
U.S. DEPARTMENT OF
HEALTH AND HUMAN SERVICES
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

# Support Document to the 2025 Substance Priority List

## (Candidates for Toxicological Profiles)

Agency for Toxic Substances and Disease Registry

Office of Innovation and Analytics, Toxicology Section

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# Background Statement

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that the Agency for Toxic Substances and Disease Registry and the U.S. Environmental Protection Agency (EPA) prepare a Priority List of Hazardous Substances commonly found at facilities on the CERCLA National Priorities List (NPL). The Priority List of Hazardous Substances is also called the Substance Priority List or SPL. The SPL includes substances that have been determined to be of greatest public health concern to persons at or near NPL sites. CERCLA, as amended, requires that the Substance Priority List be revised periodically. Each substance on the list is a candidate to become the subject of a toxicological profile prepared by ATSDR. This document describes the methodology ATSDR used to generate the 2025 Substance Priority List.

The priority list is posted at https://www.atsdr.cdc.gov/programs/substance-priority-list.html.

Substance Priority List resources are available at https://www.atsdr.cdc.gov/programs/substance-priority-list.html#cdc_program_profile_resources-resources.

# 1. OVERVIEW

Hazardous substances on the Substance Priority List are ranked based on three scored criteria. The criteria scores are combined for a total score. The three criteria are

- **FREQUENCY OF OCCURRENCE AT NPL SITES**

  Presence in at least one environmental medium per NPL site constitutes one occurrence. A substance must be identified at two or more NPL hazardous waste sites or facilities to be considered for the list. Only sites that are currently on or proposed to be on the NPL are included. For more information on NPL sites, please see EPA's NPL site status. ATSDR's science database, supplemented by EPA's Superfund Enterprise Management System (SEMS), is the data source. See Section 2 for more information on frequency scoring.

- **TOXICITY**

  A tiered approach is used to assess the toxicity of candidate substances. Priority is given to ATSDR and EPA health-based toxicity reference values (toxicity values). When ATSDR and EPA values are not available, Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) occupational exposure limits (OELs) are considered. If toxicity values are not available, then quantitative structure activity relationship (QSAR) and read-across approaches are used to estimate the substance's toxicity. If that is not possible, a modified version of ATSDR's Toxicity/Environmental Score (TES) is used. When appropriate, ATSDR assigns toxicity values based on structurally similar surrogate substances. This process is only used in scoring the substances with respect to their relative toxicity; the results should not be interpreted as regulatory values. See Section 3 for more information on toxicity scoring.

- **POTENTIAL FOR HUMAN EXPOSURE**

  The potential for human exposure is based on two parts: (1) the number of completed exposure pathways (CEPs) per substance at NPL sites and (2) the size of populations with CEPs surrounding NPL sites. ATSDR's science database and EPA's SEMS database are the sources of the CEP data. The CEP data is obtained from ATSDR's public health assessment documents and EPA site-specific risk assessments. Population data are obtained from the latest U.S. Census. See Section 4 for more information on scoring for potential human exposure.

Using these three criteria, the hazard potential of each candidate substance is ranked according to the following algorithm:

$$\underset{(1{,}800\ max.points)}{TOTAL\ SCORE} = \underset{(600\ points)}{NPL\ FREQUENCY} + \underset{(600\ points)}{TOXICITY} + \underset{(400\ CEP\ points\ +\ 200\ population\ points)}{POTENTIAL\ FOR\ HUMAN\ EXPOSURE}$$

The algorithm generates a candidate list of substances ordinally ranked based on their total score. The top 275 scoring substances become the Substance Priority List (SPL). As of 2025, there are 625 candidate substances for the priority list.

### 1.1 CRITERIA FOR INCLUSION ON THE SUBSTANCE PRIORITY LIST

Substances considered for the 2025 Substance Priority List were present at NPL sites, as indicated in either ATSDR's science database or EPA's SEMS database. Currently, over 1,600 uniquely identifiable substances are found at proposed or listed NPL sites. Only the 625 substances found at two or more sites were considered for the priority list.

The list of 625 substances was reviewed to identify petroleum-related substances. Substances of petroleum origin are regulated by legislation other than CERCLA [see CERCLA Section 101(14)]. These substances were assigned total point scores of -1 to place them at the bottom of the list of candidate substances.

