



Department of
Environment and Conservation

Our environment, our future



A guideline for the development and implementation of a dust management program

Department of Environment and Conservation

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GLOSSARY AND ACRONYMS

Air toxics	Air toxics are gaseous, aerosol or particulate pollutants which are present in the air in low concentrations with characteristics such as toxicity or persistence so as to be a hazard to human, plant or animal life.
Airborne particles (aerosols)	<p>Airborne Particles are suspended in the air and exist as aerosols - dust, fumes, smoke or mists. These different aerosols are classified according to their processes of formation.</p> <p>Dust is an aerosol formed by mechanical subdivision of bulk material into airborne fines having the same chemical composition. Dust particles are generally solid and irregular in shape and have diameters greater than 1 micrometre.</p> <p>A fume is an aerosol of solid particles formed by condensation of vapours formed at elevated temperatures. The primary particles are generally very small (less than 0.1 micrometre) and have spherical or characteristic crystalline shapes. Since they may be formed in high number concentrations, they often rapidly coagulate, forming aggregate clusters of low overall density.</p> <p>Smoke is formed by condensation of combustion products, generally of organic materials. The particles are generally liquid droplets with diameters of less than 0.5 micrometre.</p> <p>Mist is droplet aerosol formed by mechanical shearing of a bulk liquid; for example, by atomisation, nebulisation, bubbling, or spraying. The droplet size can cover a very large range, usually from about 2 micrometres to greater than 50 micrometres.</p>
Ambient air	The external air environment, it does not include the air environment inside buildings or structures.
BAM	Beta Attenuation Monitor
DEC	Department of Environment and Conservation
Dust	The generic term used to describe solid airborne particles generated and dispersed into the air by processes such as handling, crushing and grinding of organic or inorganic materials such as rock, ore, metal, coal, wood or grain and stockpiling of materials.

EMP	Environmental Management Plan
Equivalent aerodynamic diameter (EAD)	The diameter of a spherical particle of density 1000kg/m ³ that exhibits the same aerodynamic behaviour as the particle in question.
µg/m³	Microgram per cubic metre referenced to a temperature of 0 degrees Celsius and an absolute pressure of 101.325 kilopascals.
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
PAHs	Polycyclic Aromatic Hydrocarbons
PM₁₀	Refers to particulate matter with an equivalent aerodynamic diameter of up to 10 micrometres.
PM_{2.5}	Refers to particulate matter with an equivalent aerodynamic diameter of up to 2.5 micrometres.
POPs	Persistent Organic Pollutants
Quality Assurance/ Quality Control (QA/QC)	All those planned or systematic actions necessary to provide adequate confidence that a service is of the type and quality needed and expected by the customer.
Sensitive receptor	Individuals/communities/components of the environment which could be adversely affected by dust emissions, such as dwellings, schools, hospitals, offices, protected wetlands or public recreation areas that exist now and in the future.
TEOM	Tapered element oscillating microbalance
Total suspended particles (TSP)	Inert particles that have an equivalent aerodynamic diameter of less than 50 micrometres.
Trigger Levels	<p>The “Corrective Action” trigger level is the ambient air dust level which if exceeded will result in corrective action being taken to reduce dust emissions until the dust levels fall below the corrective action trigger level.</p> <p>The “Work Stoppage” trigger level is the ambient air dust level which will result in work stoppage until the dust levels fall below the work stoppage trigger level.</p>

1.0 Introduction

1.1 Purpose of guideline

This guideline deals primarily with the management of dust generated from diffuse sources such as land clearing activities, earthworks during construction, remediation of contaminated sites and mining and quarrying activities including the storage, transport and stockpiling of soil or other material on site. The purpose of this document is to assist proponents, consultants and regulators in the development and implementation of dust management programs. The guideline also discusses dust management for the remediation of contaminated sites, where other pollutants may need to be considered. These pollutants include heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs), asbestos and Volatile Organic Compounds (VOCs).

The guideline does not address control or testing of industrial stack emissions. It is aimed at minimising the impact of fugitive dust on the environment and public health. The guideline is not intended to address management or monitoring of particles generated during bushfires or other naturally occurring pollution events such as dust storms.

The guideline identifies and discusses a range of considerations in deciding on appropriate management practices to minimise adverse impacts from dust generating activities. The guideline provides advice on the development of a dust management program including the design of a monitoring program.

1.2 Application of the guideline

The WA Environment Protection Authority (EPA) *Guidance Statement No. 18 - Prevention of air quality impacts from land development sites* (EPA, 2000) and DEC's *Land development sites and impacts on air quality: A guideline for the prevention of dust and smoke pollution from land development sites in Western Australia* (DEC, 1996), provide guidance on dust and smoke management from land development sites. DEC's Contaminated Sites Management Series of documents provides guidance on the management of dust and other air pollutants during the remediation of contaminated sites and on community consultation.

This guideline provides an updated and expanded document for the management and monitoring of dust and other air pollutants and applies to all projects in Western Australia with the potential to generate significant levels of dust from diffuse sources.

1.3 Document outline

Section 2 of the document provides guidance on the sources and impacts of dust and other air pollutants.

Section 3 of the document provides guidance on the legislative and policy framework related to dust management, both at a national and state level.

Section 4 of the document provides guidance on the design of a dust management program and relevant documentation, including the contents of a dust management plan.

2.0 Sources and impacts of dust and other air pollutants

Dust and other air pollutants can arise from a range of natural and man-made sources causing various acute and chronic health effects, as well as nuisance and visibility impacts.

2.1 Sources of dust

There are many man-made sources of dust, which include the following:

- Wind-borne dust from exposed surfaces such as cleared land and construction sites.
- Wind-borne dust resulting from remediation works on contaminated sites.
- Wind-borne dust from stockpiles of material such as sawdust, coal, fertiliser, sand and mineral ores.
- Vehicle movements on paved and unpaved roads.
- Agriculture and forestry activities.
- Mines and quarries.
- Road works and road construction.
- Residential and commercial developments, such as demolition and construction works.
- Municipal landfills and other waste handling facilities.
- Explosive blasting of rock.
- Abrasive blasting.
- Handling, crushing, grinding/pulverising, screening of mineral ores or other solid matter.
- Numerous industrial operations, including grain and mineral ore transfer and storage, timber mills, stone masonry, mineral processing, cement handling and batching, and fertiliser storage and processing.

2.2 Physical nature of dust

Airborne particles are characterised as fumes, smokes, mists or dusts depending on the nature of the particle and its size. Particles are commonly classified by size expressed as equivalent aerodynamic diameter (EAD) in micrometres (μm) as follows:

- Total suspended particles (TSP) – diameter $\leq 50\mu\text{m}$
- PM_{10} – diameter $\leq 10\mu\text{m}$
- $\text{PM}_{2.5}$ – diameter $\leq 2.5\mu\text{m}$

2.3 Chemical composition of dust

The chemical composition of dust particles will depend on the nature of the source material. For example, wind-borne dust from cleared areas will reflect the composition of the underlying soil types. In cases where soil has been

contaminated, dust may also be associated with inorganic and organic pollutants such as heavy metals and polycyclic aromatic hydrocarbons (PAHs).

2.4 Impacts of dust on health

The impacts of dust are influenced by particle size, chemical composition and concentration.

Particles with an aerodynamic diameter less than 50 μ m (usually referred to as TSP) are typically associated with adverse aesthetic effects rather than health effects. This is because they are trapped in the upper respiratory tract (just behind the nose and mouth) when inhaled. These larger particles are called inhalable particles and are often termed “nuisance dust”, settling on surfaces, causing soiling and discolouration. They may, however, be associated with irritation of the mucosal membranes (eyes, nose and throat) and if contaminated may pose an increased health risk through ingestion.

Human health effects of dust tend to be associated with particles with an aerodynamic diameter of 10 μ m or less (\leq PM₁₀). These smaller particles tend to remain suspended in the air for longer periods and can penetrate into the lungs.

