

## Assessment of background concentrations

Updated July 2018<sup>1</sup>

*EPA 838/18: This guideline has been issued by the Environment Protection Authority to describe the method for carrying out assessments of the presence of chemical substances in the vicinity of a site, so as to determine background concentrations of chemical substances on a site or below its surface as set out in section 3(1) of the Environment Protection Act 1993.*

### Purpose

The Environment Protection Authority (EPA) has issued this guideline to establish the way in which assessments are to be carried out to determine background concentrations as defined in section 3(1) of the *Environment Protection Act 1993* (EP Act). This guideline has been prepared for use by site contamination consultants (consultants), site contamination auditors (auditors) and certified site contamination practitioners (certified practitioners) who assess background concentrations.

The EPA publication [Guidelines for the assessment and remediation of site contamination \(2018\)](#) should be read and used in conjunction with this guideline.

The identification of background concentrations is an essential component of the determination of site contamination, as defined in section 5B of the EP Act. This document provides specific guidance for consultants, auditors and certified practitioners when undertaking the assessment of site contamination, including the quantification of background concentrations (if any) of any potentially affected media<sup>2</sup> of the environment<sup>3</sup> to facilitate an assessment as to whether site contamination exists as at a site<sup>4</sup>.

### Introduction

In South Australia, the EP Act provides for the issuing, by the EPA, of a guideline to describe the way in which assessments are carried out for the determination of background concentrations of chemical substances on a site or below its surface. Background concentrations is defined in section 3(1) of the EP Act, which states:

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<sup>1</sup> This guideline is an update to the EPA publication *Site contamination: determination of background concentrations (2008)*

<sup>2</sup> Potentially affected media is described in Schedule B2 of the [National Environment Protection \(Assessment of Site Contamination\) Measure 1999 as amended in 2013 \(the ASC NEPM\)](#)

<sup>3</sup> Environment is defined in section 3(1) of the EP Act

<sup>4</sup> Site is defined in section 3(1) of the EP Act

... background concentrations, in relation to chemical substances on a site or below its surface, means 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<sup>5</sup>.

Understanding background concentrations of chemical substances is important when characterising the degree of environmental harm<sup>6</sup>. For more information on the EPA's approach to the regulation of environmental harm in accordance with the EP Act, refer to the EPA publication, [Compliance and enforcement regulatory options and tools \(2009\)](#).

The EPA is the regulator of site contamination for the purpose of the EP Act, and regulates site contamination in accordance with the EP Act and EPA publication [Site contamination: regulatory and orphan site management framework \(2017\)](#).

## Background concentrations and activity

An adequate background concentration assessment should provide a consultant, auditor and certified practitioner with the baseline information of the amount of naturally occurring and ambient chemical substances in the environment. Such a baseline allows a determination of the amount of a chemical substance introduced to the environment from an anthropogenic activity<sup>7</sup>.

A background concentration assessment is the primary step in determining whether there is resultant environment harm and whether site contamination exists.

A site assessment requires the location of a relevant activity (including historical) to be identified. This is critical as it is commonly associated with the source site, and may be located on the same site under investigation (onsite) or outside the boundaries of the site (offsite). Irrespective of the location of the activity, the presence of the chemical substances that results from an activity, may result in site contamination at the relevant site. The chemical substances would be in concentrations greater than the background concentration<sup>8</sup>.

## Chemical substances in the environment

Geological and hydrogeological formations have and comprised naturally occurring chemical substances. These are commonly mineralogical based substances, for example metals and metalloids, and generally associated with soils and water<sup>9</sup>. The concentrations of such chemical substances will therefore be dependent on and/or influenced by topography, geology, geography and the physical, biological and chemical properties in the natural environment. In addition, in some instances, organic substances such as polycyclic aromatic hydrocarbons (PAHs) and hydrocarbons are naturally occurring in the environment. The concentration of each of the naturally occurring and undisturbed chemical substance is considered the natural background.

In some areas, chemical substances of anthropogenic origin may exist from widespread non-point source activities. Concentrations of these chemical substances in the environment, associated with non-point source activities, are commonly referred to as ambient concentrations<sup>10</sup>.

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<sup>5</sup> The statutory definitions of 'chemical substances' and a 'site' are provided in section 3(1) of the EP Act

<sup>6</sup> Environmental harm is defined in section 5 of the EP Act

<sup>7</sup> Activity is defined in section 3(1) of the EP Act

<sup>8</sup> The chemical substances will be in concentrations greater than the background concentrations

<sup>9</sup> Water is defined in section 3(1) of the EP Act

<sup>10</sup> Ambient concentration is generally described as the amount of a chemical substance that results from diffuse (widespread) or non-point sources contributed from anthropogenic activities (ie not attributed to industrial, commercial or agricultural activities).