## 2. DETERMINATION OF THE FREQUENCY OF OCCURRENCE COMPONENT

### 2.1 FREQUENCY OVERVIEW

ATSDR uses two sources of data to score a substance's frequency of occurrence at NPL hazardous waste sites or facilities:

- **ATSDR's science database** contains site-specific information obtained from ATSDR public health assessments, health consultations, and other site-specific documents. The documents are submitted to ATSDR by EPA, state agencies, and other parties. ATSDR's database contains information on substances found in various environmental media.
- **EPA's SEMS database** contains site and substance information from EPA's Superfund program. Specifically, SEMS tracks the latest status of an NPL site and contains occurrence data for substances that EPA considers to be contaminants of concern (COCs) at a site.

The frequency of occurrence is based on the number of NPL sites at which the substance was found in any environmental medium. The instance must be recorded in either ATSDR's science database or EPA's SEMS database. Generally, only substances that are found above a health-based comparison value are included in both databases. However, older data in ATSDR's science database may include instances where a substance was detected at the site (i.e., at concentrations above the limits of detection) only in a particular medium.

ATSDR uses the latest NPL status from SEMS to identify NPL sites or sites proposed for the NPL. By excluding sites that were deleted, removed, or withdrawn from the NPL, the SPL prioritizes sites that are still of potential concern.

Generally, when EPA identifies a contaminant as a COC at an NPL site, it will also be in ATSDR's science database. But to ensure that the SPL is based on the most accurate available data, ATSDR supplements its database with COC data from SEMS. Therefore, if EPA identifies a contaminant at a site as a COC that is not found in the ATSDR science database, this count will be added to the substance's frequency count.

At the time this SPL was generated, EPA has proposed or listed 1,379 sites on the NPL.

### 2.2 FREQUENCY OF OCCURRENCE SCORE

The frequency of occurrence component is assigned a maximum score of 600 points. These points are distributed between the maximum and minimum frequencies on a log scale, with the maximum frequency receiving 600 points. Lead is the most frequently occurring substance, with a count of 939 NPL sites (i.e., the "maximum frequency" in the denominator of the equation below). Therefore, lead received 600 frequency points. The points assigned for the remainder of substances were calculated using the following formula:

$$Frequency\ Points = 600\ x \frac{\log\left(Frequency\right)}{\log\left(Maximum\ Frequency\right)}$$

The point assignment was used to scale the measured frequency values into the allotted point range (0 to 600) while maintaining their proportional relationship. Because the distribution of the frequency data is heavily right-skewed, a log scale is used to increase the variability of points assigned to candidate substances.

## 3. DETERMINATION OF THE TOXICITY COMPONENT

### 3.1 TOXICITY OVERVIEW

A tiered approach is used to characterize the relative toxicity of substances in the SPL algorithm. This hierarchy prioritizes established toxicity values to characterize a substance's relative toxicity and assigns a single toxicity weight to each candidate substance. The final toxicity score is based on the normalized weight from different exposure routes and cancer/non-cancer endpoints. The score allows comparisons on a consistent scale.

The tiered system is structured to progressively identify the most relevant toxicity value available for each substance:

- **Tier 1:** Toxicity values from ATSDR's Toxicological Profiles and EPA's Integrated Risk Information System (IRIS), specifically oral and inhalation minimal risk levels (MRLs) of chronic, intermediate, and acute durations; oral reference doses (RfDs); inhalation reference concentrations (RfCs); oral cancer slope factors (OSF); and inhalation unit risks (IURs).
- **Tier 2:** Supplemental EPA toxicity values, including values obtained from Regional Screening Levels (RSL) tables. For example, Provisional Peer-Reviewed Toxicity Values (PPRTVs); Health Effects Assessment Summary Table (HEAST) values; or values released by the National Air Toxics Assessment (NATA) program, Office of Water, or Office of Pesticide Programs (OPP).
- **Tier 3:** OELs from OSHA, NIOSH, or EPA (in the form of Existing Chemical Exposure Limits).
- **Tier 4:** QSAR models and read-across method outputs for structurally related substances.
- **Tier 5:** Modified TESs for substances without Tier 1 through Tier 4 values.

