Environment Protection Authority

Ambient air quality assessment

South Australia

Ambient air quality assessment

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Disclaimer

This publication is a guide only and does not necessarily provide adequate information for every situation. It aims to explain your possible obligations in a helpful and accessible way. In doing so, some detail may not be captured. It is important, therefore, that you seek information from the EPA directly about any obligations and, where appropriate, that you seek your own legal advice.

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Abbreviations

Air EPP	*Environment Protection (Air Quality) Policy 2016*
BATEA	best available technology economically achievable
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EIP	environment improvement plan
Emissions Manual	*Emission testing methodology for air pollution, Version 2* (2012)
EMP	environmental management program/plan
EP Act	*Environment Protection Act 1993*
EPA	South Australian Environment Protection Authority
GED	general environmental duty
GLC	ground level concentrations
GPS	global positioning system
ISC model	industrial source complex model
MM5	Mesoscale Meteorological Model version 5
NATA	National Association of Testing Authorities
PEPR	programs for environment protection and rehabilitation
QA/QC	quality assurance/quality control
STP	standard temperature and pressure (0ºC and 1 atmosphere of pressure)
TAPM	The Air Pollution Model
VOC	volatile organic compound
WRF	Weather Research and Forecasting

Summary

This publication has been developed to support assessment of ambient air quality under the *Environment Protection Act 1993* (EP Act), for which the EPA is the primary regulatory body, and the *Development Act 1993*, for which the EPA is a referral body for certain categories of developments.

The document outlines approaches and methods for obtaining information that best facilitate the EPA's assessment of a proposal, to minimise assessment times and costs associated with meeting regulatory requirements for ambient air quality. It also aims to assist people with choosing private sector practitioners on the basis of relevant and appropriate levels of skills and experience to undertake the work, and with understanding the types of information needed in related reports and submissions to the EPA.

Larger organisations with in-house testing and laboratory facilities should also find this document useful for setting up their own internal air quality programs. This document also provides the wider community with information about how the EPA assesses impacts of activities that may affect them.

An important principle is that reports should be signed off by qualified experienced practitioners (for example, senior private-sector consultants) and relevant senior authorities from within an organisation.

There are different tools for evaluating air quality impacts of proposals: atmospheric modelling and monitoring, with an emphasis on adverse effects on human health and wellbeing and, where appropriate, impacts on vegetation, within the context of economic and social factors. However, other information such as performance of similar processes elsewhere and local complaints data, may also be relevant.

1 Introduction

Ambient air quality continues to be a major environmental and community health concern within South Australia.

Ambient air refers to the air in the general environment in which we live, whether within the Adelaide metropolitan area, a regional town, an industrial centre or in a rural setting. The quality of the air we breathe may be affected by urban developments, transport emissions on major roads, industrial and agricultural activity, or by domestic sources of pollution.

It is now generally accepted that exposure to air pollutants over time is associated with adverse health effects. Even in Australia's relatively clean urban areas there is increasingly robust evidence to show that pollution normally present in our urban communities is associated with heart and respiratory disease, representing substantial suffering and significant economic costs to our society (NEPC 2011). Improving air quality will lead to better health outcomes.

The EPA plays a strong role in evaluating ambient air quality through long-term monitoring that supports various strategic management programs. However, at times, more localised issues require a focus on particular activities and sources and, in some instances the EPA will require monitoring and modelling to quantify the potential or actual effects of emissions on people living nearby.

There is a range of approaches for assessing ambient air quality, of which atmospheric dispersion modelling, emissions inventories and air monitoring are important tools. The EPA's processes are essentially the same, whether assessing new activities at the design stages or modifications to existing processes.

Atmospheric modelling is probably the tool most utilised for initial evaluation of emissions from activities and their effects, especially for residential communities. In some cases, monitoring is also required, particularly where background levels of a pollutant need to be determined, with follow up after commissioning of a facility. For example, in addition to modelling, proponents of mines near towns may be required to provide monitoring of background particle levels over a minimum period of 12 months, so their net impacts can be assessed after operations commence.

1.1 Regulatory environment

The EPA is the primary regulatory body for the *Environment Protection Act 1993* (EP Act), and also has responsibilities under the *Development Act 1993* as a referral body for certain categories of developments.

The EPA issues licences for activities scheduled under the EP Act, which may impose conditions requiring ambient monitoring, modelling studies and emissions testing. In addition to conditions under licences, section 25 of the EP Act defines a general environmental duty (GED) as taking all reasonable and practical measures to avoid causing environmental harm.

Environmental harm is defined under section 5 of the EP Act as including harm, potential harm and environmental nuisance. Harm is further categorised as **material or serious environmental harm**, according to the nature and scale of its impacts.

From an air quality perspective, **environmental harm** is caused by air pollutants having toxic or adverse effects on human health or the environment. Effects may be long term (for example, chronic cardio-respiratory conditions) or short term (for example, irritation of eyes and nose and triggering of asthma).

Environmental nuisance is often caused by odours or dust that interfere with the amenity of affected communities. Odours may be obnoxious, causing immediate discomfort. However, sometimes more pleasant odours become unpleasant to people because they are exposed continuously. Dust may be visible as clouds and can deposit on surfaces, such as window sills and doorsteps, or cause soiling of clothes.

The GED can be effected through mandatory provisions of policies and environmental authorisations—in the case of air quality, the *Environment Protection (Air Quality) Policy 2016* (Air EPP) that incorporates a range of ground level concentrations, odour criteria and in-stack concentrations for assessing impacts of a wide range of air pollutants.

This publication forms part of a suite of EPA guidance documents that should be read together to assist owners and operators of facilities with meeting their regulatory requirements for air quality and with understanding what is required for submissions for proposals referred to the EPA under the *Development Act 1993*.

Other relevant information can be found in the following documents:

- *Emission testing methodology for air pollution*, Version 2 (2012)
- *Evaluation distances for effective air quality and noise management* (2016).