The PM_{10-2.5} fraction (coarse fraction) is termed “thoracic particles”. These particles are inhaled into the upper part of the airways and lung.

PM_{2.5} particles are fine particles that are inhaled more deeply and lodge in the gas exchange region (alveolar region) of the human lung and are termed “respirable dust”. Further, if contaminated, these fine particles may pose a further health risk through absorption of the chemicals on the particles in the blood stream.

Information obtained from the World Health Organisation (WHO) and United States Environmental Protection Agency (USEPA) indicates that numerous scientific studies have linked particle pollution exposure to a variety of health effects, including:

- increased respiratory symptoms, such as irritation of the airways, coughing, aggravated asthma, development of chronic bronchitis, and breathing difficulty through decreased lung function;
- irregular heartbeat;
- non-fatal heart attacks;
- premature death in people with heart or lung disease;
- toxic effects by absorption of the toxic material into the blood (e.g. lead, cadmium, zinc);
- allergic or hypersensitivity effects (e.g. some woods, flour grains, chemicals);

- bacterial and fungal infections (from live organisms);
- fibrosis (e.g. asbestos, quartz);
- cancer (e.g. asbestos, chromates); and
- irritation of mucous membranes (e.g. acid and alkalis).

Sensitive groups such as people with heart or lung diseases, children and older adults are the most likely to be affected by particle pollution exposure. However, even healthy people may experience temporary symptoms from exposure to elevated levels of particle pollution. Recent epidemiological research suggests that there is no threshold at which health effects do not occur.

2.5 Impacts of other air pollutants on health

Emissions of air pollutants other than dust such as VOCs, PAHs (vapour phase) and acidic aerosols, may also occur during remediation works at contaminated sites, with a range of potential short-term and long-term effects. A Health Risk Assessment (HRA) would be required to determine whether any potential health risks may arise during the remediation of a particular site. The National Health and Medical Research Council (NHMRC) has developed a document for ambient air quality standard setting using an approach to health-based hazard assessment (NHMRC, 2006).

3.0 Legislative and policy framework

3.1 National position

The National Environment Protection Council (NEPC) is the national body responsible for making National Environment Protection Measures (NEPMs). NEPMs are broad framework-setting statutory instruments defined in the NEPC Act. They outline agreed national objectives for protecting or managing particular aspects of the environment, such as air quality. Ambient air NEPMs developed that are relevant to this guideline are *the National Environment Protection (Ambient Air Quality) Measure* (NEPC, 2003) and *the National Environment Protection (Air Toxics) Measure* (NEPC, 2004). Information on the Ambient Air and Air Toxics NEPMs can be accessed on the NEPC website at <http://www.ephc.gov.au>.

The Ambient Air NEPM includes six 'criteria' pollutants as primary indicators of air quality:

- Nitrogen dioxide (NO₂)
- Ozone (O₃)
- Carbon monoxide (CO)
- Sulphur dioxide (SO₂)
- Particles (as PM₁₀)
- Lead (Pb)

Standards and goals for these criteria air pollutants are specified. An advisory standard for particles as PM_{2.5} is also specified.

The Air Toxics NEPM includes:

- Benzene
- Formaldehyde
- Benzo(a)pyrene as a marker for PAHs
- Toluene
- Xylenes (as total of ortho, meta and para isomers)

Monitoring Investigation Levels (MILs) for these air toxics are specified. The MILs are based on the protection of human health.

Western Australia has voluntarily met its obligations to the NEPC by implementing the framework for the Ambient Air Quality NEPM under the *National Environment Protection Council (Western Australia) Act 1996*.

The EPA is developing an Ambient Air Quality State Environmental Policy and Ambient Air Quality Declaration to guide air quality management and to help meet the Ambient Air NEPM compliance goals within the 10-year implementation timeframe.

3.2 State position

The legislation, agencies and processes directly concerned with dust management in Western Australia are outlined in this section.

3.2.1 *Environmental Protection Act 1986 (EP Act)*

Development proposals and activities that are likely to generate dust may be subject to the provisions of the EP Act and policies developed pursuant to that Act.

Part II of the EP Act

Part II of the Act enables the development of State Environmental Policies (SEPs). SEPs are a non-statutory government policy position on a particular aspect of the environment that can include ambient air. SEPs are enabled under Part II Section 17(3) of the EP Act and are developed by the Environmental Protection Authority (EPA). Following a public consultation process, SEPs are approved by the Minister for the Environment and adopted by Cabinet on a whole-of-government basis.

SEPs can include the scope to develop Environmental Quality Objectives and can identify a framework for implementation using existing statutory mechanisms such as Environmental Protection Policies (EPPs), Environmental Impact Assessment (EIA), licensing and regulation.

As indicated above, the EPA is developing an Ambient Air Quality State Environmental Policy.

Part III of the EP Act

Part III of the EP Act authorises the EPA to prepare and publish Environmental Protection Policies (EPPs) which, following Parliamentary approval and gazetting, have the force of law.

EPPs set environmental values, objectives, standards and/or targets that Natural Resource Management agencies must adopt when carrying out their environmental responsibilities.

The *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (EPA, 1999), known as the Kwinana EPP, refers to standards and limits for sulphur dioxide and total suspended particulates. The policy applies to the local government areas of Cockburn, Kwinana and Rockingham.

Part IV of the EP Act

Under Part IV of the EP Act a proposal that appears likely, if implemented, to have a significant effect on the environment must be referred to the EPA for a decision on whether or not it should be subject to the environmental impact assessment (EIA) process.

In assessing a proposal, the EPA may make recommendations to the Minister for the Environment concerning what conditions, if any, should be imposed on

the project in the event that it is approved. Ministerial conditions commonly include a requirement to prepare and implement an environmental management plan (EMP) to control and monitor the environmental impacts of the project. For example, where an approved proposal includes activities that may result in significant generation of dust, the Minister may require the proponent to prepare and implement a Dust Management Plan. Conditions imposed under Part IV of the EP Act are legally enforceable, as are proponent commitments that appear in Ministerial Statements.

EPA Guidance Statements

In pursuing its objectives to protect the environment and to prevent, control and abate pollution, the EPA also publishes Guidance Statements for the environmental impact assessment of proposals. These guidance statements set out the minimum requirements for the protection of the environment.

The *EPA Guidance Statement No. 18: Prevention of air quality impacts from land development sites* (EPA, 2000) should be considered for activities that can generate dust, particularly when the activities form part of a project requiring formal impact assessment. The EPA Guidance Statement provides general direction on the control of dust and smoke from land development sites. This 2008 dust guideline is specifically aimed at providing practical advice for the development and documentation of management strategies, plans and programs aimed at controlling impacts of dust.

The draft *EPA Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA, 2005), provides advice on protecting the environment for land use planning and development, and in particular describes the environmental impact assessment process applied by the EPA to such schemes. The guidance is intended as a significant resource document for local government, State Government agencies, consultants, proponents and the public.

Part V of the EP Act

Where pollution or environmental harm arising from dust generation has occurred or is likely to occur, the general pollution prevention provisions of Part V of the EP Act may apply. These provisions refer to compliance with emission standards and taking all practical measures to prevent or minimise emissions.

Environmental Protection Regulations

Other Environmental Protection Regulations of the EP Act may also be relevant. Under the *Environmental Protection (Unauthorised Discharges) Regulations 2004*, materials prohibited as listed in Schedule 1 of the Unauthorised Discharges Regulation include dust produced by a mechanical process including cutting, grinding, sawing, sanding or polishing a material.

3.2.2 Department of Environment and Conservation (DEC)

DEP/DEC Dust Guidelines

In 1996, the then Department of Environmental Protection (DEP) published *Land development sites and impacts on air quality: A guideline for the prevention of dust and smoke pollution from land development sites in Western Australia* (1996 Guideline). The 1996 Guideline provides procedures to assess the dust generating potential of a development site and identifies measures and contingency arrangements to manage dust and smoke from land development sites.