Chemical substances can also be present as vapour, most notably measurable as soil gas in the subsurface (soils). Vapours have the potential to migrate through the subsurface and enter buildings or confined spaces (ie vapour intrusion). Some vapours can exist in the subsurface as a result of the natural environment (eg methane).

The EPA recognises the following conditions contribute to background concentrations of chemical substances in the environment:

- **natural** – the concentration of the chemical substance that occurs naturally (if any), and
- **ambient** – the concentration of the chemical substance (if any) that results from diffuse or non-point sources by general anthropogenic<sup>11</sup> activities not attributed to industrial, commercial or agricultural activities.

Therefore, when carrying out an assessment of the background concentration of chemical substances, it is essential to consider the conditions that contribute to background concentrations. National<sup>12</sup> and international<sup>13</sup> guidance describe the conditions that contribute to background concentrations, being the sum of natural and ambient concentrations of chemical substances in the environment.

## Carrying out assessment

The EPA acknowledges the complexities of and in some cases, the difficulties in undertaking an adequate background concentration assessment where an area of land or the environment has been subject to extensive anthropogenic activities (such as industrial/commercial land use areas).

Any assessment of background concentrations must be undertaken *in the vicinity* of the site insofar as this is reasonably practicable. Assessment is commonly undertaken at an up-gradient or up-wind location due to the behaviour and mobilisation of chemical substances in potentially affected media.

## Development of initial conceptual site model

Understanding the background concentrations of chemical substances is a critical component in developing an initial conceptual site model (CSM) for a site. The initial CSM provides an informed understanding of the nature and extent of the harm caused to the environment and can address any imminent risks associated with the harm, supporting any regulatory requirements for clean-up or remediation at the site. The initial CSM should be undertaken in accordance with Schedule B2 of the ASC NEPM.

It is fundamental to understand what other factors may contribute to the presence of chemical substances in the environment, in concentrations greater than background concentrations. Key factors for consideration when undertaking background concentration assessments include:

- the migration of chemical substances into or onsite
- the migration of chemical substances from on or offsite
- the (past and present) cadastral boundary of the site in respect to the area of where an activity was undertaken<sup>14</sup>.

<sup>11</sup> Anthropogenic is defined in the *Macquarie Dictionary* as 'caused by human beings'

<sup>12</sup> The ASC NEPM defines background concentrations as the naturally occurring, ambient concentration of a chemical substance in the local area of a site

<sup>13</sup> Review of some international policy and legislation identifies the importance of undertaking background concentration assessments. The definition of background concentrations in other international regulatory bodies (such as 'normal background concentrations' regulated by the Environment Agency in England and Wales), is commonly applied when assessing pollutants and environments that have been 'polluted'. The application of such international approaches are not applicable for the assessment of background concentrations of chemical substances in South Australia

<sup>14</sup> Historical aerial photography is a useful tool to consider previous land use of a site that is to be selected for background sampling

## Sampling

Representative sample collection is essential when characterising the background concentrations of chemical substances in any potentially affected media. Sample collection must occur at areas in the vicinity of the site that are not affected or influenced by the activity that may have caused or contributed to the presence or prevalence of a chemical substance in the environment.

Specifically for soils, composite sampling is not considered a suitable approach to determine background concentrations. Specific to sample collection of surface water bodies, samples must be collected up-gradient of the area being investigated, such as up-stream in a river.

The following sets out the minimum requirements for the collection of representative and reliable background concentration samples:

- a robust methodology for sample collection<sup>15</sup>
- a consistent and appropriate sample depth
- identification of chemical substances associated with activity<sup>16</sup>
- analytical assessment of samples using a consistent laboratory method<sup>17</sup>
- concurrent sample collection and analysis<sup>18</sup>
- well-documented quality assurance and quality control procedures
- collection from consistent geological formation (soils)<sup>19</sup>
- collection from consistent hydrogeological formation, and in particular aquifer units associated with the affected media
- collection from up-gradient and down-gradient locations.

A systematic approach for sample collection should be adopted, and should be preceded by the development of a sampling and analysis quality plan (SAQP) including an effective and robust data quality objective (DQO). This will support the collection of representative background concentration samples and provide reliable information to determine the existence of site contamination. Additional information for the appropriate collection of reliable samples is available in Schedule B2 of the ASC NEPM.

Collection of background concentration samples should occur concurrently with the sampling event required to characterise the degree of harm to the potentially affected media. This approach is considered practical and reasonable, and is cost and time effective in relation to accessibility and mobilisation to a site.

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<sup>15</sup> The methodology for the collection of background samples must be consistent with the methodology used to obtain other environmental data as a means of collecting a representative sample. Methodology refers to the following general sample collection requirements, such as drilling and installation methods, field sampling and sample preservation. For sample collection from any media, it is essential that the sample be collected using a consistent and appropriate sampling techniques.

