United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

Directive 9285.7-19FS
PB94-963313
EPA/540/F-94/030
September 1995

EPA Establishing Background Levels

Office of Emergency and Remedial Response

Quick Reference Fact Sheet

Abstract

EPA uses the Hazard Ranking System (HRS) (40 CFR Part 300, App. A) to evaluate Superfund sites to be proposed on the National Priorities List (NPL). Based on the HRS, an observed release or observed contamination is established when contaminants that are significantly above background levels have migrated away from a site through environmental media. This fact sheet describes how to determine background levels for each migration pathway, and emphasizes the necessity of strategic, efficient sampling, which is particularly important in light of conducting integrated assessments under the Superfund Accelerated Cleanup Model (SACM).

Introduction

The determination of background levels under the Hazard Ranking System (HRS), usually by chemical analysis, is necessary to evaluate an observed release (*Hazard Ranking System, Final Rule*, 40 CFR Part 300, App. A). Background levels are key in establishing attribution of contaminants where multiple sources or contaminant contributors exist. Additionally, an integrated sampling strategy should be considered when determining background levels, as appropriate.

A background level is "the concentration of a hazardous substance that provides a defensible reference point that can be used to evaluate whether or not a release from the site has occurred. The background level should reflect the concentration of the hazardous substance in the medium of concern for the environmental setting on or near a site. Background level does not necessarily represent pre-release conditions, nor conditions in the absence of influence from source(s) at the site" (*Hazard Ranking System Guidance Manual*, November 1992, OSWER Directive 9345.1-07). Background levels do not have to reflect pristine conditions.

Obtaining suitable background samples can be challenging because of varying media compositions and potentially false assumptions regarding ambient conditions. Consult the *Guidance for Performing Site Inspections Under CERCLA*, September 1992, OSWER Directive 9345.1-05, for information on establishing background levels.

Resource Considerations

A sampling strategy for an integrated assessment under the Superfund Accelerated Cleanup Model (SACM) should be considered, and planned if appropriate. The elements deemed necessary for an integrated assessment depend on the particular needs of a specific site and could involve similar, additional, or slightly different activities compared to traditional removal or remedial site assessments. (For more information, see *Integrated Removal and Remedial Site Assessment Investigations*, September 1993, OSWER Directive 9345.1-16FS.)

The data gathered from the Site Inspection (SI) may be useful later in the overall site strategy, especially where it appears that a response action may be required. In such cases, site managers may consider a broader

sampling strategy. For instance, such efforts might include collection of the accessary site information for development and use of Soil Screening Levels (SSLs) for use during the Remedial Investigation/Feasibility Study (RI/FS). It is appropriate to use data gathered during the SI for the RI, especially to develop the Conceptual Site Model.

SSLs are not appropriate for use at the SI stage because the objectives of the SI and SSL are different. The objective of the SI is to obtain information on "worst case" or "hot spot" contamination. It is not intended to be a detailed analysis of the extent of contamination, nor a risk assessment. Based on the results of the SI, EPA decides whether the site qualifies for possible inclusion on the National Priorities List or elimination from further Superfund consideration. SSLs are used in the RI to screen out potential contaminants and exposure areas for remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Draft *Soil Screening Guidance,* December 1994, OSWER Directive 9355.4-14FS).

The Agency for Toxic Substances and Disease Registry (ATSDR) should be consulted when there is the potential for human exposure to toxic substances. The sampling approach for these sites should include data collection for the human exposure information that ATSDR uses to determine if a health advisory is needed. ATSDR also uses this data in the preparation of a public health assessment, which is required within 12 months of proposal to the National Priorities List.

Usually a few background samples are necessary to evaluate an observed release and attribution for HRS purposes. The selection of strategic sampling locations is critical to the success of the SI, which is a limited scope biased sampling event. When feasible, evaluate the benefits of sampling at specific locations and assess the validity of available data to meet SI or other integrated assessment objectives. The data quality objective (DQO) process provides a logical framework for planning multiple field investigations, thereby fulfilling the integrated site assessment goal of cross-program response planning and allowing optimal cross-program data usability. (See *Data Quality Objectives Process for Superfund,* September 1993, OERR Directive 9355.9-01 for further details on the DQO process.)

Background Level Determination Without Sampling

Establishing a background level requires determining the concentration level of a hazardous substance. Sampling is not always necessary to make this determination. Some man-made hazardous substances (e.g., pesticides, chlorinated organic solvents, except drinking water chlorination) can be attributed only to a contaminant source. The presence of these substances in the release is sufficient to show contamination; a background sample is not needed (OSWER Directive 9345.1-05).

