risk to receptors that are exposed through direct contact with impacted soil. The recommendations account for exposure that may result from incidental ingestion and dermal contact with impacted soil. The DCRB concentration recommendations do not account for potential exposure via inhalation, indirect exposure pathways such as migration via runoff to nearby surface water bodies or bioaccumulation in the food chain.

The DCRB concentration recommendations were derived using the methodology described in Appendix A (*Methodology for Calculating Direct Contact Risk-Based Soil Concentrations*) contained in the NHDES RCMP. In summary, dose-response information provides a quantitative evaluation of toxicity and describes the relationship between the dose of a chemical and the potential for adverse health effects in the exposed population. The EHP developed reference dose (RfD) values for the four (4) PFAS compounds^c (Table 1) that were used to calculate the recommended DCRB concentrations to protect against non-carcinogenic health effects. The United States Environmental Protection Agency (USEPA) defines the reference dose as an estimate (with uncertainty spanning perhaps an order of magnitude) of

the daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.^d

Table 1: Select PFAS RfDs and Calculated S-1, S-2 and S-3 DCRB Soil Concentrations.^e

PFAS	CAS #	RfD (mg/kg-d)	S-1 (mg/kg)	S-2 (mg/kg)	S-3 (mg/kg)
Perfluorooctanoic acid (PFOA)	335-67-1	6.1E ⁻⁶	0.2	1.4	0.8
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	3.0E ⁻⁶	0.1	0.7	0.4
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	4.0E ⁻⁶	0.1	0.9	0.5
Perfluorononanoic acid (PFNA)	375-95-1	4.3E ⁻⁶	0.1	1.0	0.5

The methodology described in Appendix A was used to calculate the recommended DCRB concentration for the most sensitive receptor, young children aged 2 – 6 years in a residential scenario. The methodology for all scenarios contains a 20% relative source contribution factor (RSCF) for non-carcinogenic compounds. The RSCF is applied when the contribution from other potential sources of exposure to the compound is unknown. The DCRB methodology also assumes the absorption of PFAS from incidental ingestion of soil is 100%, whereas the absorption of PFAS from dermal contact is 10%. PFAS are not well absorbed through the skin^{f,g,h} so dermal contact is not expected to be an important exposure route for the general public. However, the USEPA Regional Screening Level (RSL) Calculator assumes 10% dermal absorption for PFOA, PFOS, PFHxS and PFNA.ⁱ As a conservative measure it is assumed that the dermal absorption of PFOA, PFOS, PFHxS and PFNA are at 10% to avoid underestimating exposure from impacted soil. If additional studies provide information regarding dermal absorption, EHP will review the information to determine if a recalculation of recommended DCRB values are necessary.

Please note that the RfDs developed by the EHP are chronic toxicity values and the S-3 scenario uses an exposure duration less than chronic (1 year). If sub-chronic toxicity factors were available for these four PFAS compounds, EHP would likely use them to derive S-3 DCRB soil values. Using a chronic toxicity value with a sub-chronic exposure duration often results in the S-3 DCRB value being less than the S-2 DCRB soil value. In these situations, EHP adopts the S-2 value as the S-3 value. Table 1 provides the calculated DCRB soil values for the four PFAS compounds.

Example DCRB calculation for PFOA:

$$\text{Concentration in Soil (mg/kg)} = \frac{\text{RSCF} \times \text{RfD} \times \text{CF}}{[(\text{IR} \times \text{RAF}_o) + (\text{SA} \times \text{AF} \times \text{RAF}_d)] \times \left[\frac{\text{EF} \times \text{ED}}{\text{AT} \times \text{BW}} \right]}$$

$$\text{S-1} = 0.2 \text{ mg/kg} = \frac{0.2 \times 6.1\text{E}^{-6} \text{ mg/kg-d} \times 1.0\text{E}^6 \text{ mg/kg}}{[(200 \text{ mg/day} \times 1) + (2,632 \text{ cm}^2 \times 0.20 \text{ mg/cm}^2 \times 0.1)] \times \left[\frac{160 \text{ days/year} \times 5 \text{ years}}{1,825 \text{ days} \times 17 \text{ kg}} \right]}$$