Please note: This publication supersedes three previous guidelines: *Odour assessment using odour source modelling* (2007), *Presentation of air pollution modelling outputs* (2005) and *Air quality impact assessment using design ground level pollutant concentrations (DGLCs)* (2006).

1.2 Purpose

This document outlines methods and approaches to facilitate assessment of proposals with minimal delays. The EPA takes a risk-based approach to protecting the environment, in balance with social needs, sound business and economic development targets. Submissions and supporting information should supply evidence demonstrating that a proposed development will not have adverse impacts, for example, by compromising environmental criteria recognised by the EPA.

Much of the information is designed to assist companies who want to engage private sector consultants, so they can have confidence that those consultants are qualified and experienced practitioners in ambient air quality assessment. However, larger organisations with in-house testing and laboratory facilities would also find it useful for setting up their own internal air quality assessment programs. It will also inform members of the wider community about the processes and standards set out by the EPA to assess how activities may affect them.

Other government agencies may, at times, refer to this guideline for advising on or regulating those activities that fall within their jurisdiction.

Industry, government and air quality practitioners can also use this information to develop programs to:

- determine effects of activities on air quality and demonstrate compliance with regulatory requirements
- show their responsibility as corporate members of the local community
- monitor plant performance, enabling the business to be managed in an environmentally responsible manner, eg in going ‘beyond compliance’ for regulatory requirements
- provide a basis for design and implementation of clean technology systems and identify waste minimisation opportunities towards savings in materials, energy and, ultimately cost.

1.3 Reports and submissions

The EPA has a continuing commitment to assess submissions as soon as possible, so this document sets out how best to present information in a proposal. This includes methods, protocols, comparisons against relevant criteria, quality processes that should be used and the range of supporting information needed for reports. It is important that reports are based on these principles and signed off by qualified and experienced senior practitioners.

Some general principles are discussed as follows:

- Poor quality reports and incorrect or unsupported information may prompt the EPA to request further information, or clarification of results or underlying assumptions. This, in turn, may cause unnecessary delays to approvals, most likely creating additional costs for the proponent who is paying for the service.
- If a proponent is unsure about this reporting process, the EPA strongly recommends that they discuss their concerns with the relevant EPA coordinator or environmental assessment officer as soon as possible. In particular, proposed variations from available standard methods, practices and procedures need to be discussed with the EPA.
- The EPA does not make recommendations about the services of specific private practitioners, or become involved in commercial arrangements between proponents and their practitioners. Accordingly, the EPA strongly advises proponents to undertake a full evaluation of the capabilities of prospective practitioners.
- Proponents may make use of the capability statement template in Appendix 1, which outlines the kinds of skills, qualifications, experience and, importantly, relevant accreditations that demonstrate strong capabilities in monitoring and/or modelling.

- As indicated in the template, an important expectation is that practitioners have National Association of Testing Authorities (NATA) accreditation or equivalent (in other words, internationally recognised accreditation against AS/ISO IEC 17025), for the monitoring methods they are to perform. The accredited practitioner should also sign off on reports. In the case where no accredited practitioner is available, the EPA expects the monitoring and reporting will still comply with a quality system, as detailed in AS/ISO IEC 17025.
- As air quality modelling does not have an accreditation process at this time, modelling reports need to be signed off by an experienced senior modeller.
- Where there is no accredited method identified in this document, proponents should discuss possible approaches with the EPA.
- Sound workplace health and safety systems are essential for the practitioner to manage risks associated with air quality assessment, especially where onsite installations and servicing of equipment are required.

2 Risk-based air quality assessment

The EPA takes a risk-based approach to protecting the environment, in balance with social needs, sound business and economic development targets. There are different tools for evaluating air quality impacts of proposals: atmospheric modelling and monitoring, with an emphasis on adverse effects on human health and well-being, and where appropriate, impacts on vegetation, within the context of economic and social factors. However, other information such as performance of similar processes elsewhere and local complaints data may be applicable to assess the level of risk.

To demonstrate that no adverse effects will occur at ground level due to emissions from a proposed or existing facility, owners/operators or proponents of facilities should initially use appropriate conservative models to predict the maximum ground level concentrations (GLCs) of pollutants. In some instances, results of modelling may indicate the need for further investigation of ground level impacts, including monitoring.

Owners/operators or proponents are required to demonstrate that these maximum concentrations are less than the GLCs of pollutants specified in Schedule 2 or odour criteria in Schedule 3 of the Air EPP at sensitive receptor(s). The GLCs are levels of specific pollutants or odours, below which environmental risk can be considered to be acceptable.

Odour criteria in Schedule 3 of the Air EPP are population dependent due to the increased likelihood that sensitive individuals in the exposed communities will be affected and raise odour complaints.

Nuisance dust has no specific concentration criteria as they generally create visible pollution or form deposits on surfaces or soiling clothes, rather than causing health effects. As they are so visible, they often cause complaint and the focus is therefore on control and management systems that effectively prevent or mitigate offsite impacts.

The general environmental duty (GED), defined in section 25 of the EP Act, may be applied to avoid environmental nuisance through the use of ‘best available technology economically achievable’ (BATEA) and dust management plans (DMPs). The GED requires that operators take all reasonable and practical steps to minimise impact at the ground level, which may include developing environmental improvement programs in achieving compliance with GLC or acceptable level of risk from their operations.

GLCs adopted under the Air EPP may be based on public health or amenity or may relate to other environmental values, where applicable. For example, certain types of vegetation, such as grape vines, require more stringent controls on fluoride compounds than have been found necessary for protection of human health. Safety factors are built into each GLC to provide an added level of protection for sensitive members of the community such as children and the elderly.

It is expected that existing ambient background concentrations of pollutants are also included into the assessment process, so that total concentrations of specific pollutants are less than their respective GLC. Where applicable, these background concentrations can be based on data from the nearest EPA monitoring station, modelled background levels, baseline monitoring performed for the project or advice from the EPA given on a case-by-case basis.