This 2008 dust guideline provides an updated and expanded document for the management and monitoring of dust for all projects and land use sizes.

Contaminated Sites Management

DEC has also produced a series of contaminated sites guidelines which address identification, assessment, remediation and reporting of contaminated sites and community consultation during development and implementation of Environmental Management Plans. The Contaminated Sites Management series of documents are on DEC's website.

DEC Selection of Ambient Air Quality Guidelines

As of December 2000, DEC has articulated an interim approach to adopting ambient air quality guideline values. This interim approach is to adopt the NEPM standards for Ambient Air Quality. In the absence of a NEPM standard, DEC will adopt the WHO Guidelines for Air Quality (2000), with consideration for applicability to the WA context; and in the absence of a NEPM standard or a WHO guideline, DEC will adopt criteria from another jurisdiction, once it has been assessed and determined to be applicable to the WA context (DEP, 2000).

Perth Air Quality Management Plan

The Perth Air Quality Management Plan (AQMP) was developed to ensure that clean air is achieved and maintained in the Perth metropolitan area and meets the Ambient Air NEPM goals. The Perth AQMP was launched in 2000 and details 126 actions to ensure that clean air is achieved and maintained throughout the Perth metropolitan region over the next 30 years.

3.2.3 Other government agencies

Local governments are responsible for works on subdivisional and development sites and may require the preparation of dust management plans before works can start as part of their approval processes.

The Department of Health provides advice on public health assessment and criteria or standards for various air pollutants.

The Department of Industry and Resources legislation pertaining to mining and quarrying activities may also be relevant to dust management.

4.0 Dust management program design and documentation

The following section presents the main aspects to consider when designing a dust management program and the structural components to include when preparing a dust management plan.

The following is an example of a dust management plan outline.

Dust Management Plan outline (example only)

1. Introduction (Program scope and objectives)
2. Background (contextual information)
3. Proposed work and potential impacts
 - 3.1 Aspect and impact analysis
 - 3.2 Site dust risk assessment
4. Monitoring program design
 - 4.1 Purpose of the program (Objectives)
 - 4.2 Performance criteria and monitoring methods
 - 4.3 Number and location of monitoring sites
 - 4.4 Quality assurance/quality control (QA/QC) requirements
 - 4.5 Stakeholder consultation
 - 4.6 Roles and responsibilities
 - 4.7 Complaints management
 - 4.8 Reporting
5. References
6. Appendices

Details of what to include for each section of a Dust Management Plan as outlined above are provided below.

4.1 Introduction

The introduction should describe the purpose and scope of the program and specific statutory requirements (if any) regarding control of dust and other air pollutants.

The phases of the project to which the dust management program will apply should be identified, for example, the pre-construction phase (demolition, land clearing etc), construction phase or commissioning and operational stages. The dust management program may apply to all phases of the project.

The geographic areas to which the dust management program applies should also be identified, that is, whether the program applies to the whole of the project site or to specific areas only, for example access roads or stockpiles.

The nature and source(s) of dust generation may vary both in space and time, so it is important to clearly identify and document the range of potential dust generating activities.

Program objectives must be clearly defined in order to ensure that management strategies are tailored to reflect management priorities. The main objective of a dust management program should be to protect human health and the environment, including amenity impacts. Defining the objective of the program is important as it influences the development of performance criteria and the methods used to monitor performance.

4.2. Site background

This should include:

- A description of the physical environment of the site and surrounding land use areas, particularly noting any sensitive receptors and nature conservation areas that could be affected by dust emissions and other emissions from the site.
- A description of current and historical land use on the site and the adjacent areas. This will help identify potential for contaminants at the site. DEC's publication '*Potentially Contaminating Activities, Industries and Landuses*' provides preliminary reference for the identification of potential contaminants (DoE, 2004).
- Contamination status of the site (if applicable), including distribution of contaminants across the site and levels of contamination.
- A description of the geology of the site (including soil particle size distribution).
- Information on local prevailing meteorological conditions and any physiographic factors (such as site topography or major built features) that may influence how meteorological factors such as wind direction are manifested at a local scale.
- Other sources of dust in the project locality that can contribute to ambient air particle concentrations. If possible, information should be

provided on pre-commencement atmospheric dust levels (background levels) in the project area to estimate dust levels in the absence of the project's dust generating activities.

4.3. Proposed works and potential Impacts

4.3.1 Aspect and impact analysis

The next step is to systematically identify all dust and other air pollutant generating aspects of the project and the environmental, human health and amenity impacts potentially associated with each. An example of this type of assessment is shown below in Table 1.

Site maps should also be provided that show:

- Property boundaries, topographic contours, existing land uses, wind roses, nearby natural features;
- Location of the proposed development and location of sensitive receptors;
- Areas to be disturbed;
- Location of physical barriers such as fencing, windbreaks, trees and buildings;
- Location of stockpile, storage areas and loading/off-loading areas;
- Traffic routes and exit points;
- Wash down facilities; and
- Distribution of contaminants at the site;

The maps need to be to scale and show aerial photos.

Additional information that should be provided includes:

- A brief overview of the proposed works to be carried out, including a timeline to show the proposed timing and duration of major works that have the potential to generate dust. It should also include the sequence of site disturbance/remediation and the size of exposed areas.
- Details on the method used for the removal and replacement of topsoil and remediation.

Table 1 - Example of an aspect and impact table for dust generating activities

Activity	Duration (dates)	Aspect	Impact (examples only)
Pre-mining clearing of vegetation	2 weeks (2 to 13 February)	Clearing of vegetation exposes topsoil to wind erosion.	Possible 'blow out' of dunes. Nuisance dust could impact nearby residents by creating amenity issues.
		Mulching of vegetation releases fine organic debris to air.	May impact on health of people.
Stripping and stockpiling of soil	1 month (14 March to 14 April 2007)	Stripping topsoil disturbs and creates a potential for particles to be released to the air.	High dust concentrations could affect visibility on highway adjacent to site or could affect health of endangered vegetation located near works area.
		Stockpiling topsoil releases dust particles to the air.	Dust could be deposited on building roofs, affecting palatability and potability of residents' tank water (and hence tap water/domestic) supply (in areas where scheme water is not provided).
Remediation	2 months (10 October to 10 December 2007)	Remediation works release dust (contaminated and uncontaminated) and emissions of other air pollutants such as VOCs.	The sensitive receptors adjacent to the site could be exposed to dust and other air pollutants causing health effects.
Loading of Metal ore/concentrate	Ongoing	The loading of metal ore/ concentrate could result in emissions of contaminated dust.	This dust could be deposited in the surrounding areas providing the risk of exposure to the community and ecosystems, from heavy metals.

4.3.2 Site risk assessment

Emissions of dust and other air pollutants from diffuse sources are not readily estimated, however, the factors that influence the levels of dust and other air pollutants in the ambient air can be identified and used to assess a site's risk potential. The factors influencing dust levels are provided in Appendix 1.

Factors influencing the levels of other air pollutants include the level of contamination of the site. The importance of these factors may vary from site to site. Each factor is given a rating of high, medium or low dust risk potential as shown in the 'Site Risk Assessment Chart' in Table 2 below. The overall rating is then assessed and appropriate dust control measures, contingency measures and monitoring requirements are developed.

Table 2 - Site risk assessment chart

Factor	Risk potential		
	Low	Medium	High
Soil type			
Exposed area on site			
Duration of works			
Proximity to sensitive receptors			
Contamination Level			
Prevailing wind direction and speed			
Nature of works			
Topography			
Overall site dust risk potential	Low		
	Medium		
	High		

Minimum dust management control measures, contingency measures and monitoring requirements are listed for each dust risk level as indicated in Table 3. These minimum dust control and contingency measures provide a basic guide and should be evaluated on a case-by-case basis and reviewed accordingly. Unless otherwise stipulated, the actions outlined by each classification level refer to all phases of a project. These measures indicated are the minimum requirements, however, best practice is recommended as per the EPA *Guidance Statement No 55 – Implementing Best Practice in proposals submitted to the Environmental Impact Assessment process* (EPA, 2003). The EPA encourages project proponents to adopt not merely minimum management practices to comply with environmental quality standards and limits, but to use ‘best practice’ approaches in environmental management.