<sup>16</sup> Activity is defined in section 3(1) of the EP Act

<sup>17</sup> The most current laboratory methods should be adopted. The best commercially available limit of reporting should be adopted

<sup>18</sup> Background concentration sample(s) must be collected and analysed at the same point-in-time the sampling of the affected media is undertaken

<sup>19</sup> Specifically for soils, for the purpose of determining background concentrations samples must not be collected from fill materials or disturbed soils (such as stockpiled soils). Samples must be collected in their natural state using an appropriate drilling methodology suitable to the type of media subject to assessment

## Use of published data

For the determination of background concentrations of soils and groundwater, it is possible to use previously published (historical) data which needs to be assessed on a case-by-case basis. If previously published data is being used, the practitioner must ensure that these results are representative of the media subject to investigation. Where necessary, clarification from the EPA or an auditor should be sought on the approach to undertaking a background concentration assessment.

## Confounding factors

In some environments, confounding sources of chemical substances influence the background quality to such a degree that it is extremely difficult to determine the amount of a chemical substance attributable to a point-source activity, rather than the ambient contributions of non-point source (widespread) activities. For this reason, it is essential that the development of the CSM is undertaken using a multiple-lines-of-evidence approach<sup>20</sup>. The CSM should be prepared in accordance with Schedule B2 of the ASC NEPM.

## Potentially affected media

### 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 the migration of chemical substances. The EPA also requires that background sample locations should be selected that are topographically uphill of the site.

It is important to select a reference site where the background sample collection is not likely to have been influenced or affected by the activity or chemical substances of interest<sup>21</sup>. While the EPA recognises the complexities and difficulties of locating an appropriate reference site, in order to obtain reliable and useable data the following must be avoided:

- sampling locations where potentially contaminating activities are suspected to have occurred (this includes areas that have received imported fill of unknown source and chemical quality)
- fill and re-worked natural soils
- areas likely to be subject to fallout impacts from air pollutants from defined point sources
- roads, railways and footpaths
- tracks or areas affected by runoff from sites where potentially contaminating activities have been undertaken
- open space land, storm drains or ditches currently or historically receiving industrial or urban runoff.

The EPA has highlighted these activities as examples where the chemical substances associated with these activities are varied and it is likely to be difficult to determine the extent of onsite contribution.

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<sup>20</sup> Refer to Schedule B2 of the ASC NEPM for information on undertaking assessment of site contamination using a multiple-lines-of-evidence approach

<sup>21</sup> In the absence of knowing the location of the activity, it is essential that the practitioner select a location for the collection of background soil samples unaffected by the chemicals of interest

## Groundwater

In relation to groundwater<sup>22</sup>, it is also important to have an understanding of the general water quality parameters. This information can assist in understanding the environmental value(s)<sup>23</sup> of the groundwater and the state of the chemical substances present in groundwater that may represent background concentrations or the contaminant plume (dissolved phase plume)<sup>24</sup>.

Background groundwater wells must be located hydraulically up-gradient of the site that is being assessed, and should be located as close as possible to the site that is being assessed. However, there may often be a need to sample wells some distance from the site, especially if the ambient background concentration is being determined. Ideal locations include offsite natural areas, parks and residential neighbourhoods. Background wells must not be located within the area of influence of known or reasonably suspected on and offsite contamination.

In addition, background groundwater 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 groundwater wells that have similar completion<sup>25</sup>.

## Surface water

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000* or AWQG, prepared by ANZECC and ARMCANZ provides a nationally consistent approach to the protection of and management of water quality for Australia and New Zealand. The *Environment Protection (Water Quality) Policy 2015 (WQEPP)* references the AWQG as the hierarchy document for the protection and management of water quality in South Australia. It is essential to understand, define and document the environmental values of surface water(s) in accordance with the WQEPP.

Understanding ambient influences on surface water is complex and requires a well-developed and informed CSM.

The EPA acknowledges the complexities associated with determining background concentrations in surface water environments. When assessing impacts or whether harm to water has occurred, it will be necessary to determine the background concentrations of the area affected. To achieve this, use of a control or reference site is essential. When undertaking a background assessment of the water quality of surface water environments, this should be undertaken in accordance with the guidance provided in the AWQG.

Furthermore, it may be difficult to determine the background concentrations of a surface water environment that does not receive any flow (for example a closed lake system). In this case if available, previously published data can be used. The EPA also considers that sample collection from adjacent water bodies may be representative, and this should be assessed on a case-by-case basis.

It is also required that information regarding weather is obtained as a means of understanding all influences and contributions to surface water bodies. Not only on the day(s) of sampling but within an appropriate time window prior to sampling (such as precipitation events, temperature and consideration of other variables). An appropriate suite of water quality parameters should be collected, consistent with the sampling approach, eg dissolved oxygen, temperature, pH, suspended solids and total dissolved solids.