For pollutants other than those listed in the Air EPP, the proponent is required to:

1 conduct a peer reviewed literature search to propose an appropriate GLC to the satisfaction of the EPA, or

2 demonstrate to the satisfaction of the EPA that the pollutant has no health, environmental or amenity impacts at ambient concentrations likely to be generated by the activity.

Further guidance on assessment approaches to modelling, monitoring and environmental nuisance is provided in relevant sections of this document. The document also outlines approaches and methods to obtain information that best facilitate the EPA’s assessment of a proposal and minimise assessment times and costs associated with meeting regulatory requirements for ambient air quality.

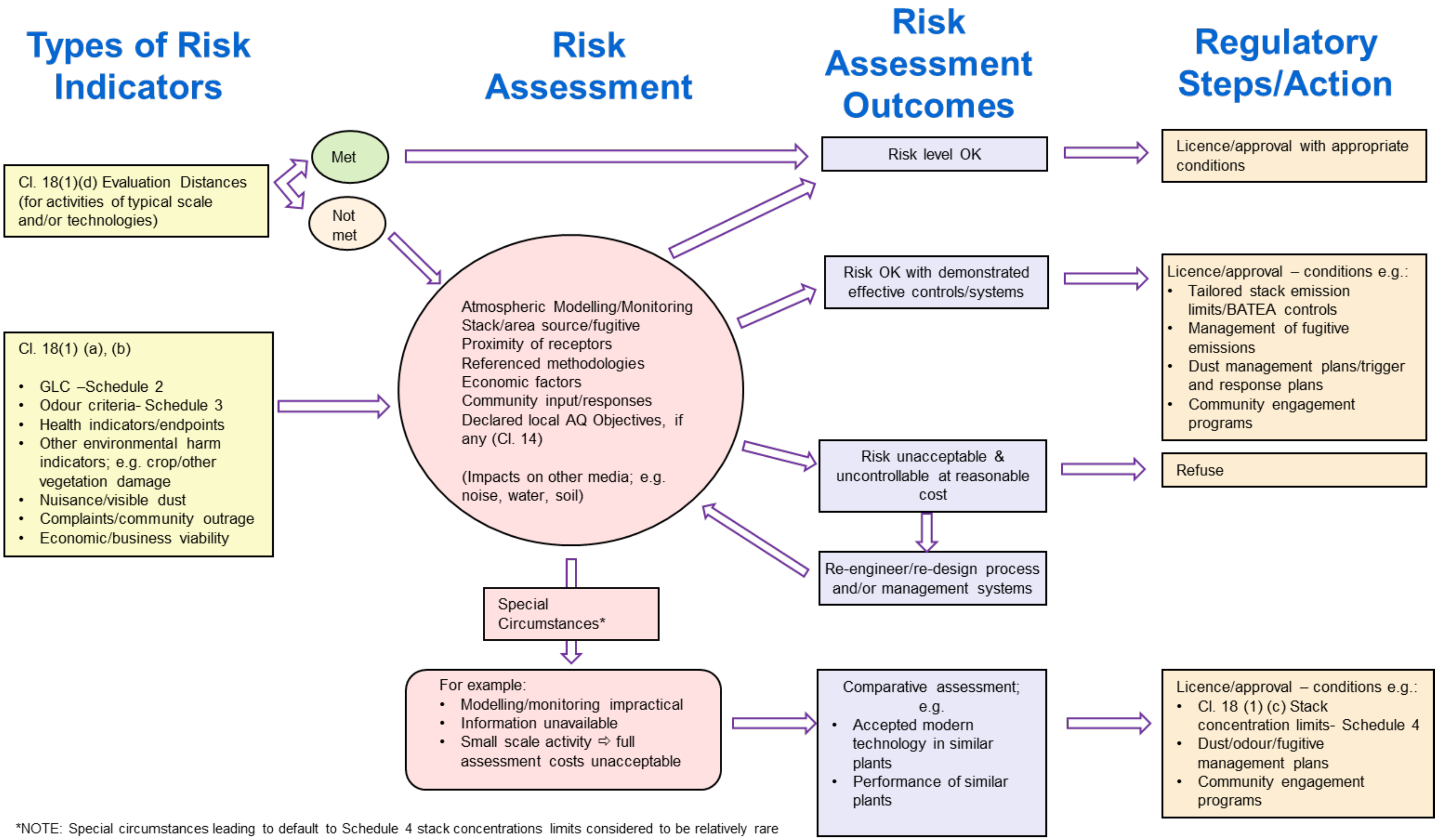

Figure 1 Outline of the EPA's risk-based approach for air quality assessment

3 Modelling

3.1 Introduction

Ambient air quality modelling, in conjunction with monitoring, plays an important role in assessing existing and potential risks to air quality, particularly as part of an initial assessment of new developments. The first step in undertaking air quality modelling is to clearly define the objectives and expected outcomes. This can be done by addressing questions such as:

- What is the reason for the air quality modelling?
- What questions need to be answered by modelling work?
- What pollutants or environmental indicators need to be modelled in order to provide the information required?
- What data and information are already available and how can these help?
- What considerations need to be made about background concentrations of pollutants?
- What type of pollutant source/s need to be modelled?
- What are the geographical features near the pollutant source/s?
- How is the modelled data best utilised and reported to describe the issues under investigation?

3.2 Low-risk atmospheric release

In general, the need for pollutant dispersion modelling may be waived at the discretion of the EPA if it can be shown that:

- the emission is released from a single point source and contains a concentration of a pollutant no more than 100 times the ground level concentration (GLC) at the discharge point. Refer to Emissions testing methodology for air pollution (Emissions manual)
- the emission will be discharged from a stack (point source) that:
  - is at least 3 m above the highest point within a 30-m radius
  - has a discharge velocity no less than 10 m/s
  - does not have a conical or similar rain protector that interferes with the upward exit flow
  - is demonstrated to be compliant through monitoring
- the proposed facility exists within flat terrain with no unusual meteorological factors. Note: a flat cut made into the side of a hill is not 'flat terrain'.

