

Site contamination

–Determination of background concentrations

Issued December 2008

EPA 838/08: This guideline provides direction on how the Environment Protection Authority requires background concentrations to be established for the purpose of determination of site contamination in South Australia. This guide is intended for use by site contamination auditors and site contamination consultants.

Purpose and use of this guideline

This guideline has been prepared by the Environment Protection Authority (EPA) to provide information on how the it expects background concentrations to be established.

The *Environment Protection Act 1993* (EP Act) defines¹ background concentrations in relation to chemical substances on a site or below its surface, as ‘results obtained from carrying out assessments of the presence of the substances in the vicinity of the site in accordance with guidelines from time to time issued by the Authority’.

The EP Act defines site contamination as:

For the purposes of the Act², site contamination exists at a site if–

- (a) chemical substances are present on or below the surface of the site in concentrations above the background concentrations (if any); and
- (b) the chemical substances have, at least in part, come to be present there as a result of an activity at the site or elsewhere; and
- (c) the presence of the chemical substances in those concentrations has resulted in–
 - (i) Actual or potential harm to the health or safety of human beings that is not trivial, taking into account current or proposed land uses; or
 - (ii) Actual or potential harm to water that is not trivial; or
 - (iii) Other actual or potential environmental harm that is not trivial, taking into account current or proposed land uses.

¹ Section 3 of the EP Act.

² Section 5B of the EP Act.

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Without establishing the background concentrations of a chemical substance in the vicinity of a site, it cannot be determined if concentrations of the chemical substance at the site are in excess of the background concentration, making the determination of site contamination (by definition) impossible.

The EP Act provides for the protection of the environment and defines the EPA's functions and powers. The objects of the EP Act³ are to promote the principles of ecologically sustainable development and to ensure that all reasonable and practicable measures are taken to protect, restore and enhance the quality of the environment. The EP Act also establishes a general environmental duty⁴ which establishes an obligation for persons to avoid causing environmental harm.

This guideline is intended for use by site contamination auditors and site contamination consultants⁵ (assessors) when making a determination as to the existence of site contamination. It covers a complex subject and cannot cover all the situations that may need to be considered at a specific site. This guideline is not intended for use by people that are not professionals in the assessment of nature or extent of site contamination. The EPA encourages assessors to contact and liaise with the EPA for guidance on the use of this document if they are unclear about the approach to be taken at the site.

This guideline contains 'must' and 'should' statements which are defined as follows:

- 'must': indicates a requirement of the guideline, which if ignored, is likely to result in an inaccurate determination of the background concentration
- 'should': indicates a recommended approach.

In accordance with the *Environment Protection (Site Contamination) Regulations 2008*, specifically Regulation 12(2)(c), it is a requirement of a site contamination auditor's accreditation that a site contamination auditor⁶ must not, when acting in his capacity, fail to comply with any guidelines issued from time to time by the Authority (insofar as they may be relevant in the circumstances of any particular case). Site contamination auditors must therefore comply with this guideline when they are carrying out an audit involving the determination of background concentrations.

Each section of this guideline includes:

- a summary of the issue and environmental concerns
- 'musts': required outcomes
- 'shoulds': recommended outcomes
- Key notes and references that may assist or further clarify the issues.

The EPA is primarily concerned with prescribing environmental outcomes and not the methods for achieving such outcomes. Assessors are encouraged to use their own experience and knowledge to identify an appropriate method for the determination of background concentrations that complies with these guidelines.

³ Section 10 of the EP Act.

⁴ Section 25 of the EP Act.

⁵ Defined in Section 3(1) of the EP Act.

⁶ Defined in Section 3(1) of the EP Act.

What is background concentrations?

The EPA has determined that while background concentrations can be influenced by human activities, these sources must be from ‘minor pollution of everyday activities’ and not from a defined incident, activity or source of pollution.

The EPA defines the conditions that contribute to the background concentration as:

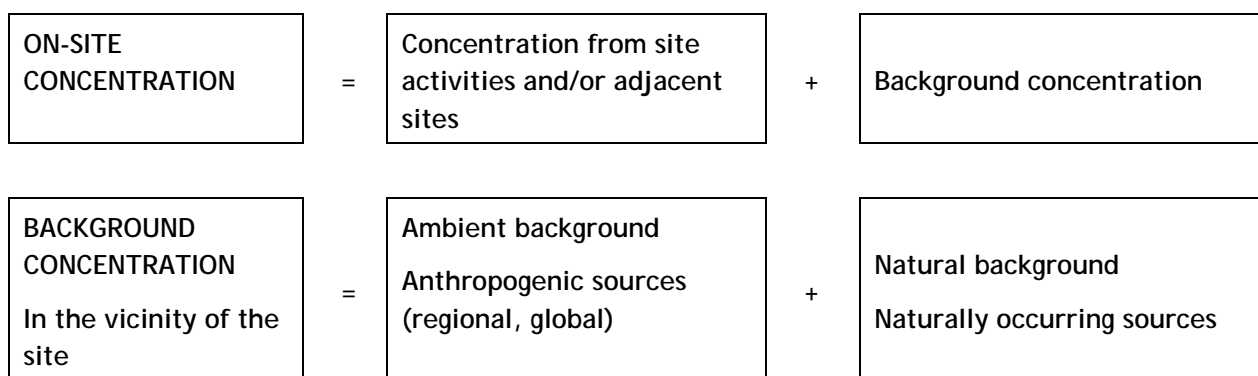
- **Natural:** this is the amount of naturally occurring chemical substances derived/originating from natural processes in the environment as close as possible to natural conditions, exclusive of specific anthropogenic activities or sources; and
- **Ambient:** the concentration of chemical substances in the environment that are representative of the area surrounding the site not attributable to a single identifiable source. These are typically from historic activities, widespread diffuse impacts, eg fall-out from motor vehicles⁷.

Chemical substances are found in soils and groundwater at varying concentrations. The source of naturally occurring chemical substances is typically from processes such as erosion and dissolution of mineral deposits. These concentrations will be dependent on/influenced by topography, geology, geography and the physical, biological and chemical properties of the soil and groundwater.

The EPA acknowledges that the natural component may be difficult to quantify especially in areas that have been subject to extensive anthropogenic activity (eg industrialised areas). Nearly all environments have been historically affected by human activity (global industrialisation) to some degree, and hence historical diffuse anthropogenic sources (such as motor vehicle dust fall-out), may have resulted in a minor ‘shift’ (increase) in what is considered ‘background’ over time.

In addition to natural or ambient sources, specific on-site activities or incidents may contribute to concentrations of chemical substances in soil and groundwater. Figure 1 provides a summary of the contributions to background concentrations.

Figure 1 Summary of contributions to background concentration



Adapted from the US EPA (1999)

The EP Act requires that background concentrations are established in order to ascertain if site contamination exists by definition. By establishing background concentrations, it can be

⁷ Defined in section 3(1) of the Environment Protection (Site Contamination) Regulations 2008.

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determined if the observed concentrations of chemical substances are due to on-site activities or are representative of natural or ambient conditions. By definition site contamination cannot exist if the chemical substances have not, at least in part, been introduced as a result of an activity at the site or elsewhere.

Determining background concentrations for a site

If an assessor does not establish the background concentration and consider that the background concentration for the chemical substance is zero, this is acceptable to the EPA. In this scenario any reported on-site concentration will by default be in excess of the background concentration.

How to determine which chemical substances may be present at a site

In order to determine background concentrations when assessing a site, it is necessary that chemical substances with the potential to have been introduced at a site are identified. The following must be undertaken prior to determining background concentrations:

- Information (in the form of a site history or preliminary assessment) must be sourced and documented to identify the past and current activities at the site to determine which chemical substances are likely to be present. These investigations must be undertaken in accordance with Schedule B(2) of the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM).
- Identification of the geology and hydrogeology at the site and in the vicinity of the site must be undertaken to determine the likely concentrations of naturally occurring chemical substances.

The assessor should also identify likely chemical substances that may be the result of activities that have occurred in the vicinity of the site.

Anthropogenic chemical substances

Chemical substances of anthropogenic⁸ origin occur in the environment as a result of human activity. Chemical substances that are indicative of anthropogenic activity can also occur naturally in some cases such as polycyclic aromatic hydrocarbons, an incomplete combustion by-product from bushfires.

If the chemical substance has the potential to be present as the result of a source in the vicinity of the site (ambient does not include a specific source) the assessor will need to consider the contribution from the source as well as the contribution from on-site activities.

The EPA considers that the background concentration of chemical substances that do not occur naturally in the environment is the laboratory limit of reporting, using a laboratory analytical method approved by the EPA.

Naturally occurring chemical substances

For chemical substances that may be present on a site as a result of an activity as well as being present in the environment naturally or as an ambient component, the assessor must determine the proportions of the concentration of the chemical substance that is attributable

⁸ 'Anthropogenic' is defined in the Macquarie Dictionary as 'being caused by humans'.

to background and the on-site concentration. This can be done through an assessment of the site and comparing the concentrations to values obtained in the vicinity of the site.

How to determine ambient background contributions

Ambient background contributions will typically need to be determined for metals in soil and waters.

Site-specific samples should be obtained in the first instance; if the assessor deems that the area surrounding the site and the site have been impacted by human influences thus making the determination of *natural background* impracticable, the assessor can undertake a determination of the *ambient background*.