Best practice is founded on the idea that there is no case for unnecessary waste discharges or degradation of the environment, *even where an environmental standard is not exceeded*. Best practice involves preventing or minimising environmental impact to ensure that environmental quality is maintained, through incorporation of Best Practicable Measures (BPM). BPM should be applied when developing and implementing specific dust management actions.

Some dust control measures are described in Appendix 2. They are not aimed at specific type of operation (i.e. mining, land development or contaminated site remediation), but are applicable to activities that are common among all operations. New or improved methods will become available and current best practice should always be followed to ensure that control measures are effective in minimising dust.

The contingency dust control measures for each dust generating aspect of project activities are specified, in case the management strategies and actions are ineffective in minimising dust emissions. As indicated in the table, monitoring may also be required. Details on monitoring are provided in Appendix 3.

Table 3 - Minimum dust control measures, contingency actions and monitoring requirements according to the dust risk potential level¹

Management Strategies	Dust risk potential		
	Low	Medium	High
Dust Control Measures			
• Dust avoidance measures shall be put in place. See Appendix 2.	√	√	√
• Dust suppression shall be applied:			
- Watering down of exposed areas during the construction phase (e.g. water carts)		√	√
- All areas of disturbed land should be stabilised by chemical stabilisation or hydromulch.		√	√
- Loading/off-loading systems such as conveyors should be enclosed or watered down with sprinklers.		√	√
• The person responsible for dust management shall maintain close control of the dust generating works.	√	√	√
• Wind barriers shall be available when required and erected before any part of the site surface is disturbed ² .			√
Contingency measures			
• Dust suppression shall be applied:	√	√	√
- Water carts and additional surface stabilisation equipment to be available when required during operational phase.		√	√
• Wind barriers shall be erected when required and dust generating works shall stop in the interim.		√	√
• Immediate review of dust management practices and work stoppage, if performance criteria are exceeded.	√	√	√
• Complaints management system in place (complaints recorded and acted on promptly).	√	√	√
Monitoring Requirements			
• On-site management system in place (complaints recorded and acted on).		√	√
• Off-site dust monitoring for compliance monitoring, at site boundary (if close to sensitive receptors) or at sensitive receptors. See Section 4 and Appendix 3.		√	√
• Exceedences to be reported to the relevant authority – DEC, local government or DOH.		√	√
• Complaints management system in place (complaints recorded and acted on promptly).	√	√	√
• Notice to be erected at the site, providing contact details of the person to be contacted and works.	√	√	√

¹ These minimum measures are a rough guide only and should be reviewed based on the monitoring data.

² Wind barrier to remain in position until the disturbed surface is stabilised. Extent and location of fencing as agreed by site manager, local government, DEC or DOH.

4.4. Monitoring program design

The Dust Management Program includes control measures for dust and other air pollutants. Monitoring may be required to assess the effectiveness of these measures and for compliance purposes. If monitoring is required, depending on the risk level, a monitoring program should be included in a dust management program and reflect management objectives. Key objectives of a monitoring program are to protect human health and the environment by ensuring that on-site management practices (for dust and other air pollutants) are adequate.

Ambient air monitoring should be conducted in accordance with relevant standards and at locations representative of community exposure. Pollutants to be monitored are to be identified and will vary from site to site. Performance criteria against which the monitoring data will be compared must also be identified.

Background air quality and meteorological monitoring are useful in the design a dust management program and facilitate the interpretation of monitoring results.

A monitoring program that provides continuous particulate and meteorological data is most useful for the assessment of source activity.

Components of a dust monitoring program include the following:

- **Purpose of the program**
- **Performance criteria and monitoring methods**
- **Number and location of monitoring sites**
- **Quality assurance/quality control (QA/QC) requirements.**

These are discussed in detail below.

4.4.1 Purpose of the program

A monitoring program should reflect the objectives of the management program and be designed to monitor the health and environmental impacts of dust and other air pollutants by ensuring that the performance criteria are not exceeded.

4.4.2 Performance criteria and monitoring methods

The air pollutants to be monitored will vary from one site to another depending on the contaminants present at the site, level of contamination, toxicity, bioavailability, physical nature of the contaminants, duration of works/remediation works, proximity to sensitive receptors and other factors.

Background monitoring may also be required. This will influence the design of the dust management program as higher background levels will require more

stringent dust control measures and on-site criteria. Background monitoring provides information on the levels of air pollutants in the ambient air in the absence of site activity.

Meteorological monitoring for wind direction and speed may also be required to facilitate interpretation of the monitoring data.

Performance criteria

After identifying the air pollutants to be monitored, the next step is to identify the performance criteria. Performance criteria provide a benchmark against which the measured levels of dust and other air pollutants may be compared. Both on-site and off-site performance criteria may be required.

An effective monitoring program should:

1. Monitor dust and other air pollutants levels within the site, close to on-site sources of dust (for comparison against on-site criteria) to assess the effectiveness of management practices in controlling emissions of dust and other air pollutants and therefore guide management decisions. On-site performance criteria are specified for short time periods (15 minutes to one hour) and are designed to prevent exceedences of the off-site criteria.
2. Monitor dust levels at or near the site boundary and/or near sensitive receptors for comparison against off-site criteria to assess health and amenity impacts and for compliance purposes.

On-site performance criteria (Trigger Levels) are set for corrective action and work stoppage. These criteria assist in achieving the off-site criteria that protect human health. Corrective action trigger levels are the levels of dust concentration on site that if exceeded will result in management action to reduce dust emissions. Work stoppage criteria are the dust concentrations on site which if exceeded will result in work stoppage. These trigger levels are determined on a case-by-case basis as there are a number of variables that can affect the relationship between the dust levels measured within the site and the resulting dust levels occurring off-site. Variables, such as:

- the distance between the dust source and the site boundary/sensitive receptors
- the number of dust sources in the area
- the level of contamination at the site
- background dust levels
- the direction of the prevailing winds in relation to sensitive receptors
- particulate matter size and characteristics

The samplers should be located downwind of, and relatively close to, the emissions source(s).

Exceedences of the performance criteria should initiate prompt review of the dust management practices.

Off-site performance criteria are used to provide protection for sensitive receptors against adverse health or amenity impacts that may arise from dust and other air pollutants.

The Victorian EPA sets neighbourhood intervention levels in their State Environment Protection Policy (SEPP - Air Quality Management) that are numerically higher than the NEPM standards. In the absence of a similar WA policy, DEC accepts the use of the NEPM standards as off-site criteria. Exceedances of the standards are not acceptable and indicate that the dust management practices may not be appropriate.

It should be noted that the allowable NEPM exceedances apply to the entire airshed, including emissions from extreme events such as bushfires, and should not be applied to an individual facility or site. For example, only five exceedances per year are allowed for PM₁₀, regardless of whether the exceedances are due to on-site or off-site activities.

The Air Toxics NEPM specifies standards for air toxics, some of which may require monitoring, during the remediation of contaminated sites.

Table 4 - Ambient air quality NEPM standards for lead and particles

Pollutant	Averaging period	Maximum concentration	Goal to be achieved by 2008 Maximum allowable exceedences*
Lead ¹	1 year ²	0.50 µg/m ³	none
Particles as PM ₁₀	1 day	50.0 µg/m ³	5 days a year
Particles as PM _{2.5} (advisory standard)	1 day	25.0µg/m ³	Under development
	1 year	8.0µg/m ³	Under development

Table 5 - Air toxics NEPM

Pollutant	Averaging period	Monitoring investigation level
Benzene	Annual average	0.003 ppm
Benzo(a)pyrene as a marker for Polycyclic Aromatic Hydrocarbons	Annual average	0.3 ng/m ³
Formaldehyde	24 hours	0.04 ppm
Toluene	24 hours	1 ppm
	Annual average	0.1 ppm
Xylenes (as total of ortho, meta and para isomers)	24 hours	0.25 ppm
	Annual average	0.2 ppm

¹ Monitoring for other heavy metals may be required, for example, during the remediation of contaminated sites. Criteria for these could be sought from WHO, DoH or adopted from other jurisdictions and organisations. Any standard chosen would need to be assessed to ensure the criteria it is based on are relevant for WA.