Proponents (or their nominated practitioners) are advised to discuss with the EPA, projects requiring assessment using air quality modelling before commencement. Please refer to Appendix 1 for the selection of an air quality assessment practitioner.

3.3 Accepted modelling approaches

Important stages for assessment using air quality modelling are:

- emissions inventory development
- consideration of meteorological and terrain effects
- modelling using suitable dispersion models
- airshed approach (if considering cumulative impacts)
- validation of air pollution modelling output
- presenting air pollution modelling results.

3.3.1 Emissions inventory

An emissions inventory provides estimates of pollution from all sources within a region or airshed. It provides a critical basis for atmospheric dispersion models, which predict impacts of emissions at ground level. Broader airshed inventories assist with understanding and managing the impacts of air pollution on the environment over the long term. The development of accurate emissions inventories is a key foundation for good air quality modelling and assessment.

A good emissions inventory comprises:

- source configuration or release type
- location
- air pollutants identified, along with their emission or release rates.

3.3.2 Source configuration

Point source: A point source is a single identifiable source of air pollutants released from a chimney stack or equivalent structure. A point source can be characterised by the height and diameter of the stack, and a flow rate of gases leaving the stack. Stack monitoring results provide necessary data to characterise point-source emissions.

Line source: A line source is where pollutants are emitted over an extended length. These can be, for example, from ridge vents on a factory, exhaust from traffic on a major road or a series of point sources along a line. For line sources, pollutant emission factors are presented as grams per unit length (g/km) and emission rates in grams per second (g/s).

Area/volume source: Area sources emit pollutants across an extended area which could, for example, be a stockpile, waste dump, landfill or wastewater lagoon. Emission generally occurs near ground level, with little or no plume rise, so it tends to disperse in two dimensions—that is, it does not move upwards very much. Emission is characterised as an emission rate per unit area ($g/m^2/s$) rather than as total emission.

Volume sources are used to simulate emissions that initially disperse in three dimensions with no plume rise, such as emissions from coke batteries, building vents, conveyor transfer points, screens and crushers, and truck loading/unloading facilities. For characterising volume sources, it is important to consider horizontal and vertical plume spread separately from release height. Many fugitive pollutant sources can be modelled either as area or volume sources.

Location: Geocodes of source (in metres) should be obtained from a map of the local region or engineering drawings for the proposed/existing facilities (for example, GPS coordinates for the location).

Emission rates: Source emission rates can be estimated by:

- considering engineering estimates or by performing mass balance calculations for pollutants
- direct measurement of sources in accordance with the Emissions manual
- emission factors available from either the National Pollutant Inventory (NPI) Emissions Estimation Technique Manuals or the US EPA's AP 42 Emission Factors.

3.3.3 Meteorological and terrain/building effects

Dispersion modelling requires the most recent representative meteorological data, best achieved by collection from a site in close proximity to an emission source. Site-specific data, if available, is preferred. Otherwise, representative data from the Bureau of Meteorology may be used. Where neither is available, a proponent may be required to collect a minimum of 12 months of site-specific meteorological data. In cases where suitable meteorological data is not available, suitable data files can be generated through recommended prognostic models (TAPM, MM5 or WRF).

For example, TAPM uses databases of terrain, vegetation, soil type, soil moisture content, sea-surface temperature and synoptic scale meteorological analyses (six-hourly data with 75 km resolution) to predict local meteorological parameters in three dimensions suitable for dispersion modelling.

Dispersion modelling software, such as Ausplume, AERMOD or Calpuff, requires information regarding the terrain and buildings surrounding emission source/s if they are present. This information should be included in input files for air quality modelling.

3.3.3 Suitable dispersion models

Once the emissions inventory is developed, the GLCs of pollutants can be predicted by modelling the complex interactions between:

- physical characteristics of the emission source
- physical and chemical characteristics of the pollutants
- meteorological parameters at, or near, the site
- local geographical features, including land contours and the built environment.

Pollutants are transported in the atmosphere both vertically and horizontally by wind and gravity forces on air parcels, while mixing and diluting in the air. Dispersion models simulate the dispersion and interaction of pollutants in air using mathematical equations based on atmospheric physics. The following dispersion models provide suitable performance in most circumstances. However, this field is always developing, and it is advisable to discuss requirements with EPA specialists.

Ausplume

Ausplume (version 6.0) is one of the simplest models that can be used for undertaking local air quality assessment. It is a model developed by EPA Victoria as an extension of the US EPA ISC model for plume calculation procedures. Ausplume is only suitable for simple applications and may not be useful for complex terrain or large changes in meteorological conditions (such as coastal or terrain effects resulting in cold-air drainage).

AERMOD

AERMOD is a new generation Gaussian plume dispersion model developed by the US EPA. The model is an improvement on Ausplume in that it incorporates recent boundary layer theory and advanced methods for handling:

- terrain
- dispersion under stable and unstable conditions
- plume rise and buoyancy
- plume penetration into elevated inversions
- treatment of elevated near-surface and surface-level sources
- computation of vertical profiles of wind
- turbulence
- temperature
- terrain effects on plume behaviour.

AERMOD also includes algorithms to take into account the effects of any buildings near the emission source/s. EPA Victoria has recently changed its preferred regulatory model from Ausplume to AERMOD.

Calpuff

Calpuff is a multi-layer advanced puff dispersion model that can simulate the effects of meteorological conditions on pollutant transport varying with time and space. It focuses on the behaviour of parcels of gases (‘puffs’) emitted from a source. It is generally considered suitable for conditions such as coastal fumigation, cold-air drainage or a location with complex terrain.

TAPM

The Air Pollution Model (TAPM) was developed by the CSIRO to simulate three-dimensional meteorology and pollution dispersion in areas where meteorological data is sparse or non-existent. The modelling system contains a number of dispersion models, including:

- a particle/puff dispersion model for dispersion from point, line, area and volume sources
- a three-dimensional grid-point model for urban air pollution studies, which allows for plume rise and building wake effects, wet and dry deposition, and photochemistry for urban airshed applications.