The determination of the ambient background follows the same principles as for the natural background. An assessor will need to determine what contribution of the chemical substances at the site is related to the site activity and what proportion is a result of the ambient contribution. It may be necessary to collect additional samples over a wider area to demonstrate the ambient component. Examples of this are:

- If an assessor is determining background concentrations at a site for an activity of fuel storage, the assessor needs to determine the concentration of chemical substances associated with that activity.
- If the site is in an area that has been historically been filled, and the chemical substances identified associated with the specific site activity are not likely to be present in the fill material, the contribution of the activity is all of those chemical substances if detected. If there are likely to be concentrations of the chemical substances in the fill material it will need to be determined what contribution is attributable to the site.
- If an assessor is trying to establish the concentration of a diffuse chemical substance in groundwater (eg nitrate) and the site activity has been, for example, composting, the assessor will need to establish the concentrations of chemical substances in the groundwater in the vicinity of the site (ie. ambient concentration) and then work out the contribution of the chemical substance that is attributable to the site activity.

In determining ambient background the assessor must demonstrate the following:

- that the chemical substances of interest are present over a wider area than the site and in the vicinity of the site and are attributed to an activity
- the concentration of the chemical substances outside of the site, is similar to the concentration at the site

If the assessor deems that it is appropriate to use published concentration values, these must have been collected from the same environment and must be representative of the site that is being assessed. The EPA may be able to provide guidance on the existing data to be used. The types of data that may be used are data from neighbouring sites, data from government databases and published data in reference material.

Background sampling locations

Background sampling locations must be selected from areas that are not affected by the same activities at the site being assessed. Typically, samples will be collected from areas on the site or in the vicinity of the site that are unlikely to have been impacted by the chemical substances of interest. Information on suitable locations for background sampling should be obtained from site history information/preliminary investigations, or alternatively, published data.

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The EPA considers that background samples can be collected from reference sites that are not located near the site (eg remote sites) that is being assessed, providing these sites are:

- geologically similar and have similar biological, physical and chemical characteristics (eg particle size, percent organic carbon, pH) as the subject site
- must be located upgradient, upstream and upwind of the subject site.

However this needs to be assessed on a site-specific basis.

Soils

Background soil samples must be collected from areas that are relatively undisturbed, free of staining, have no odour and have not been used for the storage of chemical substances of interest or affected by migrating chemical substances. The EPA also requires that background sample locations should be selected that are topographically uphill and up wind of the site.

Soil samples must be collected from similar soil characteristics (lithology) and must be collected at the same time as the investigation samples.

The assessor has to select a reference site that is not likely to have the chemical substances of interest from the activity being assessed present. Whilst the EPA recognises locating of sites for the collection of background samples can be difficult, the following locations must be avoided if the chemical substances of interest are likely to be associated with the following activities;

- where potentially contaminating activities are suspected to have occurred (this includes areas that have received imported fill of unknown source and chemical quality)
- areas likely to be subject to fallout impacts from air pollutants from a defined source
- roads
- tracks or areas affected by railway runoff
- storm drains or ditches presently or historically receiving industrial or urban run-off; and
- car parks or areas receiving runoff from car parks.

The EPA has highlighted these activities as examples where the chemical substances associated with these activities are varied and it may be difficult to determine to the on-site contribution.

Sampling

Background samples must be collected using the same method(s) that was used to collect the samples for the site investigation. Similarly, background and investigation sample chemical analysis must be undertaken using identical analytical methods, and preferably by the same laboratories.

Samples must be collected, handled and transported to the laboratory in accordance with guidance provided in Schedule B (2) of the NEPM and the relevant Australian Standards.

Quality assurance and quality control procedures recommended in the NEPM and AS4482.1-2005⁹ must be followed, in order to allow for an assessment of accuracy and precision to be made.

Composite samples must not be collected for the purposes of determining background concentrations.

The EPA requires that all samples are taken in accordance with the NEPM and EPA guidance.

Groundwater

It is possible to determine background concentrations from the following methods:

- statistical analysis
- historic analysis of groundwater
- selecting a subset of the data that is assumed to have the natural composition of groundwater based on hydrological and geochemical tracers (eg old groundwater does not contain tritium, if the groundwater is demonstrated to be old, there may be no fresh recharge entering the system and as such the groundwater has not been impacted by the site activity).

Background wells must be completed in the same hydrogeological unit(s) as the aquifer being assessed at the site. Groundwater samples must be collected from the same aquifer unit by the same methods from wells that have similar completion.

Background wells must be located hydraulically upgradient of the site being assessed, and should be located as close as possible to the site being assessed. However there may often be a need to sample wells a distance from the site, especially if the ambient background concentration is being determined. Ideal locations include off-site natural areas, parks and residential neighbourhoods. These wells must be located in the same hydrogeological unit and be located hydraulically upgradient of the site.

