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Air Quality Impact Assessment

Melbourne Metro Rail Authority

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Aurecon Jacobs Mott MacDonald
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Relevant Legislation

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Appendix C

Peer Review Report



Glossary and Abbreviations

Acronym	Definition
API	Airborne Particle Index
CO	Carbon monoxide
EMF	Environmental Management Framework
EPA Vic	Environment Protection Authority
GLC	Ground Level Concentration
hr	Hour
km	Kilometre
km/h	Kilometres per hour
m	Metre
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Ambient Air Quality) Measure
NO	Molecular formula for nitric oxide
NO₂	Molecular formula for nitrogen dioxide
NO_x	Molecular formula for oxides of nitrogen
O₃	Molecular formula for ozone
PM₁₀	Particulate Matter 10; particulate matter comprising particles with aerodynamic diameters less than 10 microns (µm) in size
PM_{2.5}	Particulate Matter 2.5; particulate matter comprising particles with aerodynamic diameters less than 2.5 microns (µm) in size
ppb	Parts per billion
PTV	Public Transport Victoria
ppm	Parts per million
SEPP (AAQ)	State Environment Protection Policy (Ambient Air Quality)
SEPP (AQM)	State Environment Protection Policy (Air Quality Management)
SO₂	Molecular formula for sulphur dioxide
µm	micron (thousandth of a millimetre)
µg/m³	Microgram (1 x 10 ⁻⁶ gram) per cubic metre
°C	Degrees Celsius



Executive Summary

This report provides an assessment of the air quality-related aspects associated with the construction and operation of the proposed Melbourne Metro Rail Project (Melbourne Metro). These include health and amenity issues, including risks and impacts associated with construction dust. Other aspects, including odour and dust from contaminated land, are covered in more detail in other impact assessments, in particular Technical Appendix Q *Contaminated Land and Spoil Management*.

Air Quality Context

This assessment addresses the specified Environment Effects Statement (EES) Scoping Requirements and specifically evaluates potential impacts to air quality based on the following assessment criteria:

Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that the proposed Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

Methodology

The methodology for the air quality assessment included:

- Review of existing air quality and meteorological conditions
- Identification of sensitive receptors that may be impacted from construction and operational air emissions
- Identification and selection of highest risk precincts during construction for dispersion modelling study
- Modelling of emissions for the three highest risk precincts, including the identification of mitigation measures necessary to minimise impacts and ensure compliance with the assessment criteria and relevant legislation and standards
- Qualitative assessment of impacts from operational air emissions.

Risk Assessment

A risk assessment was undertaken that identified potential construction and operational hazards, impact pathways, consequences to air quality values and likelihood of impacts. The risk to values was determined as the combination of consequence and likelihood. From this risk assessment, a quantitative assessment of selected construction activities was completed as was a qualitative assessment of operational activities.



Where possible, mitigation measures were identified to reduce risks and manage the project impact to air quality. Dust emissions from construction activities were identified as the main risk to air quality.

The proposed Melbourne Metro would operate on electric trains only and therefore air emissions associated with routine operation of the Melbourne Metro are considered to be negligible in comparison to construction-related air emissions and impacts. As such, this air quality impact assessment has focused on issues relevant to construction-related air emissions.

Regional impacts from the operation of the proposed Melbourne Metro are considered insignificant.

The construction of the Melbourne Metro is likely to generate dust emissions to some degree at each construction precinct and at the spoil disposal sites. Given the duration and level of civil construction activities, together with the proximity to sensitive receptors and areas of high population density, there is the potential for the Melbourne Metro to impact local air quality through dust and combustion-related emissions during the proposed construction. Six main pathways have been identified that might lead to air quality impacts during construction, as follows:

- Dust emissions from construction activities (wheel-generated dust, spoil handling and transfer, wind-generated dust from exposed surfaces, on-site concrete batching plant)
- Exhaust emissions from on-site plant and equipment
- Emissions from construction traffic movements (dust and exhaust emissions)
- Increased/concentrated traffic emissions due to road closures or diversions
- Emissions from ventilation stacks (temporary or permanent)
- Dust and/or odour emissions from excavation, transport and disposal of contaminated soils and sediments.