² This annual average standard is unsuitable for contaminated sites and a 24 hour average standard will have to be used. The same applies for air toxics.

Failure to meet agreed performance criteria should result in management review of the control measures for dust and other air pollutants and may serve to trigger contingency actions or work stoppage.

Monitoring methods

Where compliance monitoring is required, the monitoring methods selected should be in accordance with Australian Standard methods and where these are not available, USEPA or equivalent methods should be used. Details of common methods are provided in Appendix 3. Appendix 3 provides an overview of the various monitoring methods, the suitability of each method as a compliance or management tool, the limitations of each, the principles of operation and the relevant Australian, USEPA or equivalent standard methods. Monitoring methods that rely on the principle of light scattering, such as particle counters, are also included.

It is important to consider the sampling time and frequency for monitoring especially for reporting purposes. The sampling time and frequency is usually determined based on the criteria and monitoring method selected.

Sampling can be described as either batch or continuous. Continuous sampling provides uninterrupted monitoring. Batch sampling collects a sample over a designated time period, for example, over 24 hours.

The frequency of sampling could be continuous, daily, etc., depending on the objectives of the monitoring program.

Background monitoring is recommended as it provides a way of comparing levels of dust and other air pollutants that would be expected in the absence of site activity. Where limited background monitoring data are available, DEC will adopt a conservative approach in assessments. For a facility with potentially significant impacts on sensitive receptors DEC's expectation would be for one year's data to be available and reviewed in order for seasonal variations to be observed. Depending on the location of the site, the established buffer and other significant emission sources it may be necessary to undertake background sampling of other parameters in addition to dust.

There are two methods of gathering background monitoring data:

(i) *Sampling of the site before works start to provide baseline data:* This baseline sampling is most effective when sampling is conducted over a number of years. A longer sampling period will ensure seasonal and annual variability is taken into account, providing a more accurate representation of the dust levels and trends. A dust monitoring program is more effective if background dust levels are measured before work starts, for example, high background dust levels may require more stringent dust control. For short-term projects (of say up to six months) four weeks of background monitoring before works start, would provide an indication of existing air quality.

(ii) *Control site sampling*: This involves concurrent sampling near the site and at locations away from the site (outside the zone of the site, but representative of the local environment or the site before works). Control site sampling has the advantage of allowing comparison of control (background) and site samples under similar weather conditions.

Wind direction and speed are the minimum meteorological data required. Information regarding meteorological conditions for many parts of Western Australia can be obtained from the Bureau of Meteorology website at <http://www.bom.gov.au>. Where meteorological information is not available, or the site characteristics such as topography are different from those at the nearest BoM station, then site specific meteorological monitoring will be required.

The Australian Standard, *AS2923-1987 Ambient air – Guide for measurement of horizontal wind for air quality applications*, provides guidance on meteorological monitoring, including equipment selection, installation and operation.

4.4.3 Number and location of monitoring sites

The selection of monitoring sites is of paramount importance, as it can affect the quality of data obtained and the interpretation of results. The prevailing meteorological conditions, topography, predicted area of greatest impact and the location of sensitive receptors are key factors that influence the siting of a monitor. The number and location of monitors should adequately represent community exposure, and should be selected as part of a risk-based approach. The higher the risk, the greater will be the monitoring requirements.

Selection of a monitoring site should be based on the guidance provided in *AS/NZS 3580.1.1:2007 Methods for the sampling and analysis of ambient air – Guide to siting air monitoring equipment*. This standard provides, for example, minimum distances from obstacles that could affect the monitoring/sampling, such as trees and buildings. However, there may be cases where a monitoring site does not meet the requirements of *AS/NZS 3580.1.1:2007* or a deviation from the standard is required. Where this is the case, this should be detailed in the monitoring program and reports.

The practicality of an area should also be considered when determining the location of a monitoring site, such as:

- security (potential for vandalism);
- electrical services, as most monitoring equipment requires power; and
- access.

4.4.4 Quality assurance/quality control (QA/QC) requirements

Good quality control (QC) and quality assurance (QA) procedures ensure that the monitoring data are of good quality (accurate and reliable) to allow comparison with the performance criteria.

The monitoring method selected must be able to report results according to the requirements of the performance criteria. Its capability as a compliance or management tool must also be considered. Details on monitoring methods are provided in Appendix 3.

Sampling and analysis should be done in accordance with the relevant standards (Australian standard methods where these exist, otherwise USEPA or other equivalent methods), by National Association of Testing Authorities (NATA) accredited laboratories where available and by appropriately trained and competent staff.

A laboratory quality assurance system is a requirement of NATA accreditation and provides credibility as to the technical competence of the laboratory in supplying accurate and reliable results. NATA accredited facilities are regularly examined to ensure they maintain their standards of technical expertise, calibration and maintenance of sampling instruments.

Variations from the above standards and limitations should be clearly stated and justified by calibration and validation studies to show accuracy and precision comparable with the relevant Australian Standard Method (NEPC, 2004). The alternative monitoring method should provide equivalent information for reporting against criteria and objectives and reference to an ambient standard should also define the measurement method.

4.5 Stakeholder consultation

Stakeholder consultation is required as part of the development of a Dust management program. Effective consultation allows for industry and other interested parties to involve its stakeholders and community in their proposal prior to seeking approvals from the EPA and DEC. DEC's *Contaminated Sites Management Series - Community Consultation Guideline* (DEC, 2006) provides guidance on the consultation process and is available on the DEC website at www.dec.wa.gov.au. Details on who has been consulted in the development of the management strategy should be included in the dust management plan.

4.6 Roles and Responsibilities

Personnel responsible for dust management and monitoring at the site should be specified. This could be the Site Manager, Site Supervisor, Environmental Manager etc. Their roles and responsibilities should also be specified.

4.7 Complaints management

A complaints management system should be in place to include a feedback loop to the community and provide for corrective action when adverse impacts have occurred. All complaints should be logged and investigated with timely feedback provided to the complainant. Complaint forms should be kept and made available to relevant authorities upon request. A sample complaint form is provided in Appendix 4.

In cases where there are existing dust issues, it would be useful to conduct a survey to assess background issues and perceptions of air quality.

4.8 Reporting

A dust management program should detail the format for reporting monitoring results and any necessary corrective action taken to the relevant authority (DEC, DOH etc).

DEC requires that monitoring results and calibration data be provided in a summary report which includes all working spreadsheets showing the raw data and review of the results. Monitoring data should be recorded and made available to DEC and DOH on a regular basis or upon request.

The relevant authorities should be notified of any exceedences and corrective action taken, within seven days of the exceedence occurring.

A general site description should be included for each monitoring station to help interpret monitoring results. Table 6 lists the information to be recorded for each monitoring station. The table is based on the New Zealand Ministry for Environment *Good Practice Guide for Monitoring and Data Management* available at www.mfe.gov.au. A map showing the location of the monitoring sites should also be included.