$$\text{S-2} = 1.4 \text{ mg/kg} = \frac{0.2 \times 6.1\text{E}^{-6} \text{ mg/kg-d} \times 1.0\text{E}^6 \text{ mg/kg}}{[(100 \text{ mg/day} \times 1) + (3,527 \text{ cm}^2 \times 0.20 \text{ mg/cm}^2 \times 0.1)] \times \left[\frac{146 \text{ days/year} \times 25 \text{ years}}{9,125 \text{ days} \times 80 \text{ kg}} \right]}$$

$$S-3 = 0.8 \text{ mg/kg} = \frac{0.2 \times 6.1E^{-6} \text{ mg/kg-d} \times 1.0E^6 \text{ mg/kg}}{[(480 \text{ mg/day} \times 1) + (3,527 \text{ cm}^2 \times 0.20 \text{ mg/cm}^2 \times 0.1)] \times \left[\frac{83 \text{ days/year} \times 1 \text{ years}}{365 \text{ days} \times 80 \text{ kg}} \right]}$$

Table 2: Parameters used for the Calculation of Direct Contact Risk-Based Concentrations (DCRB) for Select PFAS Compounds in Soil.

Parameter	Parameter Description	S-1	S-2	S-3
Sensitive receptor	Parameter	Young Child (residential)	Outdoor Maintenance Worker	Construction Worker
RSCF	Relative Source Contribution Factor	0.20	0.20	0.20
RfD (mg/kg-d)	Reference Dose (See Table 1)	Compound specific	Compound specific	Compound specific
CF (mg/kg)	Units Conversion Factor	1.0E ⁶	1.0E ⁶	1.0E ⁶
IR (mg/day)	Daily soil ingestion rate ^{i,k}	200	100	480
RAF_o (unitless)	Relative Absorption Factor for soil ingestion	1	1	1
tRAF_d (unitless)	Relative Absorption Factor for dermal contact	0.1	0.1	0.1
SA (cm²)	Skin Surface Area available for soil contact	2,632	3,527	3,527
AF (mg/cm²)	Soil-to-skin Adherence Factor	0.36	0.20	0.20
EF (days/year)	Exposure Frequency	160	146	83
ED (years)	Exposure Duration	5	25	1
AT (days)	Averaging Time for non-carcinogens (ED x 365 days)	1,825	9,125	365
BW (kg)	Body Weight	17	80	80

^a <https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/20191211-pfas-dcrb.pdf>

^b New Hampshire Department of Environmental Services (NHDES). January 1998. Contaminated Site Risk Characterization and Management Policy (RCMP).

^c New Hampshire Department of Environmental Services (NHDES). June 2019 Report. Retrieved from: <https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-19-29.pdf>

^d United States Environmental Protection Agency (USEPA) 2014. Risk Assessment Glossary. Retrieved from: https://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&vocabName=Risk%20Assessment%20Glossary

^e The listed compounds and associated CAS numbers are for the acid forms of these PFAS compounds. The information presented in Table 1 are also applicable to the respective anionic forms of these compounds. These anions may form salts with any of a number of cations resulting in a variety of possible chemical species, each having a unique CAS number.

^f Agency for Toxic Substances and Disease Registry (ATSDR). 2019. “How can I be exposed to PFAS?”, webpage updated April 25, 2019. Retrieved from <https://www.atsdr.cdc.gov/pfas/pfas-exposure.html>

^g United States Environmental Protection Agency (USEPA). 2016. Health Effects Support Document for Perfluorooctane Sulfonate (PFOS). Document # EPA 822-R-16-002. May 2016. Retrieved from https://www.epa.gov/sites/production/files/2016-05/documents/pfos_hesd_final_508.pdf

^h United States Environmental Protection Agency (USEPA). 2016a. Health Effects Support Document for Perfluorooctanoic acid (PFOA). Document # EPA 822-R-16-003. May 2016. Retrieved from https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_hesd_final_508.pdf

ⁱ United States Environmental Protection Agency (USEPA). 2019. Regional Screening Level (RSL) Calculator. Updated May 2023. Retrieved from: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

^j Resident soil ingestion rate-child. USEPA 2011A (Table 5-1); “Upper-bound values” accounting for both soil and dust ingestion. OSWER Directive 9200.1-120. Human Health Evaluation, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Retrieved from: https://epa-prgs.ornl.gov/chemicals/help/documents/OSWER_Directive_corrected.pdf

^k Outdoor worker soil ingestion rate. USEPA 1991a (pg. 15); OSWER Directive 9200.1-120. Human Health Evaluation, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Retrieved from: https://epa-prgs.ornl.gov/chemicals/help/documents/OSWER_Directive_corrected.pdf