Air Quality Criteria and Existing Air Quality

The ambient air quality objectives relevant to the project are summarised in Section 3.2 of this report. These include air quality objectives and goals established by the National Environment Protection (Ambient Air Quality) Measure (NEPM(AAQ)) (NEPC, 2003), which were adopted by Victoria's State Environment Protection Policy (Ambient Air Quality) (SEPP AAQ) (VG, 1999). The NEPM(AAQ) was recently amended (NEPC, 2016), however the amendments have not yet been adopted by EPA Victoria. The key pollutants of concern from dust-generating activities during construction are considered to be airborne particulate matter (PM_{2.5} and PM₁₀) and dust deposition.

Particulate matter in the atmosphere refers to a range of particle types and sizes. The smaller particles are classified by their size as less than 10 microns in diameter (PM₁₀) or less than 2.5 microns in diameter (PM_{2.5}). The health effects of particles are strongly influenced by the size of the particles. Smaller particles can penetrate further into the respiratory tract, with the smallest particles penetrating to the gas exchange areas of the lungs (alveoli) and therefore they have a greater impact on human health. Larger particles primarily cause aesthetic impacts, usually associated with coarse particles settling on surfaces.

The EPA Vic monitors a range of pollutants, which are assessed against the objectives and goals set out in SEPP (AAQ). The closest EPA Vic monitoring sites to the project alignment are Richmond, approximately 2.3 km from the eastern portal and Footscray, approximately 4.5 km from the proposed western portal. Of these, Richmond is considered the most representative site for the Melbourne Metro construction work sites, being in proximity to the majority of the proposed Melbourne Metro corridor and supporting land use that is more consistent with the wider investigation area than Footscray. Monitoring data from Richmond was therefore used to represent background air quality for the Melbourne Metro, supplemented with data from Footscray where no data was available for Richmond.

Air monitoring and meteorological data from 2011-2014 was used to determine representative baseline conditions for Melbourne Metro. For dispersion modelling, the study year of 2014 was selected and is



considered representative of typical conditions, with background air quality being conservatively higher than previous years due to bush fire-related air quality events skewing statistics slightly during 2014.

The maximum 24-hour PM₁₀ recorded at Richmond was 63.6 µg/m³ in 2014 (PM₁₀ 24-hour criterion: 50 µg/m³), however there were no exceedances of the air quality goal (maximum allowable 5 exceedances of the objective per year). The maximum 24-hour PM_{2.5} recorded at Footscray was 39.1 µg/m³ in 2014 (PM_{2.5} 24-hour average criterion: 25 µg/m³), with annual average PM_{2.5} of 7.1 µg/m³ (PM_{2.5} annual average criterion: 8 µg/m³). Using EPA Vic air quality index categories, existing conditions were good to fair with the possibility of occasional exceedance of PM₁₀ and PM_{2.5}.

Modelling Approach

An air emissions inventory for each precinct was developed based on the construction activities expected and spoil volume movements predicted for each area. Based on the emissions inventory and the proximity to sensitive receptors, two areas considered to have the highest risk of air quality impacts were selected for dispersion modelling of construction dust. The modelling study areas are located where TBM spoil would be extracted as these locations have the highest spoil volume and haulage rates. They are the Arden precinct in the northern section and either the Domain precinct in the southern section or an alternative design option involving TBM spoil extraction simultaneously from both Domain and Fawkner Park.

Air dispersion modelling using the EPA Vic regulatory model 'AERMOD' was undertaken. This model was used to predict potential dust impacts in the vicinity of key construction work sites, and the significance of the model results was determined by comparison with the EPA Vic air quality objectives.

Modelling was conducted assuming truck movements were on unsealed surfaces and that the majority of the construction site was exposed to wind erosion. Mitigation methods were applied in the emissions inventory to reduce, but not remove emissions from these sources.

Impact Assessment

Modelling results showed that exceedances of the SEPP criteria are unlikely at sensitive receptor locations. There was one small area of predicted exceedance for 24-hour average PM₁₀ at the Arden site, which was located within the construction work site, extending a short distance into the adjoining rail corridor. There were no predicted exceedances of 24-hour PM_{2.5}, annual PM_{2.5} or dust deposition.