When multiple toxicity values exist for a substance within tiers 1 and 2, the most conservative (most toxic) endpoint is selected. The selection requires normalizing values across oral and inhalation exposure routes using standard exposure assumptions. Surrogate substances were selected at various points in the process as a proxy for substances without established or modeled toxicity data. Radionuclides are assessed separately using EPA Preliminary Remediation Goal (PRG) values for radionuclides as a basis for relative toxicity. Following normalization, relative toxicity scores are calculated on a scale of 0 to 600 points.

## 3.2 SOURCE OF TOXICITY DATA

Toxicity values for candidate substances were compiled from the following sources.

- **ATSDR PHAST** is a dynamic ATSDR database that houses health-based toxicity values, cancer classifications, and other toxicity information for numerous substances. It serves as a reliable internal source of continuously updated toxicity values from ATSDR's Toxicological Profiles and EPA's IRIS.
- **EPA RSL tables** incorporate chronic and sub-chronic toxicity data from several sources. The sources include IRIS values, PPRTVs, OPP values, and HEAST values. In some instances, state values such as those from California EPA's Office of Environmental Health Hazard Assessment are also included.
- **EPA OPP** develops toxicity values for pesticides in drinking water. The OPP toxicity values in EPA's RSL database were archived by the IRIS program in 2016 and only represent a subset of pesticides with toxicity values. The OPP has additional toxicity values not included in the RSL tables including from the 2021 Human Health Benchmarks for Pesticides table, and in a handful of cases, other OPP reviews (e.g., Reregistration Eligibility Decisions).
- The **NIOSH Pocket Guide** is a resource containing OELs set by NIOSH and OSHA.
- **EPA PRGs for Radionuclides** represent risk-based concentrations in environmental media at Superfund sites and are based on EPA-derived risk/dose coefficients for radionuclides. These values are used to derive relative toxicity values for radionuclides.
- ATSDR's Simulation Sciences group employs **QSAR models and read-across methods** to estimate points of departure for substances lacking established toxicity values. These approaches enable data-informed toxicity scoring for substances with limited empirical data.

## 3.3 HIERARCHY OF TOXICITY DATA

ATSDR assigned each candidate substance a toxicity value based on the following tiers in order of preference.

### 3.3.1 Tier 1 - ATSDR MRLs and EPA IRIS values

If a substance has an existing ATSDR MRL or EPA IRIS value, this value is prioritized for assigning a relative toxicity score to a substance. ATSDR MRLs and EPA IRIS values are prioritized because they are derived through rigorous, peer-reviewed processes that integrate the best available science and expert judgment. The toxicity values may be one of the following:

- **ATSDR MRLs** are estimates of daily human exposure to a substance that is likely to be without appreciable risk of adverse non-cancer health effects. ATSDR derives oral and inhalation MRLs for acute (1-14 days), intermediate (>14-364 days), and chronic (365+ days) exposure durations.
- **EPA RfCs and RfDs** represent chronic exposures that are likely to be without an appreciable risk of deleterious effects during a lifetime. RfDs are daily oral doses and RfCs are continuous inhalation doses.
- **EPA IURs and OSFs** are estimates of the increased cancer risk from lifetime exposure of 1 microgram per cubic meter ($\mu g/m^3$) or 1 milligram per kilogram per day (mg/kg/day), respectively. EPA develops IURs and OSFs to measure the relative potency of carcinogens.

The ATSDR and EPA toxicity values were obtained from PHAST. If a substance has multiple toxicity values, the most health protective value is selected according to the normalization approach described in Section 3.4.

### 3.3.2 Tier 2 – Other EPA values

If an ATSDR MRL or EPA IRIS value was not available, other EPA values were used. The alternative values are typically found in EPA's RSL tables. The toxicity values in these tables come from a range of sources that may vary in the rigorousness of review but are generally considered well-established. As with the EPA values in Tier 1, these values consist of RfCs, RfDs, OSFs, and IURs. While most toxicity values in this tier are from the EPA RSL tables, supplemental values were included from EPA's OPP.

### 3.3.3 Tier 3 – OELs

When toxicity values from Tier 1 or Tier 2 were not available, OELs were used to assess a substance's relative toxicity. OELs are regulatory or advisory limits on the concentration of substances in workplace air, established to protect workers from adverse health effects during occupational exposures. These values are derived from comprehensive reviews of toxicological and epidemiological data and consider exposure durations typical of occupational settings.