3.3.4 Other models for special circumstances

Some particular emissions or sources are best addressed using specialised models. These include the following examples.

AusRoads

Motor vehicle emissions or traffic emissions are major contributors of hazardous pollutants in urban airsheds. AusRoads determines maximum ground level pollutant concentrations due to traffic emissions. The model is used routinely in Victoria to assess air quality impacts against air quality objectives.

AusRoads was developed by EPA Victoria and it is based on the algorithms developed for the CALINE4 roads model used to assess the impact of road emissions for some years in the US. AusRoads is a simple line source Gaussian plume dispersion model that predicts the near-road impact of vehicle emissions in relatively uncomplicated terrain and within a few hundred metres of the road.

SLAB

SLAB is used where emissions of materials that are denser than air, are released from a ground level evaporating pool, an elevated horizontal jet, a stack or elevated vertical jet, or an instantaneous volume source.

Dispersion is calculated based on the principles of conservation of mass, momentum, energy and species. The mathematical description of the physics of heavy gas dispersion and normal atmospheric advection and turbulent diffusion processes are inherently included in the mathematical equations. Development of the SLAB model was supported by the US Department of Energy.

It is recommended that practitioners use the latest version of these dispersion models. Other dispersion modelling software and guidance documents can be electronically downloaded free of charge from the US EPA website at www.epa.gov/ttn/scram/.

3.4 Protocol for selecting new air quality models

Where possible, the models listed under section 3.3.3 of this document should be used. If a different model is considered appropriate, practitioners should discuss this with the EPA and demonstrate that the model:

- provides appropriate applicability, outputs and performance required to characterise impacts of emissions
- has support in, for example, the peer-reviewed literature and well-designed validation studies
- has been benchmarked against existing approved models as shown by validation studies
- has support within other jurisdictions or international authorities.

3.5 Airshed modelling for cumulative impacts

An airshed is a part of the atmosphere that behaves in a coherent way with respect to the dispersion of emissions where pollutants can be trapped and have a cumulative effect in terms of their impact on the environment. An airshed will likely have several existing sources of the pollutant concerned, including a natural background level.

At an airshed level, the assessment of pollution is expected to be undertaken by modelling emission sources at both the micro- (<1 km from source) and meso- (up to 10 km from source) scale.

Airshed modelling is required for an assessment when multiple sources of an air pollutant are present up to 10 km from the source of interest and where cumulative effects may need to be considered. Airshed modelling requires an advanced modelling package such as Calpuff or TAPM, as discussed in section 3.3.3 of this document.

In the absence of emissions data from all sources within an airshed, it is expected that a suitable ambient background concentration of pollutants be included to reflect the cumulative impact. These background concentrations can be either based on data from the nearest EPA monitoring station or background monitoring performed for the project.

Air quality practitioners should contact the EPA to discuss and clarify whether a given project or proposal warrants the airshed modelling approach.

3.6 Presentation of modelling inputs and outputs

Information should be provided about the inputs used for a model. For example, for emissions inventory data fed into the model, it is essential to provide:

- all release parameters of stack, line, area and volume sources including temperature, exit velocity, stack dimensions, flow rate, moisture content, pressure, carbon dioxide and oxygen concentration
- pollutant emission concentrations and a comparison against the requirements of the Air EPP (if applicable)
- location of source
- calculation procedure if emission rates are estimated by emission factors
- any assumptions made in deriving emission rates
- input/output files and reporting requirements.

In addition, it is essential that air pollution modelling results are supported by:

- a description of the input data including source of data, references if literature values are being used, validity of data and any assumptions
- discussion about the accuracy of results and comparison with appropriate criteria
- the source of meteorological data and detailed analyses including wind-rose plots at the location identifying prevailing wind directions, with analyses of worst-case meteorological conditions
- a map of pollution contours
- an electronic copy of all input files required to run the model
- a hard or electronic copy of the output text file.

Averaging period: Averaging period of pollutant concentrations predicted by a model should correspond to the relevant air quality criteria.

A backdrop for contour plots: All plotted contours should be overlaid onto a current aerial photograph, topographic map or street map. The source site and closest sensitive receptors should be highlighted. Large residential areas can be shown as a single receptor. Emission source locations should be displayed on the pollution contours.

Scale: The scale selected should be appropriate for displaying ground level effects. For normal single-point sources, a scale of 1:10 000 is generally adequate. If impacts are more regional, a scale of (up to) 1:100 000 may be required. The scale selected should show all relevant ground level impacts, and should be shown as part of the output, with labelled axes and a separate scale bar.

Gridlines: The eastings and northings used in presenting the modelling output should conform to a recognised geodetic system (currently WGS 84 and GDA 94). The chosen geodetic system should be stated as part of the output. The map should clearly display the 'north' direction.

Contours: The selected contours should adequately display the results of the modelling. The number of contours should be kept to a minimum and be distributed evenly over the whole plotted area. All significant contours should be labelled. Critical isopleths such as concentrations exceeding GLC criteria need to be highlighted.

All plots should have correct titles and descriptions adequately showing the modelling conditions and modelling output. Where this would yield an overly long title, the full information should be given in the body of the report.

Top hundred table: The modelling output data should include the top hundred (of all predicted values) GLCs to identify where the highest concentrations are predicted. In practice, this means the top hundred GLCs outside the source(s) and at a location where a sensitive receptor/s is identified.

4 Environmental nuisance

Odour and nuisance dust are the two more prevalent sources of environmental nuisance in relation to air quality. This section provides guidance on the management of odour and nuisance dust emissions, particularly for new or expanding developments—specifically the use of computer modelling and the determination of appropriate separation distances. There is also a subsection offering advice about best practice for odour measurement in the field.

4.1 Nuisance dust and odour

Air quality nuisance criteria in South Australia are based in principle on compliance with the general environmental duty (section 25 of the EP Act) to avoid environmental nuisance using ‘best available technology economically achievable’ (BATEA).