The modelling has demonstrated that with appropriate mitigation, activities at the Arden, Domain and Fawkner Park construction work sites can be managed within SEPP criteria for sensitive receptor locations, however, on days when background particulate concentrations are high there would still be the potential for exceedances of air quality criteria.

Historical air quality statistics show that there are occasional exceedances of air quality criteria within metropolitan Melbourne. To minimise the contribution by construction activities on days with high background concentrations, which could potentially lead to an exceedance of air quality criteria, the adoption of best practice mitigation measures is necessary.

The major contributors to dust emissions are truck movements on unsealed surfaces, and wind erosion of open areas. Best practice would be to minimise the potential for dust generation from these processes by reducing and minimising the sources of the emissions. This would be achieved by reducing the distance travelled by trucks on unsealed surfaces by planning stockpile locations and haul road routing to minimise the distance travelled, and by sealing haul roads where possible. Wind erosion from exposed areas would be minimised through sealing or establishing vegetation on exposed surfaces or by enclosure with sheds if practicable.

Maintenance of sealed haul roads and open areas may require the use of rumble grids or wheel washing for haul trucks and regular street sweeping or road washing. Where it is not possible to remove the source of the emissions, mitigation measures would be required including the use of windbreaks and water sprays on stockpiles and exposed surfaces, and dust suppression on unsealed roads by water trucks.



Dust monitoring at key sensitive receptors would be required to demonstrate compliance with SEPP air quality criteria. In addition to providing a record of compliance, the monitoring program would provide the basis of a reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions. The proposed Melbourne Metro is consistent with draft EES evaluation objectives as it is expected to meet air quality criteria, and air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

Environmental Performance Requirements

The following Environmental Performance Requirements are recommended:

Environmental Performance Requirements

Develop and implement plan(s) for dust management and monitoring, in consultation with EPA, to minimise and monitor the impact of construction dust.

The plan must address monitoring requirements for key sensitive receptors including, but not limited to:

- Residential and commercial properties
- Hospitals and research facilities within the Parkville precinct
- Universities, including the University of Melbourne and RMIT
- Schools, including Melbourne Grammar School (Wadhurst Campus) and Christ Church Grammar School
- Public parks including the Shrine of Remembrance Reserve and JJ Holland Reserve.

Undertake air modelling for construction to inform the dust management plan.

Manage construction activities to minimise dust and other emissions in accordance with EPA Publication 480, Environmental Guidelines for Major Construction Sites (EPA 1996).

Control the emission of smoke, dust, fumes and other pollution into the atmosphere during construction and operation in accordance with the SEPPs for Air Quality Management and Ambient Air Quality.



1 Introduction

This report provides an assessment of the air quality impacts on the proposed Melbourne Metro Rail Project (Melbourne Metro).

1.1 Project Description

The proposed Melbourne Metro comprises two nine-kilometre long rail tunnels from Kensington to South Yarra, travelling underneath Swanston Street in the Central Business District (CBD), as part of a new Sunbury to Cranbourne/Pakenham line to form the new Sunshine-Dandenong Line.

The infrastructure proposed to be constructed as part of Melbourne Metro broadly comprises:

- Twin nine-kilometre rail tunnels from Kensington to South Yarra connecting the Sunbury and Cranbourne/ Pakenham railway lines (with the tunnels to be used by electric trains)
- Rail tunnel portals (entrances) at Kensington and South Yarra
- New underground stations at Arden, Parkville, CBD North, CBD South and Domain with longer platforms to accommodate longer High Capacity Metro Trains (HCMTs). The stations at CBD North and CBD South would feature direct interchange with the existing Melbourne Central and Flinders Street Stations respectively
- Train/tram interchange at Domain station.