Background wells must not be located within the area of influence of known or reasonably suspected on- and off-site contamination.

Sampling

All groundwater samples must be collected and analysed in accordance with the *EPA Guideline: Regulatory monitoring and testing: groundwater sampling*, and the relevant Australian Standards.

If available, previously published data can be used, however this needs to be assessed on a site-specific basis. If published or historical data is being used the assessor must ensure that these results are representative of the hydrogeological unit being assessed.

Surface water

It may be necessary to determine background concentrations of surface water at some sites. The EPA provides the following information in regards to the determination of background concentrations.

⁹ AS4482.1-2005 *Guide to the investigation and sampling of sites with potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds.*

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- Where possible samples must be collected upgradient of the area being investigated (eg upstream in a river).
- Any method used to determine the background concentrations of surface water must take into account the conditions of the surface water. It may be difficult to determine the background concentrations of a surface water environment that does not receive any flow (eg a closed lake system). In this scenario it is considered that if available, previously published data can be used. The EPA also considers that sampling of adjacent water bodies may be representative, however this needs to be assessed on a site-specific basis.
- It is important to recognise that storm events are likely to significantly impact upon the apparent concentration of chemical substances in water bodies. Ignoring any short-term contribution to the concentrations from sediment re-suspension in the water body itself, runoff from roads, drains, industrial and residential properties may elevate the concentrations of anthropogenic chemical substances to substantial levels in the short term prior to sedimentation.
- Consistent with good practice in sampling, information regarding weather must be obtained. Not only on the day(s) of sampling but within an appropriate time window prior to sampling, (eg detailing precipitation events and other variables). An appropriate suite of water quality parameters should be collected, consistent with the sampling approach eg Dissolved Oxygen (DS), Temperature, pH, Suspended Solids (SS), Total Dissolved Solids (TDS), etc.
- Note that the sampling protocol should be designed and implemented so as to provide data indicative of the background status of the water body.

Vapour

Site contamination may exist at some sites due to the presence of vapour from chemical substances. Vapours have the potential to migrate through the sub-surface and enter buildings.

The EPA considers that it is necessary to consider the presence of background concentrations of vapour when determining the background concentrations of chemical substances that have the potential to be present in a vapour phase. To be able to determine the vapour concentration that is present as a result of the activity it is recommended that sampling be undertaken in the sub-surface (eg soil and/or groundwater interface).

Background concentrations from site activities may be impacted by volatile chemicals commonly found in the home or found in local atmospheric emissions. For example, in urban areas air quality is often affected by multiple atmospheric emission sources. In addition, human activities (eg smoking, craft hobbies) or consumer products (eg cleaners, paints and glues) typically found in the home provide additional indoor vapour emission sources that can contribute to increased indoor air concentrations of some chemicals. In fact, there may be dozens of detectable chemicals in indoor air even in the absence of sub surface contribution.

There are also vapours that occur in the sub-surface as a result of the natural environment (eg methane). It is recommended that if there is an identified potential for concentrations of a chemical substance to be present as vapour in the environment, that the assessor determine the contribution from the natural environment in accordance with documented procedures using an appropriate soil gas sampling methodology. If a mathematical soil gas diffusion model is used to assist in the site assessment process, it is essential that the investigator proceeds to validate/test the model findings against empirical data obtained from soil vapour wells.

Interpretation of data

Effective and robust interpretation of data requires that once background samples have been collected and analysed, this information is interpreted to establish representative background concentration(s) for the subject site. This background data must then be compared with subject site data, in order to determine if site concentrations are elevated above background and hence, determine if site contamination exists at the site.

The EPA will not be approving specific methods for the determination of background concentrations and considers that the assessor must use a method that is valid and appropriate for the site that is being assessed. As the development of background concentrations is site-specific and there are a wide number of methods available for the determination of values the EPA will provide general advice on the types of data interpretation.

The EPA does not have to accept a determination of site contamination if it considers that the establishment of background concentrations and the site assessment have not been undertaken in accordance with the principles of the NEPM, guidelines issued by the EPA, relevant Australian Standards, or where inappropriate statistical techniques or inappropriate sample locations have been applied in the making of the determination.

Currency of this guideline

This guideline may be replaced, amended or updated periodically by the EPA to ensure that site contamination auditors and site contamination consultants are notified of, and provided with, updates of this guideline. Others should refer to the EPA website or contact the EPA for details of the most recent version of this guideline and other related publications

FURTHER INFORMATION

Legislation

Legislation may be viewed on the internet at: <www.legislation.sa.gov.au>

Copies of legislation are available for purchase from:

Service SA Government Legislation Outlet 101 Grenfell Street Adelaide SA 5000	Telephone: Facsimile: Internet:	13 23 24 (08) 8204 1909 < shop.service.sa.gov.au >
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