Sampling may not be necessary for certain sample locations, such as wells, which may serve as their own background (OSWER Directive 9345.1-05). A release can be demonstrated when historical data from a contaminated well or intake show that it was previously uncontaminated or less contaminated. Detailed historical data are useful to define encroachment of a contaminant plume. Often, historical data are available for wells and surface water intakes at industrial sites or municipal water facilities which have a regular monitoring program (OSWER Directive 9345.1-07). For example, a ground-water well or surface water intake may have associated historical analytical data.

In some cases, published background levels may exist that can be applied to a specific site. The following published data sources may be consulted:

- Background sample results from other nearby CERCIA site investigations
- Local surveys by other Federal or State agencies (e,g., U.S. Geological Survey (USGS), Soil Conservation Service (SCS))
- University studies
- Tables or databases with natural concentration ranges and averages in local or regional soils (OSWER Directive 9345.1-05)

Published data may be useful when selecting background sampling locations. If published data are used, multiple sources of information help to support a comparison determination. The use of background level data without sampling (e.g., published data) may be acceptable for SI or HRS scoring activities. The analytical package for the published data should be obtained whenever possible (OSWER Directive 9345.1-05).

Published information may not be appropriate to use in many cases. Published data may not account for regional variations or unique site-specific characteristics (OSWER Directive 9345.1-05). Background levels may vary with regional and local geology (e.g., ore veins, soils with naturally high metals content). It may be difficult to demonstrate comparability using published data because of the difficulty of duplicating sample method and analysis. For comparison, published or existing data should be generated under quality assurance/quality control (QA/QC) measures equivalent to EPA requirements.

Considerations for Selecting Background Samples

Under the HRS, the collection of background samples usually is necessary for the following reasons:

- A release cannot be determined by direct observation;
- The source consists of contaminated soil;
- Historical data are unavailable or insufficient;
- The substance of interest is ubiquitous.

Under the HRS, the highest background sample concentration generally can be used as a background level. In a non-industrial area, average background concentrations may be used when sufficient background samples are collected in a relatively homogeneous environment, and there are no alternative sources of contamination nearby. Qualified analytical data may also be used for background level determination (refer to the interim fact sheet *Using Qualified Data to Document an Observed Release*, July 1994, OSWER Directive 9285.7-14FS, for more information). At least one background sample per pathway or medium of concern should be collected. Preferably the samples should be taken outside the area believed to be influenced by the site. However, it is often necessary to collect more than one background sample.

Determining the location and number of background samples depends upon the following factors:

- Hazardous substances present at the site and expected concentrations the following factors:
- Availability and quality of existing information and analytical data;
- Objectives of the investigation;
- Site hypotheses to be tested;
- Media variability;
- Size of the site, number, and type of sources;
- Pathway-specific considerations (e.g., geologic formations, types of surface water bodies); and
- Other potential sources of contamination in the vicinity of the site (OSWER Directive 9345.1-05)

The number of background samples collected may also depend upon the type of investigation performed. At times, a contaminated background sample can be compared with a release to demonstrate that the site under investigation contributes at least part of the contamination in the release (OSWER Directive 9345.1-05).

In all evaluations, release and background samples must be similar for comparison. Factors which determine sample similarity include location, type, depth, medium, sampling method, preservation, handling, timing, and weather conditions during sampling.

In some situations, collection of a comparable background sample is not possible (e.g., when there is no surface water sample similar to an isolated pond, or when a surface water body originates from a spring) (OSWER Directive 9345.1-05). If background sampling is not possible, substitute published data, as available.

When collecting samples at a site, the activities of the investigation team should not introduce any non-attributable contaminants to samples. Sampling methodology can minim, these potential errors.

Variability introduced by sampling methods can be much greater than that introduced by the analytical laboratory. When feasible, consider variability factors for each HRS pathway under investigation. The following are specific considerations when selecting background samples for each HRS pathway.

Ground-water Pathway

A direct observation of a release to ground water can be documented if it is observed or known that a hazardous substance has been deposited, or the source lies below the water table of the aquifer of concern (e.g., injection well, buried waste). Therefore, a direct observation of a release to ground water does not require establishing a background level, but the presence of a hazardous substance in the release should be documented by manifest data or chemical analysis (OSWER Directives 9345.1-05 and 9345.1-07.