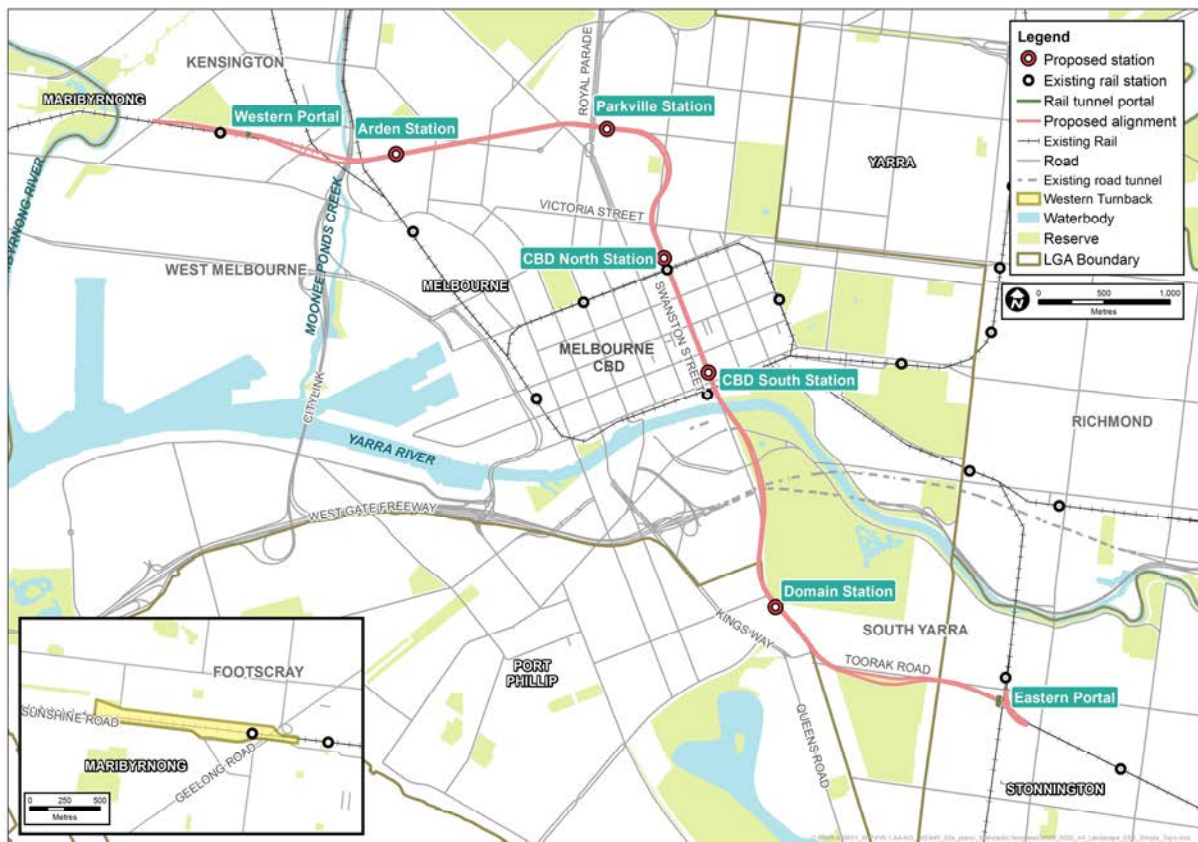


Figure 1-1 Map of the proposed Melbourne Metro alignment and five underground stations



Proposed construction methods involve bored and mined tunnels, cut-and-cover construction of station boxes at Arden, Parkville and Domain and portals, and cavern construction at CBD North and South. The Melbourne Metro would require planning, environmental and land tenure related approvals to proceed.

1.2 Purpose of this Report

The purpose of this report is to assess the air quality impacts associated with the proposed construction and operation of the proposed Melbourne Metro, and define performance requirements necessary to meet air quality objectives.

The air quality assessment consists of a quantitative assessment of selected construction activities and a qualitative assessment of operational activities, based on the Concept Design.

1.3 Project Precincts

For assessment purposes, the proposed project boundary has been divided into precincts as outlined below. The precincts have been defined based on the location of project components and required construction works, the potential impacts on local areas and the character of surrounding communities.

The proposed precincts are:

- Precinct 1: Tunnels (outside other precincts)
- Precinct 2: Western portal (Kensington)
- Precinct 3: Arden station (including substations)
- Precinct 4: Parkville station
- Precinct 5: CBD North station
- Precinct 6: CBD South station
- Precinct 7: Domain station
- Precinct 8: Eastern portal (South Yarra)
- Precinct 9: Western turnback (West Footscray).