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<sup>22</sup> Groundwater has a corresponding meaning to underground water. Refer to section 83A of the EP Act for regulatory requirements relating to the notification of site contamination of underground water

<sup>23</sup> Environmental value as described in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality or AWQG (ANZECC & ARMCANZ 2000). For additional information on environmental values of groundwater, refer to the EPA publication *Guidelines for the assessment and remediation of site contamination (2018)*

<sup>24</sup> For additional information in relation to sources of contamination and contaminant plumes, refer to the EPA publication *Guidelines for the assessment and remediation of site contamination (2018)*

<sup>25</sup> Refer to the EPA publication [Regulatory monitoring and testing – groundwater sampling \(2007\)](#)

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. Sufficient time gap between sample collection and a storm event should be undertaken by the practitioner. It is recommended that sample collection occur (as a minimum) one week following the cessation of a storm event. Greater time intervals may be required and should be assessed on a case-by-case basis.

## Background concentrations for the determination of site contamination

Due to the statutory importance of background concentration assessment, the following guidance is provided specific to the determination of the existence of site contamination at a site. The establishment of background concentrations is a core component in determining the existence of site contamination at a site.

The nationally recognised guidance for the assessment of site contamination is the ASC NEPM. The framework for the assessment of site contamination is outlined in Schedule A of the ASC NEPM. Guidance is provided in Schedule B2 of the ASC NEPM specifically the development and preparation of a preliminary site investigation (PSI).

Background concentration assessment is generally undertaken during the preliminary stages of site contamination assessment. Using the recommended process for the preparation of a PSI, a desktop study may provide an adequate assessment of background concentrations of chemical substances at a site.

Where insufficient or inadequate data is identified at the site history stage (such as historic non-representative data), it is likely that site-specific sample collection will be necessary. This is to be undertaken in accordance with the minimum requirements outlined within Schedule B2 of the ASC NEPM.

Following sample collection and analysis, review and updating of the initial CSM is necessary. Additional assessment may be required to further characterise the nature and extent of site contamination, using the tiered-risk assessment approach outlined in the ASC NEPM. For additional information on the assessment and remediation of site contamination refer to the EPA publication *Guidelines for the assessment and remediation of site contamination (2018)*.

## Background concentrations and vapour assessment

In some cases, indoor air sampling may be necessary to understand risk to human health from vapour intrusion. Vapour sampling should be undertaken in accordance with the Schedule B2 of the ASC NEPM, other relevant EPA publications, national and international guidance<sup>26</sup>.

If indoor air sampling is necessary to understand vapour intrusion to a potentially exposed receptor (human health), point-in-time sample collection using a multiple-lines-of-evidence approach is critical. Sample locations should, as a minimum, include subsurface soil gas in close proximity to the building, sub-floor coupled with indoor air sampling, and where applicable, outdoor air sampling. Sample collection methodologies and the selection of chemical substances for laboratory analysis must consider background indoor air quality and any confounding sources. Recording of other variables such as weather and particularly barometric pressure at the time of sampling is also recommended. Targeting chemical substances associated with the activity and site contamination from subsurface sources reduces ambiguity in interpreting chemical data.

## Accessibility and community engagement

It is recognised that sample collection from a private property can require extensive engagement with the property owners and can be quite intrusive, in particular for sensitive use<sup>27</sup> properties. In addition, implications on property owners

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<sup>26</sup> Refer to the EPA publication *Guidelines for the assessment and remediation of site contamination (2018)*

<sup>27</sup> Sensitive land uses is defined in section 3(1) of the Act

in relation to the EPA Public Register (section 109 of the EP Act) must be considered during the development of any sampling and analysis quality plan or SAQP.

For any matter where sample collection is required on land not associated with the site, it is recommended that a communication and engagement strategy be developed and implemented. The strategy should outline affected stakeholders, key messages, engagement approach, informed consent, the sample location plan and timeframes. For matters that relate to sampling on sensitive use property, it is recommended the EPA be identified as a key stakeholder for engagement.

Further information in relation to communication and engagement when undertaking assessment on and in the vicinity of third party land, refer to the EPA publication *Guidelines for the assessment and remediation of site contamination (2018)*.

## Disclaimer

This publication is a guide only and does not necessarily provide adequate information in relation to every situation. This publication seeks to explain your possible obligations in a helpful and accessible way. In doing so, however, some detail may not be captured. It is important, therefore, that you seek appropriate advice regarding your obligations, including legal advice.

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## Further information

### Legislation

[Online legislation](#) is freely available. Copies of legislation are available for purchase from:

Service SA Government Legislation Outlet  
Adelaide Service SA Centre  
108 North Terrace  
Adelaide SA 5000

Telephone: 13 23 24  
Facsimile: (08) 8204 1909  
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### General information

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