When establishing an observed release to ground water by chemical analysis, background samples generally are needed. Background samples should be collected from nearby wells that are not expected to be influenced by the source of contamination or by other sites. If there are other sites or potential local sources of ground-water contamination, additional background samples should be collected where possible to differentiate their contribution from that of the site under investigation (OSWER Directive 9345.1-05).

Similarity of Aquifers

Aqueous release and background samples must be collected from comparable zones (e.g., saturated zone) in the same aquifer and, where possible, should be collected during the same sampling event. Interconnected aquifers should not be considered as one aquifer when comparing samples for an observed release. When collecting background samples, it is preferable not to use samples from a well screened in two or more aquifers (OSWER Directive 9345.1-05).

When feasible, evaluate aquifer characteristics before selecting wells for sampling. especially in areas of complex or variable geology. Be aware of the existence of mines, faults or other aquifer intrusions which may affect sample representativeness. (Note: Section 7.1 of OSWER Directive 9345.1-07 provides detailed guidance on determining aquifers and aquifer boundaries.)

Note information on ground-water flow direction if it is known or can be easily determined. This information may also be useful in selecting monitoring well installation locations for Expanded Site Inspection (ESI) and Remedial Investigation (RI) work. Information on flow direction should be obtained by using piezometers, by comparing static water levels in existing wells in the same aquifer, and by using data from published reports. The well used for background sampling should be beyond the influence of the site (OSWER Directive 9345.1-05).

Comparability of Well Samples

Samples from any two wells can be considered comparable if both are collected from the same aquifer. Filtered ground-water samples should be compared to filtered background samples; unfiltered ground-water samples should be compared to unfiltered background samples. Ideally, well completion techniques and usage of background wells should be similar to those of the well under investigation. Sampled wells generally should be screened at similar zones within the same aquifer, depending on the site hydrogeologic setting, because different depths may have different contaminant levels and water chemistry. Depth should be measured as elevation relative to a reference (e.g., mean sea level) instead of below ground surface for data consistency.

Where possible, duplicate purge parameters and method, sampling method, and sampling equipment for all well samples. If possible, sample release and background samples on the same day, but preferably not more than three days apart (OSWER Directive 9345.1-05).

In cases where a background well is not available, consider the possibility of sampling a spring before it reaches the surface by inserting a pipe or well point near the location where ground water discharges at the spring (OSWER Directive 9345.1-05). Sampling data may be supplemented with applicable published data. Springs may be used for background sampling of surficial aquifers only.

Surface Water Pathway

Direct observation of a release to surface water may be documented if material containing a hazardous substance is seen entering surface water; is known to have entered surface water through direct deposition; or is present in a source which is in contact with surface water through flooding. Direct observation of a release to surface water eliminates the need for background sampling, but the presence of a hazardous substance in the release should be documented analytically. A background sample is not required when sampling an effluent discharge from the site into surface water, because the effluent is considered a direct observation.

In non-tidal surface water bodies, it is preferable to sample downstream to upstream. Background sediment samples should be from a location comparable to that of the release (e.g., fine sediments from quiescent zones) (OSWER Directive 9345.1-05). Generally, sediment samples are preferred over aqueous samples for evaluating the surface water pathway because sediments are more likely to retain contaminants. In general, aqueous samples might represent current release conditions, whereas sediment samples might exhibit historical release conditions.

When it is necessary to collect biological samples, background samples from essentially sessi1e, benthic organisms (e.g., sponges, oysters) can be compared to

similar (same species) tissue samples. Organisms selected for background tissue sampling should be the same gender and approximate age, wherever possible, of those selected for release tissue sampling (OSWER Directive 9345.1-05).

Special Considerations for Tidal Water Bodies

Where appropriate, determine the need to collect aqueous and sediment samples when the surface water body is tidally influenced. One approach for background sampling is to collect outside of the zone of tidal influence (this can be gauged by the level of the highest tide). It is possible that tidal flow could pick up additional sources upstream. The effect of the tides on contaminant concentration should be considered. (Upstream concentrations would be highest during the rising tide and lowest at falling tide.) Consider collecting release and background samples at the same tidal level (OSWER Directive 9345.1-07).