The nine precincts are shown in Figure 1-2.

1.4 Study Area

With the exception of TBM tunnelling works (for which emissions to air are contained within the tunnels), impacts to air quality are expected at all locations where construction activity is being conducted. As such, the study area spans all the construction precincts with the areas of greatest risk being the precincts with the highest intensity of construction works and handling of excavated spoil.

The air quality assessment is therefore focussed on the proposed major construction work sites at Arden, Domain and Fawkner Park (Concept Design provides for the use of Domain or the use of Domain and Fawkner Park). These sites would be the extraction points for removal of TBM tunnelling spoil and a high number of truck movements would be required in addition to the other construction activities at those sites. Section 6 of this report provides more detail on the risk assessment and activities which may lead to air quality impacts.

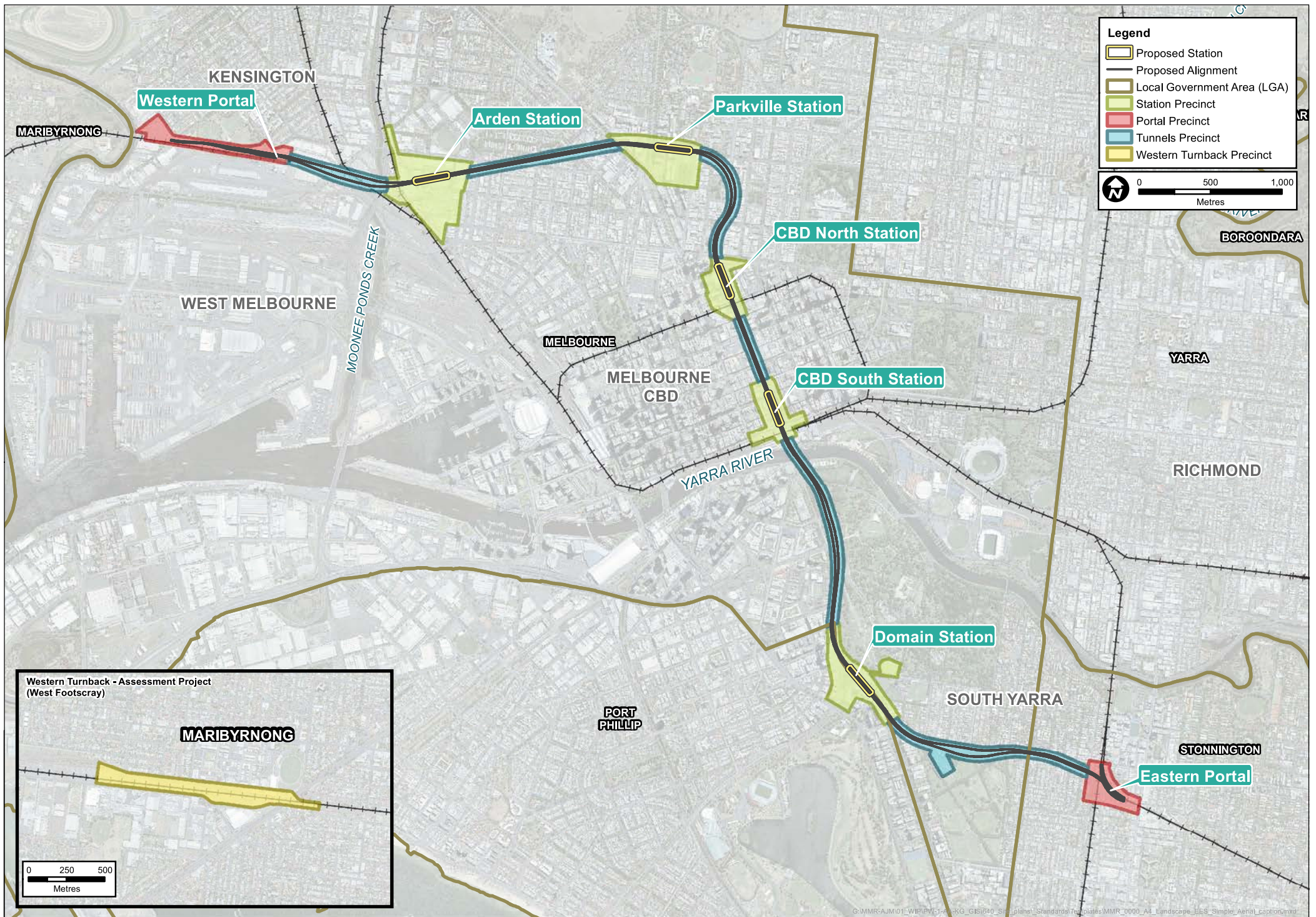


Figure 1-2 Melbourne Metro precincts



2 Scoping Requirements

2.1 EES Objectives

The following draft evaluation objectives (Table 2-1) are relevant to amenity and identify the desired outcomes in the context of potential project effects. The draft evaluation objectives provide a framework to guide an integrated assessment of environmental effects of the project, in accordance with the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978*.

Table 2-1 Draft amenity evaluation objective

Draft EES evaluation objective	Key legislation
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p><i>Environment Protection Act 1970, State Environment Protection Policies and guidelines</i></p> <p><i>Planning and Environment Act 1987</i></p> <p><i>Transport Integration Act 2010</i></p>

2.2 EES Scoping Requirements

The following extracts from the Scoping Requirements, issued by the Minister for Planning, are relevant to the amenity objectives (Table 2-2).

Table 2-2 Scoping Requirements for Amenity

Aspect	Relevant responses
Key Issues	<ul style="list-style-type: none"> Adverse effects on air quality, due to dust or other emissions from construction works and project operations including ventilation systems.
Priorities for characterising the existing environment	<ul style="list-style-type: none"> Existing air quality conditions and trends, relative to relevant SEPP standards, including known factors which may lead to local exceedances, to which project air quality management may need to be adapted or respond.
Design and mitigation measures	<ul style="list-style-type: none"> Design, management and intervention measures which may be applied to prevent or control emissions of dust or other air pollutants from construction works sites.