OSHA sets Permissible Exposure Limits (PELs), which are legally enforceable standards to protect workers from hazardous exposures over an 8-hour workday. NIOSH sets Recommended Exposure Limits (RELs), which represent advisory limits based on the best available scientific evidence. While not legally enforceable, RELs are widely used as benchmarks for workplace safety and have been developed for a wider range of substances than PELs. Different types of

PELs and RELs can be set based on duration of exposure. ATSDR used the following OELs in decreasing order of preference:

- **Time-Weighted Averages (TWAs)** represent the average concentration of a substance a worker can be exposed to over a typical workday. OSHA defines TWAs based on an 8-hour workday, while NIOSH's RELs are up to a 10-hour workday.
- **Short-Term Exposure Limits (STELs)** are 15-minute average concentrations of a substance that workers can be exposed to without experiencing adverse effects. These limits help prevent acute health risks from short-duration exposure.
- **Ceiling Limits** specify the maximum concentration of a substance that should not be exceeded at any time during the workday. These limits provide additional protection against acute toxicity from brief, high-level exposures.

OELs were obtained from the NIOSH Pocket Guide to Chemical Hazards.

### 3.3.4 Tier 4 – QSAR and Read-Across Approaches

For substances lacking direct reference toxicity values, ATSDR's Simulation Sciences group employed a structured approach combining QSAR modeling and read-across methodologies to estimate points of departure (PODs). These approaches enable data-informed toxicity scoring for substances with limited empirical data by leveraging the structural and chemical similarities of related compounds. QSAR models use computational algorithms to predict toxicity endpoints, while read-across techniques extrapolate data from well-characterized substances to fill data gaps.

ATSDR's process begins with the QSAR VEGA models,[1] which use computational algorithms to predict toxicity endpoints based on chemical structure and properties. If the VEGA models identify experimental values with good reliability, these values are used in the assessment. However, if only low or moderately reliable values are available, ATSDR turns to EPA's GenRA (Generalized Read Across) model.[2] GenRA leverages data from structurally similar compounds to estimate toxicity endpoints. For POD estimation, 5% of chronic and sub-chronic values are used, incorporating both lowest-observed-adverse-effect levels (LOAELs) and no-observed-adverse-effect levels (NOAELs).

### 3.3.5 Tier 5 – Modified TES

For previous iterations of the SPL algorithm, ATSDR used EPA's reportable quantities (RQs) to represent toxicity values. EPA assigns CERCLA hazardous substances to one of five RQ categories (1, 10, 100, 1,000, and 5,000 pounds) based on acute mammalian toxicity, chronic

[1] Toropov, AA, Toropova, AP, Pizzo F, et al. 2015. CORAL: model for no observed adverse effect level (NOAEL). Molecular Diversity 19:563-575.
[2] Patlewicz G., Karamertzanis P, Friedman KP, et al. 2024. A systematic analysis of read-across within REACH registration dossiers. Computational Toxicology 30:100304.

toxicity, carcinogenicity, aquatic toxicity, and ignitability and reactivity. When RQs did not exist, ATSDR used the RQ approach to calculate TESs.

For the current SPL, ATSDR used a modified TES approach for those substances with no Tier 1 through Tier 4 values. Modified TESs were derived considering the three factors relevant to human health: acute mammalian toxicity, chronic toxicity, and carcinogenicity. The modified TES was then used to assign substance-specific toxicity scores as described in section 3.5.2.

For the purposes of calculating modified TESs, the following factors were considered.

- **Mammalian Toxicity**: Mammalian toxicity is represented by lethal doses or lethal concentrations (e.g., LD50s [oral/dermal], LC50s [inhalation]).
- **Chronic Toxicity**: Chronic toxicity data are represented by a substance-specific minimum effective dose and associated type of effect. If only developmental or reproductive effects data were available, they were used to assess the chronic toxicity component.
- **Carcinogenicity**: For substances with information on carcinogenicity, EPA's weight-of-evidence cancer classification or the International Agency for Research on Cancer (IARC) were used to assign TESs based on the specific classification.