Table 6 - Recommended information to be recorded for each monitoring station

For each monitoring station	
Parameter	Explanation
Indicators/contaminants monitored	List all the pollutants that have been or are being monitored at the monitoring station
Co-ordinates	GPS co-ordinates if possible
Equipment owners name/s	Name of party/parties who own the equipment
Equipment operators name/names	Name of party/ies who maintain and calibrate the equipment (may be the same as equipment owner)
Data owner's name and address	Party who actually 'owns' and is responsible for the data produced from the equipment (may be the same as above)
Equipment housing	Shed, lab, air conditioning etc.
Housing environment	Air conditioning, humidity etc
Topography	Description of the topography surrounding the station, for example, open valley with little trees or vegetation. This should also include a description of surrounding receptors e.g. residential to the north.
Location of monitoring station.	Reasons for selecting the location. e.g. prevailing winds, sensitive receptors etc. Description of potential sources of dust that can contribute to results recorded by the station.
Supplementary information	Description and dates of any unusual events that may have affected air quality e.g. bushfires, weather extremes etc.
Meteorological variables measured	Wind speed, wind direction, temperature and height at which they are measured.
Meteorological data operator	Operator of the meteorological station.
Location of meteorological station	For example, on site mast 6m high or at the neighbouring airport.
Regional and local meteorological characteristics	A brief description of meteorological conditions likely to affect air quality at the station.
Sampling Objective	On-site, off-site or background.
Instrument/s	Name and any other detail of the instrument/s (make/model and serial number)
Period of operation	Dates (and times, if applicable) when equipment was operated
Standard method followed and deviations	Details of the Australian Standard method followed to operate the equipment. If any of the requirements of the standard method is not met or if an alternative standard is used, provide justification.
Data storage	Describe how the data is stored
Data logging	E.g. remote via modem or not used.
Sampling period and frequency	E.g. Sample collected daily or every one in six days, over 24 hrs or over six days.
QA/QC	Field and laboratory QA/QC: <ul style="list-style-type: none"> • use of standard operating procedures (SOPs) for sample collection and analysis; • use of chain-of-custody and sample identification procedures; • sample preservation, handling and decontamination; and • use of QC samples such as field and trip blanks, duplicates and equipment rinses; • instrument standardisation, calibration and verification; • use of trained technicians and analysts; • use of NATA accredited laboratories.

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APPENDICES

Appendix 1: Factors influencing levels of dust and other air pollutants

Factor	Description
Soil type	<ul style="list-style-type: none"> • The soil properties of a site will have a considerable impact on the amount of dust generated. • In general soils with a dominant particle size corresponding to gravel size or larger have less potential of becoming airborne than finer particles such as fine sand, silt and clay. However, soil may comprise a mixture of different soil particles, for example, fine contaminated dust, such as heavy metals, mixed with coarse particles. • Soil moisture content is also important. Dry or non-wetting soils are more likely to become air borne. • An assessment of soil particle size distribution can help to determine the potential for particles to become airborne. As a general guide, particle sizes of 50µm or more tend not to become airborne. A soil profile will also provide information on the different soil layers and their potential for particle lift off.
Exposed area on site	<ul style="list-style-type: none"> • Sites with a larger exposed area are identified as having a greater dust generating potential.
Duration of works	<ul style="list-style-type: none"> • The longer the project, the greater the dust risk as the potential for exposure increases.
Proximity to sensitive receptors	<ul style="list-style-type: none"> • The proximity of a site to sensitive receptors has a significant influence on the dust risk potential of a site. • A site that is located close to sensitive receptors, such as, residential housing, children's daycare, schools, hospitals, sports fields etc., will generally require more preventative measures compared to a site in an isolated remote location.
Contamination level	<ul style="list-style-type: none"> • The concentration and distribution of contaminants at the site will determine the risk potential for dust and other air pollutants of the site. The higher the concentration of contaminants and the greater the distribution of contaminants at the site, the greater will be the risk potential.
Prevailing wind direction and speed	<ul style="list-style-type: none"> • The direction of the prevailing winds can also influence the risk potential of a site for dust and other air pollutants. If the prevailing winds (predominant wind direction) are blowing towards sensitive receptors, the risk potential increases because the sensitive receptors are more likely to be impacted than if the winds are blowing away from the sensitive receptors. • The higher the wind speed, the greater the potential for dust lift. • Daily and seasonal variation of wind speed and direction should be considered.
Nature of works	<ul style="list-style-type: none"> • The nature of works to be conducted will affect the dust levels, for example, land clearing and stockpiling may generate more dust than site levelling.
Topography	<ul style="list-style-type: none"> • The topography of the site may influence wind behaviour at the site which could influence the dispersion of dust and other air pollutants from the site.

Appendix 2: Dust control measures

Dust Control Measure	Description
Limit cleared areas	<p>Before the commencement of any site works and during the operation, as much vegetation as possible should be retained, including patches and strips to minimise dust. Dust emissions can be controlled using the following procedures:</p> <ul style="list-style-type: none"> • Before any site works commence, plan and locate the vegetation cover that needs to be retained. • Protect this vegetation by fencing or blocking off from the rest of site operations. • In other areas, maintain the original vegetation cover for as long as possible. • Avoid clearing the entire site at once, instead clear areas as required in stages of the operation. <p>Retaining the original trees, shrubs and grasses is one of the most efficient and effective ways of minimising dust emissions. Even low or sparse scrub can be very effective at dissipating wind velocity at the ground surface, where dust lift off occurs.</p>
Vegetative stabilisation	<p>Vegetation is a very effective form of reducing dust emissions. The following procedures should be considered in minimising dust emissions:</p> <ul style="list-style-type: none"> • Retain as much existing vegetation as possible. • If an area needs to be cleared, transplant established plants that must be disturbed to areas that need vegetation. • If existing vegetation must be removed and can not be immediately transplanted elsewhere, remove and maintain them for replanting at project completion. • If trees and plants must be removed and it is not possible for them to be replanted, consider chipping and using the material as mulch – the advantage is that reseedling of original vegetation can occur. <p>Where possible, restore vegetation that is native to the area to maximise plant success and improve environmental conditions.</p>
Timing of development	<p>It is the developer's responsibility to schedule work on land development sites such that it is carried out at the time of the year, and in a way, which reduces the potential impacts of dust and smoke to a minimum. The time of year when these activities are conducted is critical. Historical records of complaints received by DEC show that very few dust problems occur during winter.</p> <p>Activities with high dust-causing potential, such as topsoil stripping, should not be carried out in sensitive areas during adverse wind conditions. When necessary, topsoil should be stripped in discrete sections, allowing buffer strips (windbreaks) between clearings.</p>

Dust Control Measure	Description
Development staging	<p>Dust generated by bulk earthworks being done during the summer months, particularly with housing in close proximity, can adversely impact upon people who live near development sites. These effects may be reduced if developments can be staged in a sequence whereby bulk earthworks are carried out in the winter months and the completed earthworks “front” is kept to about 100 metres in advance of newly-created lots.</p> <p>In planning the staging of developments, it should be recognised that completed subdivisional stages are often quickly built upon and, hence, the completed stage should be considered to be an improved area when developing the next stage. This means that subsequent stages of any development can require more stringent dust control measures, as the completed subdivisional areas represent an increase in the potential for adverse impacts.</p>
Wind barriers	<p>Having appropriate wind barriers can be an effective measure for the control of dust Over short distances. Wind barriers provide a positive visual impact and offer a protection against the movement and impact of dust on nearby land uses.</p> <p>Wind barriers should be placed on site before commencement of works and when it is apparent that one is required during the phase of the operation. Consider the following options when placing barriers to prevent dust emissions:</p> <ul style="list-style-type: none"> • Wind barriers are most effective when placed perpendicular to the direction of the prevailing wind, but will have little or no effect when the wind direction is parallel to the fence. • When choosing wind barriers it has been observed that solid barriers provide Significant reductions in wind velocity for relatively short leeward distances, whereas porous barriers provide smaller reductions in velocity for more extended distances. • Wind barriers should be at least 2 metres high. • Screening material with a porosity of 50% appears to be optimum for controlling dust.
Earth moving management	<p>Earth-moving works have the potential to generate large amounts of dust. Planning earth-moving works particularly at the start of an operation can reduce dust emissions by limiting the time the site is exposed. Options for dust control can include the following:</p> <ul style="list-style-type: none"> • Plan earth-moving works so that they are completed just prior to the time they are needed. • Observe weather conditions and do not commence or continue earth moving works if conditions are unsuitable e.g., under conditions of strong winds. • Reduce off-site hauling via balanced cut and fill operations. • Pre-water areas to be disturbed.