Assessment of likely effects	<ul style="list-style-type: none"> Analysis of risks of exceeding relevant air quality standards resulting from project works, either in isolation or in addition to background levels of air pollutants.
Approach to manage performance	<ul style="list-style-type: none"> Describe the principles to be adopted for setting key elements of proposed monitoring programs for air quality, noise and vibration, both during construction works and for project operations, as appropriate. Describe the principles to be adopted for developing contingency measures to be applied if monitoring demonstrates more significant adverse effects than predicted or permitted.



3 Legislation, Policy and Guidelines

3.1 Overview

Table 3-1 identifies legislation and policy that are relevant to the proposed Melbourne Metro as well as the implications, required approvals, interdependencies and information requirements associated with obtaining approvals. Note that the State Environment Protection Policy (Ambient Air Quality) (VG, 2003) reflects the National Environment Protection (Ambient Air Quality) Measure (NEPC, 2016) standards and goals, with the exception of the recent amendments enforced on the 25 February 2016. This is discussed further in Section 3.2 and Appendix A of this report.

Table 3-1 Primary legislation and associated information

Legislation/ policy	Key policies/ strategies	Implications for this project	Approvals required	Timing / interdependencies
Commonwealth				
National Environment Protection Council Act 1994	<p>National Environment Protection (Ambient Air Quality) Measure (NEPM AAQ) (NEPC, 2003; NEPC, 2016).</p> <p>National Environment Protection (Air Toxics) Measure (NEPM Air Toxics) (NEPC, 2011).</p>	<p>Through the SEPP (AAQ), EPA Vic assesses air quality in Victoria by adopting the air quality standards and goals provided in the NEPM (AAQ) for six primary air pollutants: carbon monoxide, nitrogen dioxide, ozone, sulphur dioxide, lead and particles (as PM₁₀).</p> <p>Ground level impacts of air emissions (construction and operation) should comply with the air quality standards and objectives provided in NEPM (AAQ) and NEPM (Air Toxics).</p>	NA	NA
State				
Environment Protection Act 1970	<p>State Environmental Protection Policy (Ambient Air Quality) (SEPP AAQ), (VG, 1999).</p> <p>State Environment Protection Policy</p>	<p>Ground level impacts of air emissions (construction and operation) should comply with the air quality standards and objectives provided in SEPP (AAQ),</p>	<p>No approval is required, however, compliance with the SEPP (AAQ) is required, which is given effect under the <i>Environment Protection Act</i></p>	NA