The National Library of Medicine (NLM) databases were the main sources of this information. These databases include the Hazardous Substances Data Bank (HSDB), Chemical Carcinogenesis Research Information System (CCRIS) and Toxicology Literature Online (Toxline) database.

Certain substances without toxicity data or surrogate data and were determined to be sufficiently non-toxic were dropped to the bottom of the candidate list and received a total score of zero points.

### 3.3.6 Radionuclides

Radionuclides are handled differently from other substances in the SPL algorithm, and they do not fall under the tiered toxicity approach described above. Instead, ATSDR used EPA's PRGs for radionuclides to evaluate their relative toxicity. PRGs provide risk-based concentration benchmarks and when expressed in mass units, are comparable to RSLs for non-radionuclide substances under similar exposure scenarios. ATSDR compared PRG values to the RSL values of substances on its candidate list. For example, a PRG for residential soil exposure is comparable to an RSL for residential soil exposure. PRGs were used to assign toxicity points as described in Section 3.5.3.

### 3.3.7 Surrogate Substances

For several substances with no available toxicity data, ATSDR assigned toxicity values based on structurally similar surrogate substances. Surrogates are identified through expert judgement of chemical structures and properties. This approach is designed to be conservative and should not

be interpreted as a direct replacement for substance-specific data. Instead, it provides an approximate measure of relative toxicity in the absence of direct values.

The toxicity of dioxins and dioxin-like compounds and polycyclic aromatic hydrocarbons (PAHs) were assigned relative toxicity values according to approaches described by ATSDR guidance. Specifically, Toxicity Equivalence Factors (TEFs) were assigned to dioxin and dioxin-like compounds and the toxicity values for 2,3,7,8-TCDD were applied as the reference substance. Similarly, Potency Equivalency Factors (PEFs) were assigned to PAHs and benzo[a]pyrene was the reference substance.

Once a suitable surrogate is identified, its toxicity values are used to represent the substance in question. The specific toxicity value assigned to the surrogate substance follows the tiered approach described above.

## 3.4 RELATIVE TOXICITY WEIGHTS

ATSDR collected toxicity values for multiple exposure routes, durations, and cancer and non-cancer endpoints. This resulted in some hierarchy tiers having more than one value and being difficult to compare to one another. As such, ATSDR normalized the values for each exposure route and duration within the tier to determine which represented the most conservative measure to use as a final toxicity weight for the substance. This normalization enables comparisons of toxicity across different exposure routes, durations, and cancer and non-cancer endpoints. This toxicity weight can then be used to determine the relative toxicity across substances.

### 3.4.1 Toxicity Weights for Tier 1 and Tier 2 – ATSDR and EPA Values

The toxicity weight is calculated by converting the toxicity value to an inverse dose in mg/kg/day$^{-1}$ using the following assumptions:

- To convert inhalation concentrations to oral-equivalent doses, the formula assumes standard adult human exposure factors (i.e., inhalation rate of 20 cubic meters per day [m$^3$/day] and body weight of 70 kilograms [kg]), and no difference in toxicokinetics across exposure routes.
- The toxicity values for cancer compares the OSF and IUR of a substance to a possible cancer risk of one in one million people.

$$Non-Cancer\ Inhalation\ Toxicity\ Weight = \frac{70\ kg}{20\ m^3/day} \times \frac{1}{MRL_i\ or\ RfC}$$

$$Non-Cancer\ Oral\ Toxicity\ Weight = \frac{1}{MRL_o\ or\ RfD}$$

$$Cancer\ Inhalation\ Toxicity\ Weight = \frac{20\ m^3/day}{70\ kg} \times \frac{IUR}{10^{-6}}$$

$$Cancer\ Oral\ Toxicity\ Weight = \frac{OSF}{1 \times 10^{-6}}$$

### 3.4.2 Toxicity Weights for Tier 3 – OEL Values

To convert OELs, which are inhalation toxicity values, to general population exposures, a time-adjustment factor was applied depending on the specific OEL. NIOSH and OSHA TWAs are developed for up to a 40-hour workweek. To convert to continuous exposure, consistent with a chronic MRL, the adjusted TWA was calculated as follows:

$$Adjusted\ TWA = TWA \times \frac{10\ hr}{24\ hr} \times \frac{4\ days}{7\ days}$$

