

2 Soil Background Definition

The soil background definitions provided below were developed for purposes of this guidance document only. These soil background definitions are not intended to capture all of the existing definitions that regulatory agencies and other entities use. They are intended to provide sufficient context to inform and support the reader.

Soil is fragmented particulate material consisting of discrete rock and mineral particles less than 2.0 millimeters in size and varying amounts of organic matter (humus) ([ITRC 2020](#)). At some locations, the particulate material may have formed in place from the physical and chemical erosion of the underlying bedrock, been deposited by geological processes, or be associated with material that was transported to the location.

Soil background includes both natural soil background and anthropogenic ambient soil background. These terms, as well as other terms, are described in detail below. Soil background concentrations vary depending on many factors, including local geology and physical and chemical properties of the soil. The relationship between the soil background concentration to the physical and chemical properties of the soil is described in [Section 5](#). There may be heterogeneity both laterally and vertically and over small and large areas. The background concentrations of a chemical are more accurately described as a range. However, for practical purposes, regulatory agencies often use one specific value to represent soil background. It is important to consider the many factors that can influence soil background concentrations of a chemical and their variability when evaluating whether observed concentrations are a result of a release or natural or anthropogenic ambient soil background.

Soil background can be derived and presented as a range of values or can be expressed as a single numerical value. The decision on whether to present background as a concentration range, a population, or as a single value is based on the project- or program-specific needs. For example, states often use one single value to represent background across an entire state or region of a state to determine whether concentrations for a site reflect soil background. In contrast, responsible parties often compare (using a statistical test) an entire dataset from a site that is being evaluated to an entire dataset of a soil background reference site to determine whether site chemical concentrations reflect only soil background or if they also reflect soil contamination. Understanding the applicable state regulations, study objectives, and how the soil background will be used is critical to determining which approach is most appropriate.

2.1 Natural Soil Background

For purposes of this document, natural soil background is defined as the concentration of a substance, or family of closely related substances (for example, similar element species or similar compounds), present in soil due to geological characteristics, natural processes, or releases from nonanthropogenic sources (for example, wildfires, volcanic activity). Natural soil background does not include releases from local anthropogenic sources, releases from distant anthropogenic sources of persistent chemicals, or other anthropogenic sources of ubiquitous or widespread contamination.

Natural soil background has been defined in multiple federal and state guidance documents. For instance, the USEPA defines natural (soil) background at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites as substances present in the environment in forms that have not been influenced by human activity (([USEPA 1989](#)), ([USEPA 2002](#))). This definition has been adopted by some states and programs.

Some states, such as Maine, Vermont, Wisconsin, Washington, Florida, and Texas, have defined natural soil background in their guidance documents, and in some cases have placed the definitions into rule. Other states, such as Idaho, have definitions for natural (and anthropogenic) background that acknowledge the need for representative measurement to determine background.

2.2 Anthropogenic Ambient Soil Background

For purposes of this document, anthropogenic ambient soil background is defined as the concentration of a substance, or family of closely related substances (for example, similar element species or similar chemical compounds), present in soil due to anthropogenic nonpoint sources, especially when chemicals have the ability to be transported long distances. “Anthropogenic” describes the activity that caused the release while “ambient” describes the widespread distribution of the chemical. This is potentially most relevant to some recalcitrant organic compounds, such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), which can be present in soil at low concentrations because of their persistence, their ubiquity, or their ability to be transported long distances. Additionally, this could be relevant to metals with a widespread urban source, such as the long-distance transport of mercury. Additional information about these chemicals can be found in [Section 7](#).

What constitutes anthropogenic input and how that is allowed within the context of a project or site has been subject to divergent interpretation. Anthropogenic soil background, anthropogenic ambient soil background, and ambient soil background as defined in various state and federal guidance documents may not be consistent with the definition used in this document. For instance, USEPA defines anthropogenic soil background as natural and human-made substances present in the environment as a result of human activities, not specifically related to the site release in question (([USEPA 1989](#)), ([USEPA 2002](#))), therefore, this definition would include nonpoint ambient sources (or sources that come from many diffuse sources). USEPA's definition of anthropogenic soil background includes both natural and anthropogenic soil background that is not associated with a release from the site that is being evaluated.

When establishing anthropogenic ambient soil background as defined in this document, it is important to carefully consider the intended purpose and clearly define anthropogenic ambient soil background to identify which sources should and should not be included. The definition for anthropogenic ambient soil background varies more widely between regulatory agencies and other entities than that for natural soil background. In most cases, it is defined as including both natural background and diffuse sources of chemicals that can be transported long distances and are present in similar concentrations across a large area (for example, dioxins or PAHs). Local direct or indirect release sources such as those from a specific facility or stormwater runoff are excluded.

For example, when investigating lead, the areas near roadways may be excluded since the impacts of lead-based gasoline may not be uniform throughout the area. However, when investigating lead impacts from an air emission source, it may be necessary to understand anthropogenic ambient soil background near roadways to discern the contribution from the air emission source compared to lead related to gasoline engine emissions on the roads.