Unlike odour, environmental nuisance from visible dust has no specific concentration criteria, and management is focused on mitigating off-site impacts, which are often detected through public complaints. Operators must take all reasonable and practical steps to minimise such impacts, which may include physical barriers, watering sprays, vegetation or chemical stabilisation, and routine vehicle washing may reduce the amount of dust carried off-site by trucks.

Dust management plans are an important, often essential, tool for managing off-site impacts of dust. They may include relatively simple requirements for observing and managing dust raising by equipment or sophisticated systems based on monitoring and well-designed trigger levels for actions to reduce the severity of an episode or even predict when an episode is likely (for example, during high winds), so that proactive steps can be taken to avoid off-site impacts.

Odour criteria are population dependent. As the population density increases, this increases the possibility of sensitive individuals, which raises the potential for odour complaints, and more stringent criteria are necessary. These criteria are now included in Schedule 3 of the Air EPP.

The predicted odour levels (three-minute average) must not exceed the odour criteria 99.9% of the time at sensitive receptors, noting that this does not include houses on the property associated with the activity. Differing situations may require the use of more than one criterion, so good judgement may be required to determine the best criteria to use.

4.2 Odour emission measurement or estimation

There are currently no instrument-based methods that can measure an odour response in the same way as the human nose. Dynamic olfactometry, as it is known, is the basis of odour management and is the method approved by the EPA. Dynamic olfactometry is the measurement of odour by presenting a sample of odorous air to an independent panel, in a range of dilutions, and seeking responses from the panellists about whether they can detect the odour. The correlations between the known dilution ratios and the panellists’ responses are then used to calculate the odour measurement of the sample, referenced against n-butanol. The units for odour measurement using dynamic olfactometry are ‘odour units’, which are dimensionless and are, effectively, ‘dilutions to threshold’.

There is a rigorous definition of **odour threshold** as it applies to odour emissions measurement in the Australian Standard: *AS/NZS 4323.3:2001—Stationary source emissions: Determination of odour concentration by dynamic olfactometry* (Standards Australia 2014). See also the EPA’s Emissions Manual for the testing methodology.

For a practical understanding, the odour threshold can be thought of as a concentration at which about of the people can detect the odour from a material. In turn, if an odour is present at one odour unit, about 50% of people will not be able to smell it, but the other 50% or so will still be able to detect an odour. Further, it is noted that the threshold measured in this way is a **detection threshold**. In other words, people may be able to detect an odour, but may not be able to recognise it.

In addition, **dilutions to threshold** implies diluting the odorous air sample until 50% of the panel can detect it. This simple odour panel measurement does not provide information about how obnoxious or pleasant the odour may be. Some more sophisticated approaches aim to do this, but the EPA’s criteria focus on whether an odour can be detected (and the data displayed in odour units). This is reasonable, given that some odours, which may be pleasant in short bursts, can become highly irritating to people who are exposed to them 24 hours each day.

When undertaking practical measurements of ambient odour, one of the hand-held, one-person olfactometers (diluters) is a quick way to gain information about the source, character and strength of an odour during an odour event, and can be effected at the house of a complainant

Odour assessment methods

The modelling process should not be seen as obviating the need to adopt a BATEA approach to process or emissions control, where there is a risk of adverse environmental impacts. Modelling should not be the only method used to assess the potential odour impacts of a development. Other tools include:

- complaints history
- previous practical experience with the activity or similar activities
- consultation outcomes
- community odour diaries and surveys
- assessment of emission control proposals.

Odour perception within a community can vary widely. Care should be taken while assessing modelling outputs against relevant criteria. Odour modelling should be undertaken by experienced and suitably qualified air quality assessment practitioners (see Appendix 1) using suitable dispersion models, as described in section 3.3 of this document.

In making an odour assessment, the number of people in a defined area or cluster should be determined. Also, differing situations may require the use of more than one criterion.

Management of odorous industries/facilities

The overall objectives in the management of odorous industries or facilities are to:

- minimise odour emissions and their impacts
- ensure that the proposed industry or facility does not expose neighbouring land-users to an unacceptable level of odorous emission
- ensure that the industry continues to operate in such a manner that the odour emissions are managed within the accepted criteria
- apply principles of ongoing risk evaluation and management, given the evolving understanding of odours and their potential health effects.

5 Ambient monitoring

Ambient monitoring may be required in some cases to assess background concentrations of a pollutant and/or to assess net impacts of an activity on human health or the wider environment. Monitoring programs may be established to understand long-term impacts of an activity on air quality and consequent risks to nearby communities.

Results of monitoring may be used to inform licence conditions, for example, for in-stack emission limits, designed to reduce risks for residential communities, or susceptible crops or native vegetation. Monitoring can also help to improve the accuracy and utility of atmospheric models at specific ground level sites.

Monitoring may also be used to assist a facility to manage its off-site impacts from dust and fine particulate material (PM_{10} and $PM_{2.5}$) on a nearby township or residential area. Pollution monitoring around an activity is normally accompanied by meteorological monitoring, most commonly wind speed and direction. This provides additional information for determining emission sources and under what wind conditions off-site impacts occur. In turn, this information can provide operators with triggers for managing events or even for predicting conditions under which pollution episodes may occur so they can take proactive action to avoid off-site impacts.

Therefore, although not widely used in regulatory situations, ambient monitoring can be seen as one of many tools to assist development assessment or performance improvement of activities.

5.1 Planning a monitoring program

Objectives

The first step in developing a monitoring program is to clearly define the objectives of the monitoring. This can be facilitated by asking clear questions about the purpose of setting up what can be an expensive program, as follows:

- What questions need to be answered by a monitoring program?
- Is ambient monitoring the only or best way to answer these questions?
- What pollutants or environmental indicators need to be monitored in order to provide the information required?
- What data and information are already available and how can they help?
- Will the results point to actions to eliminate or manage a problem?
- What are the constraints, assumptions, inclusions and exclusions of the program?
- What considerations need to be made about background concentrations of pollutants?
- How is the data best utilised and reported to address the issues under investigation?
- How does the data relate to operational parameters and possible impacts?
- How will any actions be implemented?