Comparability of Water Bodies

Consider collecting release and background samples from the same type of water body. Flow characteristics can be used to determine similar water bodies. For example, a background sample from a small tributary should not be compared to a sample from a river. Physical and chemical properties of the surface water (e.g., lack of mixing in large, slow-flow segments of rivers, physical transport mechanisms, and biological influences) are other ways of determining whether water bodies are similar. Where possible, collect release and background samples during the same time period, since thermal stratification and salt/freshwater stratification vary with the time of year. Consider the thermoclines of a pond or lake or measure them in the field prior to sampling (OSWER Directive 9345.1-05 and 9345.1-07).

Simple surface water pathway sampling generally consists of taking a minimum of one Probable Point of Entry (PPE) sample and one upstream background sample. If the surface water pathway has multiple PPEs, multiple background samples may be needed. The number of background samples collected depends on the complexity of the path of the surface water body. The presence of multiple tributaries upstream with multiple potential sources would require collecting multiple background samples in each tributary to differentiate the potential contribution of contamination from off-site sources (OSWER Directives 9345.1-05 and 9345.1-07).

For ponds and lakes, background samples may be collected near the inflow to the water body if it is not influenced by the source. A pond near the site may be selected for background sampling if it exhibits similar physical characteristics to the pond on site. For large ponds and takes, background samples may be collected from the water body itself, but as far away as possible from the influence of the PPE and other potential sources (OSWER Directive 9345.1-07).

Air Pathway

Background levels need not be established for the air pathway when an observed release by direct observation is documented. Direct observation of release to the air pathway can be documented in two ways: a release containing hazardous substances is seen entering the atmosphere directly (e.g., observing dust blowing off a pile known to contain hazardous substances), or an adverse effect is demonstrated (e.g., a documented health effect from a reaction of incompatible substances).

Generally, it is necessary to determine background levels for the air pathway because weather conditions can greatly affect them. Throughout the sampling period, it may be necessary to determine the predominant wind direction and speed, effects of low temperatures, existence of flat, open terrain, and any atmospheric instability or lack of air movement. Background sampling should be collected upwind of site sources, although cross-wind samples may be acceptable. It is preferable to collect multiple samples for this pathway, from the same height, and at the same time. Samples from great heights such as rooftops generally are not useful because they do not represent target conditions; very low heights are subject to potential interference from particulates introduced by field activities. Dust, wipe, soil, and soil gas samples are not acceptable for background sampling in the air pathway. Even though these types of samples may be used, along with field air monitoring equipment, to select release and background sample locations, it is recommended that samples and background be collected concurrently. A minimum 12-hour monitoring period is recommended for sampling the air pathway, particularly during hot and dry weather conditions (OSWER Directives 9345.1-05 and 9345.1-07).

Wind roses may be used to determine predominant wind direction, or to document changes in it. Wind direction is important when selecting sample stations (OSWER Directive 9345.1-07). The "rose" diagram consist of bars on a compass face indicating the frequency of each wind

direction during the selected time period, as well as the average high wind speed for the period. If wind roses are utilized, try to determine the elevation for which the wind rose was calculated; this elevation should be representative of target exposure. Weather stations and airports may provide information on local wind direction at ground level and at various elevations.

Soil Exposure Pathway

Because it is not possible to directly observe contamination in the soil exposure pathway, soil must be sampled to determine background levels. As previously mentioned, there will be sites that appear to require response actions (e.g., early actions). In such cases, site managers may consider a broader sampling strategy. Such efforts might include collection of the necessary information for development of soil screening levels (SSLs).

Establishing background levels in the soil pathway can be difficult, particularly if the hazardous substances attributed to the site are naturally occurring. Where possib1e, collect on-site background soil samples from surficial soils not likely to be affected by the source. Offsite background soil samples should be collected from shallow soils which ideally should not be affected by other sources and sites in the area. However, if there are alternative sources of contamination in the area, background levels should be measured to determine contributions, from them. When possible, sample release and background samples on the same day or within three days. (See Highlight 9-1 of OSWER 9345.1-07 for information on background samples for non-soil sources in the soil exposure pathway.)