Some studies and projects may use alternative definitions of anthropogenic ambient soil background to fit the goals of the specific project. For example, some historical diffuse releases, such as vehicle emissions, might be included in an urban background study if the entire area being included has been subjected to this source and it aligns with the goals of the study and regulatory authority requirements. Some nonpoint or point sources, such as urban runoff, might be included for a site-specific project if the entire area being included has been subjected to this source and it aligns with the goals of the project and regulatory authority requirements. It is generally not appropriate to include releases from industrial activities or reuse of contaminated fill. However, it is noted that some states, such as New Jersey and Massachusetts, recognize historic fill as an anthropogenic ambient soil background condition; historic fill as a background condition is not addressed in this document. In cases where anthropogenic ambient soil background is being characterized for a large area it may not be appropriate to include local diffuse releases or nonpoint or point sources that do not impact the entirety of that area.

2.3 Additional Background Definitions

In addition to natural and anthropogenic ambient soil background, two other types of background definitions are used in this guidance document. Default and site-specific soil background are defined below and are discussed in more detail in subsequent sections ([Section 3](#)).

2.3.1 Default soil background

Default soil background is generally established by regulatory agencies for a larger area (for example, a state, a region, or a unique geological area) that generally shares similar physical, chemical, geological, and biological characteristics. Because default soil background is intended to be used to evaluate a large number of sites, it is generally established to be conservative. Default soil background can be established for both natural and anthropogenic ambient soil background concentrations.

Regulatory agencies use default soil background as a screening tool to determine whether contaminant concentrations at an individual site are within the background concentrations of the larger area. A single value (also known as a background threshold value (BTV)) is most often used to represent soil background since this is easier to use in screening. Many states have default soil background values relevant to the entire state or different regions of the state that are used to compare to cleanup site concentrations to determine whether site contaminant concentrations are considered background (site contaminant concentrations are less than the BTV used as the default soil background). For the purpose of this document, default soil background will be referred to as a single value, which is consistent with findings from the state survey and investigation of regulatory guidance conducted to produce this document ([Section 12](#) and [Section 13](#)).

Default soil background may be established using a dataset from either:

- an existing soil background study that was conducted for another purpose if it has been evaluated to ensure that it is appropriate to use or
- a soil background study conducted specifically to establish the default soil background.

2.3.2 Site-specific soil background

Site-specific soil background is generally established by a responsible party for an area of limited geographic scope that represents one specific site (for example, an incinerator cleanup site, a railroad yard cleanup site). This is generally a more accurate way to evaluate whether site chemical concentrations are representative of background since it uses information relevant to a specific site in a limited geographical area. Site-specific soil background can be established for both natural and anthropogenic ambient soil background.

If the soil chemical concentrations at a site exceed default soil background values or there is reason to believe that default soil background is not applicable to the site, most regulatory agencies allow responsible parties to complete a more refined evaluation by establishing site-specific background. An area that has similar physical, chemical, geological, and biological characteristics as the cleanup site being evaluated, but has not been subjected to the same chemical releases as the cleanup site, is used to represent site-specific background. The physical, chemical, geological, and biological characteristics of the site being evaluated and of the background reference area used to establish site-specific background are generally more comprehensively characterized when establishing site-specific background.

Site-specific soil background may be established using a dataset from either:

- an existing soil background study that was conducted for another purpose if it has been evaluated to ensure that it is appropriate to use
- a site-specific soil background study conducted specifically to establish soil background for the site being evaluated

The site-specific soil background dataset can be used to:

- establish a site-specific soil background value (for example, a BTV)
- compare the site-specific soil background dataset to the site dataset

Establishing a site-specific soil BTV and comparing it to site contaminant concentrations provides an upper-end estimate of the site concentrations compared to soil background concentrations. Comparing a site-specific background dataset to a site dataset provides an estimate of whether the site concentrations are similar to soil background concentrations or if they exhibit a positive bias that can be attributed to contamination of the site soil.

2.3.3 Soil background reference area

Soil background reference areas are the areas identified as appropriate for collection of samples used to ultimately determine a soil background concentration or range and are also used in ecological risk assessment as described below. Thus, a soil background reference area may serve multiple purposes.

Background reference areas used in ecological risk assessment should be chosen to closely represent natural and geochemical conditions for the site that is being evaluated for potential ecological risks. USEPA states that a soil background reference area for ecological risk assessments is intended to “mirror the physical, climatic, chemical, and biological aspects of the Superfund site” ([USEPA 1994](#)). A well-developed conceptual site model helps to inform the appropriate selection of ecological background reference areas. When conducting an ecological risk assessment, ecological background reference areas may be used in two ways:

- To evaluate impacts on community composition: Biological surveys of flora and fauna present at the background reference area are conducted and compared to ecological receptors present at the site being evaluated. This approach may be used to determine whether the presence of the contaminant has impacted a specific species, or to compare the composition of the community on the sites. For this type of comparison, similarity of the habitat and community composition is generally the most important selection characteristic.
- For selection of COPC. Soil samples from the ecological background reference area can be analyzed to determine background soil concentrations, which may be used to identify COPC needing further evaluation. It is assumed that wildlife, which has evolved in the presence of naturally occurring background, is not impacted by these background concentrations. For this type of comparison, comparable soil characteristics and geologic formation are generally the most important selection characteristics.

Background reference areas used in developing soil background concentrations are chosen to closely represent background conditions for the site being evaluated for potential human health and ecological risks. In some cases, the background reference area is located off site as close to the site as possible, but at larger investigative sites it could also be an area of the site that has not been subjected to site releases. Regulatory agencies have different requirements for identifying soil background reference areas.