NIOSH and OSHA STELs are 15-minute TWAs, unless noted otherwise. NIOSH and OSHA ceilings should not be exceeded at any time but can also be assessed as a 15-minute TWA in the absence of instantaneous monitoring. We converted STELs to 24-hour continuous exposure, which we recognize has uncertainties inherent to the transformation particularly given that reaching the STEL or ceiling limit is not a linear trajectory from no exposure. This is consistent with an acute MRL, and the adjusted STELs and ceiling values were calculated as follows:

$$Adjusted\ STEL/Ceiling = STEL/Ceiling \times \frac{0.25\ hr}{24\ hr}$$

### 3.4.3 Toxicity Weights for Tier 4 - QSAR Values

The results of the QSAR and read-across analyses represent an estimated POD in units of mg/kg/day. ATSDR applies two uncertainty factors to this POD: a factor of 10 for animal to human extrapolation and a factor of 10 for human variability. The toxicity weight was therefore calculated as:

$$Toxicity\ Weight = \frac{1}{100 \text{ x POD}}$$

Toxicity weights were not calculated for values based on modified TESs or for radionuclides. The modified TES substances and radionuclides are assigned a toxicity score directly as described in Sections 3.5.2 and 3.5.3, respectively.

## 3.5 TOXICITY SCORE

The toxicity component of the SPL algorithm is calculated primarily using a log-based scaling of the toxicity weights calculated in section 3.4. However, substances with modified TESs and radionuclides follow distinct scoring methodologies. The general toxicity scoring formula is described in Section 3.5.1, while the specific methods for TES substance and radionuclides are detailed in Sections 3.5.2 and 3.5.3, respectively.

### 3.5.1 General Approach for Toxicity Score

The toxicity component of the algorithm was assigned a maximum score of 600 points. For most of these substances, these points were distributed between the maximum and minimum toxicity weight on a log scale, with the maximum frequency receiving 600 points. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and related compounds are the non-radionuclide substances with the highest toxicity weight of 1.3E11 $(mg/kg/day)^{-1}$, calculated from an EPA OSF. Therefore, TCDD received 600 toxicity points. The assignment of points for the remainder of substances was calculated using the following formula:

$$Toxicity\ Points = 600\ x \frac{log\ (Toxicity\ Weight) - Min\ (log(Toxicity\ Weight))}{Max(log(Toxicity\ Weight) - \text{Min}\ (log(Toxicty\ Weight))}$$

This method of point assignment was used to scale the toxicity weights into the allotted point range of 0 to 600, while maintaining their proportional relationship. Because the distribution of toxicity weights is heavily right-skewed, a log scale is used to increase the variability of points assigned to candidate substances on the SPL. In addition, because the log of certain toxicity weights produced negative numbers, the range of observations was adjusted to a positive scale by subtracting the smallest log toxicity weight from all values.

### 3.5.2 Toxicity Score for Modified TES

For the subset of substances that fell into Tier 5 (Modified TES), the toxicity points value is equal to 2/3 raised to the exponent of the cumulative ordinal rank, multiplied by 600 (the highest value for the toxicity points). The toxicity point assignments are presented in

Table 1 and described by the following formula:

$$Toxicity\ Points = {}^{2}/_{3}{}^{COR} \times 600$$

**Table 1. Toxicity Component Scoring**

| TES (pounds) | Ordinal Rank | Cumulative Ordinal Rank (COR) | 2/3 Raised to Exponent of COR | Toxicity Points |
|---|---|---|---|---|
| 1 | 0 | 0 | 1.0000 | 600 |
| 10 | 1 | 1 | 0.6667 | 400 |
| 100 | 2 | 3 | 0.2963 | 178 |
| 1,000 | 3 | 6 | 0.0878 | 53 |
| 5,000 | 4 | 10 | 0.0173 | 10 |

### 3.5.3 Toxicity Score for Radionuclides

For radionuclides, toxicity points were based on PRG values. ATSDR compared PRG values to the RSL values of substances on its candidate list and assigned the toxicity points of the candidate substance that had the nearest RSL value to the radionuclide's PRG. Because PRG

values for radionuclides are typically orders of magnitude smaller than RSLs for non-radionuclide substances (and thus more toxic), most radionuclides were assigned the highest toxicity points available of 600 points. For example, if a PRG (e.g., Radium-226) was lower than the lowest RSL, it indicates greater toxicity and was thus assigned the highest number of points (e.g., 600).