Carefully document location, depth, and appearance of all soil samples. If depths and thicknesses of soil strata vary with location, ensure that release and background samples are from a similar stratum and soil type. Samples should have similar texture, color, and grain size (OSWER Directive 9345.1-05). Grab samples (as opposed to composite) are preferred for determining soil contamination in the SI. Preferably obtain the background sample from an undisturbed, unfilled area, because fill may have contaminants which are not representative of background conditions. If a site is located on fill , it may be necessary to obtain the background samples from a similarly filled area (where the fill is not considered one of the areas of observed contamination at the site) (OSWER Directive 9345.1-07). It is a recommended strategy to select more than one background sample and location for the soil exposure pathway. Avoid collecting background soil samples from a drainage channel which receives water from off site (OSWER Directive 9345.1-07). Where possible, collect background samples from a higher elevation than the sources to avoid the effect of potential surface drainage. Avoid background sample locations that are subject to airborne contamination from the site or other sources (OSWER Directives 9345.1-05 and 9345.1-07).

Determining Background Levels In Industrial, Mining, and Radioactive Areas

Industrial areas can pose a special challenge to determining background levels. Ambient conditions may include elevated concentrations of common contaminants from sources not associated with the site. Some common contaminants in background samples in industrial and urban areas include:

- Metals in soils (e.g., lead)
- Trichloroethene (TCE) and perchloroethene (PCE) in urban aquifers
- Organic substances in harbor sediments (OSWER Directive 9345.1-05)

In industrial areas, the investigator often needs to document that a sample is above background sample variability. One approach is to determine where potential alternative sources exist and where they could possibly interfere with release or background samples. Because industrial areas are affected by increased levels of contaminants and greater local variability, additional background samples may be required to establish off-site conditions. Be sure to collect a sufficient number of samples between the site and all other potential sources of contamination in order to attribute the increase to the site (OSWER Directive 9345.1-05). In general, it is inappropriate to average background samples in an industrial area where more than one type of industry existed because doing so could lead to unacceptable levels of local variability (see *Establishing Areas of Observed Contamination*, September 1995, OSWER Directive 9295.7-18FS, for more detailed information).

Mining areas, like industrial areas, pose a challenge to determining background levels. Often the contaminants associated with the mine are naturally occurring elements. Surface water may originate from the mine, presenting no upstream location for background

sampling. Surface water may pass through the mined watershed. Consequently, the nearest upstream location away from the influence of the site may be in a different geologic formation, with different water chemistry, producing uncertainty about comparability.

When surface water in mining areas originates in the source or when no similar upstream location exists, a water body with similar physical characteristics (e.g., a similar stream on the other side of a mined hill) should be selected for background sampling. The similar water body should not be directly affected by the site. Concentrations in the vicinity of mining sites may be so significantly elevated that published data may provide a more reasonable background level.

Mines are often located in areas with aquifers that are highly fractured or influenced by mine drainage tunnels. In mining areas, it may be difficult to find undisturbed areas in which to locate ground-water wells and therefore, difficult to determine ground-water background levels. In such cases, it is preferable to determine an observed release by direct observation.

Mine tailings generally contain minerals and are considered waste. Collecting background samples is not necessary if tailings are analyzed and the mineral concentrations are shown to be elevated well beyond what might be expected under natural conditions.

To sample sites with radioactive wastes, follow sampling strategies similar to those for other hazardous substances. Criteria to establish an observed release through chemical analysis for radioactive substances exist for the following three groups:

- Radionuclides that occur naturally, or ubiquitous man-made radionuclides;
- Non-ubiquitous man-made radionuclides; and
- External gamma radiation (soil exposure pathway only).

Some portion of the release must be attributable to the site. For each group, compare release concentrations against known background radionuclide concentrations against detection limits for a sample medium. Section 4.9.4 of OSWER Directive 9345.1-05 provides details on establishing an observed release for each group.

Summary

Thorough documentation of the locations of the background samples and potential alternative sources is necessary to assess the adequacy of the background levels and to evaluate release and attribution. The benefits of sampling at specific locations should be evaluated and the validity of existing analytical data should be assessed. Meet SI objectives while conserving Superfund resources. Direct observation of a release does not require background sampling if detectable concentrations of hazardous substances are documented to be present in the source. Background samples may not be necessary for certain man-made compounds. If demonstrating a release or establishing actual contamination is critical to evaluating a site, background or QA/QC samples should not be limited unduly because of budgetary considerations–collecting these samples may prevent having to return to the site.

To establish background levels by chemical analysis, on-site and off-site sources and their locations should be thoroughly reviewed. Release and background samples should be collected from similar locations and media. Ground-water samples are similar when they come from the same zone within an aquifer and undergo similar sample preparation. Background samples for surface water should be collected upstream of the PPE. Additional site reconnaissance and review are often needed to select sampling locations in industrial and mining areas and at complex sites.