Answering these questions will, to a large extent, determine the test methods and equipment to be used.

Required information

Information categories for a successful monitoring program include:

- the number and type of air pollutants to be measured in relation to:
  - their expected concentrations
  - the monitoring methods to be used and, consequently, the best methods for acquisition, analysis and reporting
  - data quality assurance and control
  - meteorology data and the need to monitor it locally
  - the length of the sampling program.
- the number of sites required and their locations, depending on:

  - category, such as background monitoring sites, peak sites and sites for source identification
  - appropriateness for evaluating impacts on residential areas or other sensitive uses, and potential interference from other sources
  - appropriate siting criteria.
- environmental operating conditions, those being:
  - requirements for electricity and air conditioning
  - site security issues
  - access (for both people and service vehicles)
  - approval for use of the site and security of tenure.
- other relevant information:
  - if modelling is required to accompany monitoring (for more information see section 2 of this document)
  - regarding resources required and their availability
  - in relation to a communication strategy for nearby residents and stakeholders (ie how results of the monitoring program will be made available to potentially affected people).

Short-term monitoring

Short-term monitoring might be used at proposed development boundaries to determine any impact on air quality before and after a development. This may include odour, particulate matter, volatile organic compounds or pollutants that might be specific to a process. Weather effects, however, should be taken into account when assessing data, especially wind direction.

Long-term monitoring

Long-term monitoring stations may be needed near sites under investigation that is, where receptors are located near large industries, industry parks or roadways, and may include sampling particulate matter, carbon monoxide or oxides of nitrogen. Long-term monitoring may be required to determine trends or obtain background monitoring data, and assess the effectiveness of environment improvement programs (for example, EIPs, EMPs or PEPRs).

However, a primary objective for monitoring is to provide operators with, as far as practical, real-time information about how their facility is managing its off-site impacts, for example nuisance dusts around industries. In some instances, this is best achieved using three or more monitoring stations incorporating weather monitors so that actual process emissions can be distinguished from background or regional episodes (‘triangulation’). This assists the operators to focus on actions that can mitigate a developing event or predict the weather conditions under which an event may occur and take actions to avoid or minimise contributions from the process. This type of approach has been successfully adopted for dust management around mining and extractive industries.

Biological monitoring

A detailed treatment of biological sampling is beyond the scope of this publication. However, sampling of biological materials is commonly used where an effect on environmental health endpoints needs to be evaluated, often in conjunction with traditional air pollutant monitoring.

A clear practical example is the assessment of the effects of fluoride emissions on vegetation or on animals that consume that material. For example, some native and crop plant species are especially susceptible to damage by fluoride, and cattle eating contaminated pasture grasses may develop fluorosis.

In humans, the assessment of blood lead levels in children (and consequent cognitive effects) has been a strong driver for changing airborne lead standards, removing lead from petrol and reducing industrial emissions of lead near communities. In such studies, environmental authorities normally work collaboratively with health authorities.

Noting this, recent research, which has demonstrated clear adverse effects of air pollution on human cardiorespiratory endpoints in Australia, has been critically dependent on long-term air quality data provided by jurisdictional EPAs, including the South Australian EPA.

It is also noted that organisations such as the Asthma Foundation undertake routine air sampling of pollens and other biological particles to inform asthmatics and people with other respiratory conditions about precautions they need to take to avoid problems.

5.2 Available ambient test methods

Selection of test method and monitoring equipment

The EPA, using Australian Standard test methods, monitors long term for a specific group of pollutants in ambient air for which there are set national air quality standards in Australia. However, there is a whole range of materials for which the EPA uses ground level concentration criteria that have no Australian standard method.

There are also newer technologies that may be coming onto the market providing practical solutions for monitoring impacts of emissions on nearby communities. Generally, methods that have received endorsement by recognised international authorities will be preferred. However, method selection should be based on the nature and severity of environmental risks, the purpose for which data is to be used and costs for establishment and operation. It is strongly recommended that proponents discuss approaches to monitoring with the EPA in the early stages of a proposal.

5.3 Quality assurance and control

Good quality assurance/quality control (QA/QC) procedures are required if the air quality data collected is to be of sufficient quality to allow comparison with relevant air quality criteria and to meet project objectives.

To ensure consistency and reliability of results and processes, all sampling and analysis of ambient air required by the EPA for authorisations or environment improvement programs should be undertaken by test and analytical laboratories with NATA accreditation or equivalent, for both sampling and analytical laboratories components. If a laboratory does not have this accreditation initially, and the monitoring program is to continue for two years or more, it is expected the testing laboratory will gain this accreditation.

5.4 Assessment and reporting

Practitioners undertaking monitoring of ambient air should prepare a report for the proponent in accordance with the conditions set out in any environmental authorisation and/or environment improvement program.

Reports should, as a minimum, contain the following information in addition to requirements set in other relevant documents:

- purpose of monitoring
- details of the test and analytical laboratories

- duration of monitoring
- location of source/s (address and map reference/s)
- ambient conditions during monitoring, including temperature, pressure, wind speed and direction
- location of monitors (latitude and longitude with reference to datum used)
- altitude of monitoring site above mean sea level
- height above ground level of sample intake
- test methods used
- any variations from siting or test methods
- factors that may have affected results
- comparison of results against criteria agreed to in the environment improvement program, environmental authorisation or other relevant criteria
- summary of QA/QC processes
- percentage of valid data obtained
- estimate of the measure of uncertainty for the test results
- an assessment against the requirements of the monitoring. There is a range of analytical tools and graphical presentations that may assist with this. It is worth discussing related options with EPA specialists.

Summary data for ambient levels of particulates should be expressed as micrograms per cubic metre ($\mu g/m^3$) at standard temperature and pressure (STP, that is 0^oC and 100 kPa (~ 1 atmosphere)), and for gases should be expressed as parts per million by volume.