# 4. DETERMINATION OF THE POTENTIAL FOR HUMAN EXPOSURE COMPONENT

The exposure component of the algorithm is based on two factors: (1) the number of unique CEPs at sites, and (2) the population surrounding NPL sites. These two parts of the potential for human exposure portion of the algorithm were assigned a maximum of 400 and 200 points each, respectively. If no completed exposure pathways were available for the substance, no points were assigned.

## 4.1 COMPLETED EXPOSURE PATHWAYS (CEP) COMPONENT

### 4.1.1 CEP Overview

The CEP portion of the potential for human exposure component includes information concerning documented exposure to the environmental media in which a substance was found. In this component, the number of pathways with a reported occurrence of exposure to a substance is counted. A substance can be counted as occurring in as many as four media pathways at a site. As is the case with the frequency component, only sites that are on or proposed to be on the NPL are included.

### 4.1.2 Source of CEP Data

The sources of the CEP data are the ATSDR science database and the EPA SEMS database:

- The **ATSDR science database** provides information obtained from ATSDR public health assessments and health consultations on documented exposure to specific substances and to media, such as drinking water, in which substances have been reported. The database contains the number of times that a substance was explicitly mentioned as being in a CEP in an ATSDR site document. For the CEP component, the media and sub-media with documented occurrences are mapped to one of four pathways (“media types”) as described in Table 2.
- The **EPA SEMS database** documents substances that are determined to be a COC at a given site and the associated media. The COCs in SEMS represent substances shown to present unacceptable risk after EPA's baseline risk assessment, which considers the potential for human exposure at a site and substance-specific toxicity. As such, a SEMS COC is considered generally analogous to a substance flagged in ATSDR's database as a CEP.

**Table 2. Types of Media Used as Sources of Exposure Data**

| **Media Type (Water):** |
|---|
| Private well |
| Public well |
| Public supply |
| Tap |
| Surface water |
| Groundwater |
| Sample station |
| Other |
| **Media Type (Soil/sediment):** |
| Surface or topsoil |
| Subsurface |
| Sediment |
| Unspecified |
| **Media Type (Air):** |
| Indoor |
| Outdoor |
| **Media Type (Biota):** |
| Fish |
| Crops/Garden/Produce |
| Game Animal |
| Farm Animal |

### 4.1.3 CEP Score

A maximum of 400 points was possible for this part of the algorithm. Points were distributed from the highest to the lowest count of CEPs on a log scale, with the maximum count receiving 400 points. Arsenic had the highest count, with 1,248 CEPs (In the equation below this would be max CEPs), and therefore received 400 exposure points. The assignment of points for the remainder of substances was calculated using the following formula:

$$CEP\ Points = 400\ x \frac{\log\ (CEPs)}{\max\ (\log\ (CEPs))}$$

## 4.2 POPULATION SURROUNDING NPL SITES

### 4.2.1 Population Data Overview

The population portion of the potential for human exposure component estimates the number of people living near an NPL site where a substance was found in a CEP; however, inclusion in this

population does not mean the entire population living near the site will be exposed. Specifically, the total number of people residing in a census block within a 1-mile radius of the NPL site boundary are summed across sites for each substance. However, this does not imply that all those residing near a site were exposed to the substance.

### 4.2.2 Source of Population Data

The sources of the population data are the 2020 U.S. Census block data and U.S. EPA Superfund site boundaries. The two datasets were spatially joined with a 1-mile radius surrounding the site boundaries. The total population across all census blocks within the join were summed and assigned to that NPL site. As is the case with other components in the SPL, only sites on or proposed to be on the NPL were considered. For a site's population to be assigned to the substance, it must have been found at the site in at least one CEP for the media considered in Table 2.