Dust Control Measure	Description
Management of Material stockpiles	<p>Material stockpiles are capable of generating large amounts of dust. In particular, fine materials stored in stockpiles can be subject to dust pick-up. Materials being loaded onto conveyor belts or into trucks, rail cars or marine vessels are also potential sources of dust emissions. Dust emissions from material stockpiles can be minimised through the use of the following procedures:</p> <ul style="list-style-type: none"> • Locate stockpiles in sheltered areas or in warehouses where possible with building panels and doors effectively sealed. Otherwise, stockpiles should be covered. • Where stockpiles are located in open areas, limit the height and slope of the stockpiles to reduce wind pick up, orient stockpiles lengthwise into the wind so they offer the minimum cross-sectional area to prevailing winds, install wind barriers on three sides of the stockpile. • Limit activity to the downwind side of the stockpile. • Limit drop heights from loading facilities and use closed conveyors where possible. Transfer points should also be minimised. Sprinkler systems could also be used on conveyor systems. Alternatively, dust collection systems, such as, cartridge or baghouse systems could be used instead of sprinklers, where moisture is of concern , for example, with mineral concentrates.
Watering	<p>Watering is applicable to almost every aspect of site operations, from reducing dust lift off from roads and other traffic areas and during earthworks, to controlling dust during movement of materials such as loading/offloading and transportation of materials.</p> <p>Watering is a very effective short-term measure, however its efficiency decreases as wind velocity and evaporation rate increase. Dust emissions can be minimised using the following watering procedures:</p> <ul style="list-style-type: none"> • The surface should be dampened to prevent dust from becoming airborne but should not be wet to the extent of producing run-off. Alternatively, wetting agents could be used, particularly for non-wetting soils. • Watering is more effective when undertaken prior to strong breezes. • Use watering sprays on materials to be loaded and during loading. • The use of scheme water should be discouraged and alternative supplies used whenever possible. However care must be taken to ensure that the quality of water will not have adverse environmental health impacts. • Real time automated response systems to turn on water cannon systems in response to dust levels or high wind speeds could be used. These can help save water by only turning on water cannons during the right conditions and also help reduce the possibility of operator error.

Dust Control Measure	Description
Hydromulch	<p>Hydromulch is a very effective measure for preventing dust lift-off from areas where bulk earthworks have been completed and little or no further vehicular or pedestrian traffic is likely. It is a versatile tool, as the constituents of spray mulch can be varied to suit the requirements of the user and the site. The following procedures for hydromulch can be utilised to reduce dust emissions:</p> <ul style="list-style-type: none"> • Vehicular and pedestrian access to treated areas should be restricted to prevent disturbance to the hydromulch layer. • Wind barriers placed in isolated locations or where long-term effectiveness is required to control access and achieve maximum benefit. • For short-term stabilisation, hydromulch without grass seed should be sufficient stabilisation. • For longer-term stabilisation, hydromulch with grass seed and fertiliser should be included in the spray. Organic stabiliser can also be added to the mix to provide a more stable base for the germination of seeds. <p>Recommended application rates for hydromulch should be sought from suppliers to ensure that application rates and the constituents of the mulch are appropriate to the task.</p>
Chemical Stabilisation	<p>Chemical stabilisers provide immediate coverage and protection; they are effective in areas that receive little traffic or disturbance. They provide a longer-term solution compared to watering, although it may be necessary for the chemical ingredients to be evaluated with regard to their environmental effects.</p> <p>Chemical stabilisers work by binding the soil particles together to create an artificial crust on the soil surface that is less prone to disturbance by wind. The following options should be considered when using chemical stabilisers to reduce dust emissions:</p> <ul style="list-style-type: none"> • Physical barriers or other methods of preventing traffic access should be used to protect stabilised areas. • The manufacturer's instructions should be followed to optimise performance.
Maintenance	<p>The following routine maintenance procedures should also be implemented as a dust control measure:</p> <ul style="list-style-type: none"> • There should be a nominated person with the responsibility for dust management. • All staff should be aware of the potential for dust generation and inducted on dust minimising practices. Staff operating dust control equipment should be trained and regularly have a refresher course. • Dust control equipment should be inspected regularly and defects repaired promptly. Spares should be kept on site for critical items of control equipment, such as water pumps for dust suppression sprays.

Appendix 3: Relevant standards, monitoring methods and principles of operation³

	Equipment/Monitoring Method	Pollutants Monitored	Suitability for compliance/M anagement monitoring	Applicable standards ⁴	Limitations/Comment
1	<p>High volume sampler</p> <p>(A constant flow rate of ambient air is drawn through a filter paper. The mass of the collected particles is determined by weighing the sample filter before and after sampling in a temperature and humidity controlled environment. Particle concentration is calculated using the mass of sample collected and total volume of air drawn. it is operated to sample over a 24 hour period).</p> <p>PAHs occur in the ambient air particle bound or in vapour form. USEPA Method TO-13A uses a combination of a quartz filter (for the particle</p>	<ul style="list-style-type: none"> • Particulate Mass (PM₁₀ & TSP) • Heavy Metals • Polycyclic Aromatic Hydrocarbons (PAHs) 	<p>Compliance</p> <p>(QA/QC requires several working days between the completion of the sampling and calculating results due to filter paper conditioning)</p>	<p>AS/NZS 3580.9.6:2003 – Methods for sampling and analysis of ambient air - Determination of suspended particulate matter – PM₁₀ high volume sampler with size-selective inlet - Gravimetric method</p> <p>AS/NZS 3580.9.3:2003 - Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method</p> <p>AS 2800 – 1985 – Ambient Air – Determination of Particulate Lead – High volume sampler gravimetric collection – Flame atomic absorption spectrometric method. This method could be used for other heavy metals. Alternatively, USEPA Compendium Method IO-3.4. Determination of metals in ambient particulate matter using inductively</p>	<p>A high level of operator skill is required for the siting, operation and processing of results.</p> <p>A power source is required. Generators may be used where a power source is unavailable. Diesel generators produce particles that may influence monitored levels.</p> <p>Security for the equipment is required.</p> <p>Different filters are required for sampling each of the different compounds (TSP, heavy metals, PAHs).</p> <p>For PAHs, both the particle and vapour phase are collected.</p> <p>Does not provide continuous data output.</p>

³ Further information, including the principle of operation of the equipment is provided in Appendix 3.

⁴ These standards are subject to review and the Australian Standards website should be used to check for updated standards. Where an Australian Standard does not exist, a USEPA or equivalent method could be used.