The results of testing should be supplied as a hard copy summary report and in electronic format as required in the environmental authorisation or to the specific requirements of the EPA.

Information supplied may, at the discretion of the EPA and in line with regulatory requirements, be published in full, or in summary form, in annual or other reports.

6 References

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7 Glossary

analytical laboratory	The laboratory that carries out analysis of samples taken by the test laboratory, and its staff
aerodynamic or equivalent aerodynamic diameter	Measurement used to define particle sizes in air. The diameter of a spherical particle of unit density that exhibits the same aerodynamic behaviour as the particle in question
AS/ISO IEC 17025	General requirements for the competence of testing and calibration laboratories
background concentration/s	Concentration/s of a pollutant that would exist were the source/s of pollution assessed not present
environmental authorisation	Works approval, licence or exemption
environment	Land, air, water, organisms and ecosystems, including human-made or modified structures or areas, and the amenity values of an area
geographical feature	Prominent structure and pattern related to geography (earth, land, sea and air)
Industrial Source Complex model	Type of plume dispersion model that can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial complex
isopleth	Line on a map or diagram connecting points for which a pollutant concentration has the same value
licence	Licence under Part 6 of the *Environment Protection Act 1993* to undertake a prescribed activity of environmental significance (see also ‘environmental authorisation’)
licensee	Includes the holder of an environmental authorisation, works approval or environment improvement program under the *Environment Protection Act 1993*
PM_{10}	Name given to particles in the air that are small enough for us to be able to breathe them in. Some of the larger particles may only reach as far as our throats, while others may travel right down into our lungs. ‘PM’ means particulate matter, while the '10' tells us how big the particles are, in micrometres (or millionths of a metre) as an equivalent aerodynamic diameter. This is written as 10 µm. PM_{10} means that the biggest particles in a sample are about 10 µm in diameter. A sample of PM_{10} particles may also contain $PM_{2.5}$ particles (see $PM_{2.5}$)
$PM_{2.5}$	Name given to particles in the air that are so small that when we breathe them in, they can travel right down into the deep parts of our lungs. $PM_{2.5}$ means that the largest particles have sizes of around 2.5 micrometres or µm as an equivalent aerodynamic diameter [see explanation of µm under PM_{10}]. Common types of $PM_{2.5}$ particles are smoke and exhaust fumes from vehicles.
practitioner	Person carrying out the assessment process
regulatory model	A dispersion model that has been approved by the EPA for use in the assessment of emissions to air
sensitive receptor	Fixed location such as a house, building, other premises or open area where health, property or amenity is affected by emissions that increase the concentration of the emitted parameter above background levels

standard temperature and pressure	Standard conditions under which most ambient air quality data is reported in Australia, ie, 0ºC and 1 atmosphere of pressure (101.3 kilopascals or kPa)
test equipment	Includes all equipment used in obtaining and analysing samples for stack emissions and ambient air testing. This equipment must comply with requirements of approved methods and standards
test laboratory	The laboratory and its staff that carry out sampling of emissions from the licensee's premises through chimney stacks or sampling of ambient air to determine performance of the licensee
volatile organic compounds (VOC)	Broad range of carbon-based chemicals that can exist in the vapour phase at normal ambient temperatures. VOCs come from vehicle exhausts, burning of wood and other fuels (coal, petrol and oil), bushfires and planned burning, storage of fuels and solvents for paints, dry cleaning and cleaning of machinery. Large amounts also come from the oils released by trees and other vegetation into the air, especially in warm weather.

Appendix 1 Choosing air quality assessment practitioners

As discussed in the Introduction, the EPA aims to ensure that submissions are of a high quality in order to minimise delays and avoid additional costs to the proponent. This applies to documents that come to the EPA directly or are referred to it by other government agencies.

A key initial action for a proponent is to establish confidence in the abilities of all practitioners who will be responsible for the whole process. This includes qualifications, experience, accreditation and quality of reports, not only of practitioners within the primary consultancy, but in organisations such as specialist analytical laboratories or modelling subcontractors.

What to look for

Among other things, the EPA strongly recommends that a proponent asks a basic set of questions, including:

- What are the qualifications, knowledge and experience of the practitioners within the primary consulting organisation?
- Who is the responsible person with the authority to sign off on reports?
- What is the consultancy's knowledge of the proponent's industry?
- What methods will they use and are they covered within this document?
- Will the primary consultancy be undertaking all stages of the process, or will subcontracting companies, such as analytical laboratories or specialist modellers, be engaged to perform some work?
- Who will sign off for the components supplied by the subcontractors?
- Are all practitioners affiliated with recognised professional bodies and can they show evidence of a reputation within the field?

To assist with this evaluation, the EPA recommends that practitioners produce a 'capability statement' based on the guide shown in Table 1.

Table 1 Information for a capability statement

Section	Requirements	
Cover page	Project title Proponent details Location of the premises	
Primary consulting organisation (in-house capabilities)	Name of the practitioner/s Company name ACN Responsible person: Qualifications of relevant staff Experience and practitioner affiliation Accreditation: (NATA or equivalent) Is the accreditation specific to methods to be employed?	 (sign-off authority) (include examples, CV)
Subcontractors	(a) Monitoring practitioners: Company name ACN Responsible person Qualifications of relevant staff Experience and professional affiliations Accreditation: (NATA or equivalent) Is the accreditation specific to methods to be employed?	 (sign-off authority) (include examples, CV)
	(b) Analytical laboratories Company name ACN Responsible person Qualifications of relevant staff Experience and professional affiliations Accreditation: (NATA or equivalent) Is the accreditation specific to methods to be employed?	 (sign-off authority) (include examples, CV)
	(c) Modelling practitioners Company name ACN Responsible person: Qualifications of relevant staff Experience and professional affiliations:	 (sign-off authority) (include examples, CV)
Methods to be used	List of monitoring or analytical method(s) being used for which practitioners have accreditation, or dispersion models for which the practitioners have demonstrated experience	