Legislation/ policy	Key policies/ strategies	Implications for this project	Approvals required	Timing / interdependencies
	<p>(Air Quality Management) 2001 (SEPP AQM) (VG, 2001).</p> <p>Protocol for Environmental Management (PEM): Mining and Extractive Industries (EPA Vic, 2007).</p>	<p>SEPP (AQM) and the PEM.</p> <p>Apply best practice mitigation measures.</p> <p>Ongoing reporting and pursue continuous improvement.</p> <p>The PEM is not mandatory for this project but it has been prepared under the SEPP AQM and contains the only relevant criteria for dust deposition associated with mobile equipment.</p>	<p>1970.</p>	
<p>Environment Protection Act 1970</p>	<p>Environmental Guidelines for Major Construction Sites (EPA Vic, 1996).</p>	<p>Guideline recommends a dust prevention strategy be developed at the project planning stage and outlines a range of dust control and suppression measures.</p>	<p>No approval is required, however the Guidelines are given effect under the <i>Environment Protection Act 1970</i>.</p>	<p>Environmental Management Framework (EMF) must incorporate the requirements of this Guideline.</p>
<p>Planning and Environment Act 1987</p>	<p>All Planning Schemes.</p> <p>Clause 13.04-2 provides for air quality, with the objective of assisting the protection and improvement of air quality.</p>	<p>Strategies to assist are:</p> <p>Ensuring that land-use planning and transport infrastructure provision contribute to improved air quality by:</p> <ul style="list-style-type: none"> • Integrating transport and land-use planning to improve transport accessibility and connections • Providing infrastructure for public transport, walking and cycling • Ensure, wherever possible, that there is suitable separation between land uses that reduce amenity and sensitive land uses. <p>Planning must consider the State Environment Protection SEPP (AQM).</p>	<p>NA</p>	<p>NA</p>



Legislation/ policy	Key policies/ strategies	Implications for this project	Approvals required	Timing / interdependencies
Local				
Activities Local Law (City of Melbourne, 2009)	Management of air emissions should comply with local government regulations and policies.	Management requirements to be captured in the EMF to be prepared for Melbourne Metro.	NA (guidance document only).	NA
Construction Management Plan Guidelines (City of Melbourne, 2006)	Management of air emissions during construction.	Airborne dust and pollutants in and around construction work sites are to be maintained at acceptable levels throughout construction.	NA (guidance document only).	NA
General Local Law 2008 (No. 1), amended 2011 (City of Stonnington)	Section 716: description of management of construction dust.	Nil. Typically aimed at residential occupiers and small construction projects rather than major construction projects.	NA	NA
City of Port Phillip	NA	NA	NA	NA
City of Maribyrnong	NA	NA	NA	NA



3.2 Air Quality Criteria

The Ambient Air Quality NEPM and SEPP (AAQ) air quality objectives and goals are summarised in Table 3-2 and Table 3-3 respectively. Definitions are provided in the Glossary and Abbreviations at the front of this report. The recent amendments to the objectives and goals for PM₁₀ and PM_{2.5} are included in the Ambient Air Quality NEPM and the standard for visibility reducing particles included in the SEPP (AAQ).

Table 3-2 NEPM Ambient air quality objectives and goals (Ambient Air Quality NEPM)

Environmental indicator (air pollutant)	Averaging period	NEPM ambient air	
		Objective	Goal (exceedances) ¹
CO (maximum conc.)	8 hours ²	9.0 ppm	1 day/year
NO₂ (maximum conc.)	1 hour	120 ppb	1 day/year
	1 year	30 ppb	none
O₃ (maximum conc.)	1 hour	100 ppb	1 day/year
	4 hours ³	80 ppb	1 day/year
SO₂ (maximum conc.)	1 hour	200 ppb	1 day/year
	1 day	80 ppb	1 day/year
	1 year	20 ppb	none
Lead	1 year	0.50 µg/m ³	none
Particles as PM₁₀⁴	1 day	50 µg/m ³	none
	1 year	25 µg/m ³	none
Particles as PM_{2.5}⁴	1 day	25 µg/m ³	none
	1 year	8 µg/m ³	none

¹ Goals are maximum allowable exceedances of objective.