### 4.2.3 Population Score

A maximum of 200 points was possible for this part of the algorithm. Points were distributed from the highest to the lowest population sum on a log scale, with the maximum sum receiving 200 points. Trichloroethylene had the highest population sum, with 10,719,193 (in the equation below this would be max population) people living near NPL sites where it was identified in a CEP, and therefore received 200 population points. The assignment of points for the remainder of substances was calculated using the following formula:

$$Population\ Points = 200\ x\ \frac{\log(Population)}{\max(\log(Population)}$$

The calculation of the population surrounding NPL sites was included in the methodology as a proxy for the number of people potentially exposed to hazardous substances at NPL sites. ATSDR recognizes that not everyone in the estimated population may be exposed, which is why this component is weighted less than the CEP portion of the potential for human exposure component. However, populations are only included in this calculation when a substance was detected in a CEP at the site.

# Appendix A: Acronyms, Abbreviations, and Symbols

| | |
|---|---|
| ATSDR | Agency for Toxic Substances and Disease Registry |
| CCRIS | Chemical Carcinogenesis Research Information System |
| CEP | completed exposure pathway |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC | contaminant of concern |
| COR | cumulative ordinal rank |
| EPA | Environmental Protection Agency |
| GenRA | Generalized Read-Across |
| HEAST | Health Effects Assessment Summary Table |
| HSDB | Hazardous Substances Data Bank |
| IARC | International Agency for Research on Cancer |
| IRIS | Integrated Risk Information System |
| IUR | inhalation unit risk |
| kg | kilogram |
| $LC_{50}$ | lethal concentration, 50% kill |
| $LD_{50}$ | lethal dose, 50% kill |
| LOAEL | lowest-observed-adverse-effect level |
| $m^3$ | meters cubed or cubic meters |
| mg/kg/day | milligram per kilogram per day |
| MRL | Minimal Risk Level |
| MRLi | MRL inhalation |
| MRLo | MRL oral |
| NATA | National Air Toxics Assessment |
| NIOSH | National Institute for Occupational Safety and Health |
| NLM | National Library of Medicine |
| NOAEL | no-observed-adverse-effect level |
| NPL | National Priorities List |
| OEL | occupational exposure limit |
| OPP | Office of Pesticide Programs |
| OSF | oral cancer slope factor |
| OSHA | Occupational Safety and Health Administration |
| PAH | polycyclic aromatic hydrocarbon |
| PEF | potency equivalency factor |
| PEL | permissible exposure limit (OSHA) |
| PHAST | Public Health Assessment Site Tool |
| POD | point of departure |
| PPRTV | provisional peer-reviewed toxicity value |
| PRG | preliminary remediation goal |
| QSAR | quantitative structure activity relationship |
| REL | recommended exposure limit (NIOSH) |
| RfC | reference concentration |
| RfD | reference dose |
| RQ | reportable quantity |
| RSL | regional screening level |

| | |
|---|---|
| SARA | Superfund Amendments and Reauthorization Act |
| SEMS | Superfund Enterprise Management System |
| SPL | Substance Priority List |
| STEL | short-term exposure limit |
| TCDD | tetrachlorodibenzo-p-dioxin |
| TEF | toxicity equivalence factor |
| TES | toxicity/environmental score |
| Toxline | Toxicology Literature Online |
| TWA | time-weighted average |
| % | percent |
| µg | microgram |

## Appendix B: Publicly Available Data Sources

1. ATSDR Public Health Assessments:

   https://www.atsdr.cdc.gov/hac/products/pha.html
2. ATSDR Toxicological Profiles:

   https://www.atsdr.cdc.gov/toxicological-profiles/about/index.html
3. EPA's Human Health Benchmarks for Pesticides (HHBP) table:

   https://www.epa.gov/sdwa/human-health-benchmarks
4. EPA's NPL Superfund Boundaries:

   https://www.arcgis.com/home/item.html?id=d6e1591d9a424f1fa6d95a02095a06d7
5. EPA Radionuclide Preliminary Remediation Goals (PRG):

   https://epa-prgs.ornl.gov/radionuclides/prg_download.html
6. EPA's Regional Screening Levels (RSL) Database:

   https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
7. EPA's Superfund Enterprise Management System (SEMS) database:

   https://cumulis.epa.gov/supercpad/cursites/srchsites.cfm
8. NIOSH Pocket Guide (NPG) database:

   https://www.cdc.gov/niosh/npg/default.html
9. US Census Blocks:

   https://hub.arcgis.com/datasets/d795eaa6ee7a40bdb2efeb2d001bf823_0/about