	Equipment/Monitoring Method	Pollutants Monitored	Suitability for compliance/Management monitoring	Applicable standards ⁴	Limitations/Comment
	PAH phase) and a sorbent cartridge (for the vapour phase). Both are then solvent extracted and analysed by gas chromatography with mass spectrometry (GC/MS) detection.			coupled plasma (ICP) spectroscopy, could be used. High volume sampler gravimetric collection for PAHs, but with analysis by method TO-13A. (PAH) USEPA Method TO-13A. Determination of Polycyclic Aromatic Hydrocarbons (PAHs) using Gas Chromatography/Mass Spectrometry (GC/MS) – Jan 1999.	
2	Tapered Element Oscillating Microbalance (TEOM) (The TEOM provides near continuous monitoring of particle mass. The TEOM consists of an oscillating tapered tube with a filter on its free end. As particles land on the filter, the filter mass change is detected as a frequency change in the oscillation of the tube. The mass change and the flow rate through the system provide a measure of the particle concentration. is typically operated at 10-minute intervals),	<ul style="list-style-type: none"> Particulate Mass (PM₁₀, PM_{2.5} & TSP) 	Compliance & Management	AS 3580.9.8-2001 - Method for sampling and analysis of ambient air - Determination of suspended particulate matter – PM ₁₀ continuous direct mass method using a tapered element oscillating microbalance analyser	<p>A high level of operator skill is required for the siting, operation and processing of results.</p> <p>A TEOM can be configured with an alarm system that is set off when Trigger Levels are exceeded, which is useful for management purposes.</p> <p>A power source is required. Generators may be used where a power source is unavailable. Diesel generators produce particles that may influence monitored levels.</p> <p>Security for the equipment is required.</p>

	Equipment/Monitoring Method	Pollutants Monitored	Suitability for compliance/Management monitoring	Applicable standards ⁴	Limitations/Comment
					<p>A climate –controlled enclosure is required.</p> <p>Operation at 10-minute intervals, allows detailed comparison with meteorological conditions.</p>
3	<p>Beta attenuation monitor (BAM)</p> <p>(The BAM is a continuous monitoring method and operates by drawing air through a continuous glass or filter tape. Beta radiation emits low energy electrons that pass through the particles deposited on the tape, and the attenuation of electrons is measured in a sensor located above the tape. The attenuation is converted to an estimate of mass based on the absorption coefficient. The response of the beta gauge will depend on the absorption coefficient of the particles, and will vary with different particle concentrations. It is operated with a time resolution of 1 hour).</p>	<ul style="list-style-type: none"> Particulate Mass (PM₁₀, PM_{2.5} & TSP) 	Compliance & Management	Under development.	<p>A high level of operator skill is required for the siting, operation and processing of results.</p> <p>A BAM can be configured with an alarm system that is set off when Trigger Levels are exceeded, which is useful for management purposes.</p> <p>A power source is required.</p> <p>Security for the equipment is required.</p> <p>A climate –controlled enclosure is required.</p>

	Equipment/Monitoring Method	Pollutants Monitored	Suitability for compliance/Management monitoring	Applicable standards⁴	Limitations/Comment
4	<p>Particle counter</p> <p>(Particle counters use the principle of light scattering and measure the particle size distribution and number of particles to provide an estimate of particle mass. A narrow air stream is directed through a small sensing zone, where an intensive light beam illuminates it.. Light is scattered by individual particles and sensed by a detector as an electrical pulse. Particle size is determined from the pulse amplitude and the particle number is determined from the number of pulses).</p>	<ul style="list-style-type: none"> • Particulate Mass (PM₁₀, PM_{2.5} & TSP) 	Management	NIL	
5	<p>Stainless steel sample canisters</p> <p>(6L summa/silico canisters (silica –lined canisters) are used. These canisters are specially prepared by treating the internal surfaces to render them inert. The canisters are</p>	<ul style="list-style-type: none"> • VOCs: including benzene toluene, xylene & formaldehyde³ 		<p>United States Environmental Protection Agency Compendium Method TO-14A. Determination of Volatile Organic Compounds (VOCs) In Ambient Air Using Specially Prepared Canisters With Subsequent Analysis By Gas Chromatography – Jan 1999.</p>	<p>Method TO-14A measures non-polar VOCs such as benzene, toluene and xylene.</p> <p>Method TO-15 measures both non-polar VOCs and Polar VOCs (aldehydes and ketones), such as formaldehyde. However, currently there are no</p>

³See Air Toxics NEPM

	Equipment/Monitoring Method	Pollutants Monitored	Suitability for compliance/M anagement monitoring	Applicable standards⁴	Limitations/Comment
	then evacuated. In the field, a sample of ambient air is collected by opening the valve of the canister. The canister is then taken to the laboratory for analysis).			OR United States Environmental Protection Agency Compendium Method TO-15. Determination of Volatile Organic Compounds (VOCs) In Ambient Air Using Specially Prepared Canisters With Subsequent Analysis By Gas Chromatography/Mass Spectrometry (GC/MS) – Jan 1999.	laboratories in Australia capable of analysing canisters using method TO-15. Canister samples should be analysed within 30 days of collection.
6	Adsorbant cartridges (Adsorbant cartridges are coated with a substance that adsorbs the VOC or PAH of interest. A pump could be used to draw a known volume of air through the adsorbent tube (active sampling) or the tubes could be left in the field for a certain period of time (passive sampling). For passive sampling, the tubes are fitted with different orifices that control the flow of air. Therefore the tubes can be left out for varying periods of time ranging from say 1 hour to 1 week. The tubes are then taken to the lab for analysis.	<ul style="list-style-type: none"> • Formaldehyde (and other polar VOCs - aldehydes and ketones) • Non-polar VOCs 	Compliance	United States Environmental Protection Agency Compendium Method TO-11A. Determination of Formaldehyde in Ambient Air Using Adsorbant Cartridge Followed by High Performance Liquid Chromatography (HPLC) [Active Sampling Methodology] – Jan 1999. United States Environmental Protection Agency Method TO-1. Method for the determination of Volatile Organic Compounds in ambient air using Tenax® adsorption and Gas Chromatography/Mass Spectrometry (GC/MS). United States Environmental Protection Agency Compendium	Method requires the use of a sampling pump. The pump sampling rate and time is has to be calculated prior to sampling as these are dependent upon the expected concentrations of the compounds in the air to be sampled. The tubes have to be stored below 4°C after sampling. A power source is required for active sampling. However, most pumps can be operated using battery power. Passive sampling may be conducted. However, the sampling is generally conducted

	Equipment/Monitoring Method	Pollutants Monitored	Suitability for compliance/Management monitoring	Applicable standards⁴	Limitations/Comment
	At the lab the VOCs/PAHs are extracted using an organic solvent or thermally desorbed for analysis).			Method TO-17. Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes.	over longer periods (24 hours to 1 week) and there are no standard methods for passive sampling.
7	Membrane Filtration Method (A measured quantity of air is drawn through a membrane filter. The filter is then transformed from opaque to a transparent, optically homogeneous specimen. The respirable fibres are then sized and counted, using a microscope and calibrated eyepiece graticule. The result is expressed as fibres per millilitre of air, calculated from the number of fibres observed on a known area of filter and the volume of air sampled).	<ul style="list-style-type: none"> Asbestos 		Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres 2 nd Edition [NOHSC:3003(2005)]	
8	Meteorological monitoring	<ul style="list-style-type: none"> Wind speed, wind direction, relative humidity, temperature and rainfall. 	Management	AS 2923-1987 Ambient Air – Guide for measurement of horizontal wind for air quality applications.	

	Equipment/Monitoring Method	Pollutants Monitored	Suitability for compliance/Management monitoring	Applicable standards⁴	Limitations/Comment
9	Siting of equipment		Compliance	AS/NZS 3580.1.1:2007 Methods for the sampling and analysis of ambient air – Guide to siting air monitoring equipment	The surrounding topography and obstacles such as trees and building, could limit meeting the requirements of AS 3580.1.1:2007.

Appendix 4: Dust complaint form (example only)

<p>Date:</p> <p>Date on which the complaint was received</p>	<p>Time:</p> <p>Time the complaint was received</p>	<p>Received by:</p> <p>Name of the person receiving the complaint</p>
<p>Name:</p> <p>Name of the person making the complaint</p> <p>Address:</p> <p>Address of the person making the complaint</p> <p>Phone:</p> <p>Telephone number of the person making the complaint</p>		
<p>Municipality:</p> <p>Name of the local government where the site is located</p>		
<p>Complaint details (effect/frequency)</p>		
<p>Referred to:</p> <p>Name of local government Environmental Health Officer or DEC officer if this complaint has been referred.</p> <p>Date:</p> <p>Date of referral to local government officer or DEC officer</p>		
<p>Possible causes and actions taken:</p> <p>Actions taken to eliminate pollution</p>		
<p>Recorded by:</p> <p>Name of the person completing the form</p> <p>Date:</p> <p>Date on which the form was completed</p>		