² Rolling 8-hour average based on 1 hour averages.

³ Rolling 4-hour average based on 1 hour averages.

⁴ PM₁₀ and PM_{2.5} objectives and goals have recently been amended (see discussion below), and are not currently reflected in SEPP (AAQ).

Table 3-3 Victorian ambient air quality objectives and goals (SEPP (AAQ))

Environmental indicator (air pollutant)	Averaging period	SEPP (AAQ)	
		Objective	Goal (exceedances) ¹
CO (maximum conc.)	8 hours ²	9.0 ppm	1 day/year
NO₂ (maximum conc.)	1 hour	120 ppb	1 day/year
	1 year	30 ppb	None



Environmental indicator (air pollutant)	Averaging period	SEPP (AAQ)	
		Objective	Goal (exceedances) ¹
O3 (maximum conc.)	1 hour	100 ppb	1 day/year
	4 hours ³	80 ppb	1 day/year
SO2 (maximum conc.)	1 hour	200 ppb	1 day/year
	1 day	80 ppb	1 day/year
	1 year	20 ppb	None
Lead	1 year	0.50 µg/m ³	None
Particles as PM₁₀	1 day	50 µg/m ³	5 days/year
Visibility reducing particles⁴ (minimum visual distance)	1 hour	20 km	3 days/year

¹ Goals are maximum allowable exceedances of objective.

² Rolling 8-hour average based on 1 hour averages.

³ Rolling 4-hour average based on 1 hour averages.

⁴ Visibility reducing particles is listed in the SEPP (AAQ), but not included in the Ambient Air Quality NEPM.

The NEPM air quality objectives and goals have recently been amended and came into force on the 25 February 2016 (NEPC, 2016). This follows the release of a draft variation of the NEPM and impact statement for public consultation between 31 July 2014 and 10 October 2014, and the announcement of a National Clean Air Agreement on 5 December 2015.

The changes to the NEPM strengthen national ambient air quality reporting standards for airborne fine particles, PM₁₀ and PM_{2.5}. The previous air quality objectives and goals and the changes enforced by this recent amendment are summarised in Table 3-4.

Table 3-4 Amendment to Ambient Air Quality NEPM (2016)

Environmental indicator (air pollutant)	Averaging period	SEPP (AAQ)		Comment
		Objective	Goal (exceedances) ¹	
NEPM air quality objectives and goals - prior to 25 February 2016				
Particles as PM₁₀	1 day	50 µg/m ³	5 days/year	
Particles as PM_{2.5}⁴	1 day	25 µg/m ³	-	PM _{2.5} is an advisory reporting standard in the NEPM.
	1 year	8 µg/m ³	-	
NEPM air quality objectives and goals enforced on 25 February 2016				
Particles as PM₁₀⁴	1 day	50 µg/m ³	none	Removal of 5 allowable exceedances per year.
	1 year	25 µg/m ³	none	Addition of annual PM ₁₀ standard



Environmental indicator (air pollutant)	Averaging period	SEPP (AAQ)		Comment
		Objective	Goal (exceedances) ¹	
Particles as PM _{2.5} ⁴	1 day	25 µg/m ³	none	PM _{2.5} advisory reporting standard adopted as a national air quality standard
	1 year	8 µg/m ³	none	

While all jurisdictions have agreed to this action, no States (including the EPA Vic) have prescribed a change to their air quality objectives to be used for the assessment of specific projects. As such, the criteria contained in Table 3-5 and discussed in detail in Appendix A remain current for the assessment of potential impacts.

Table 3-5 Air quality criteria adopted for assessment

Pollutant	Averaging period	Maximum concentration
PM ₁₀ ¹	24 hour	50 µg/m ³
PM _{2.5}	24 hour	25 µg/m ³
	Annual	8 µg/m ³

¹ For assessment purposes, there is no allowable exceedance of the criteria (goal).

The main risk for ambient air quality and amenity from construction activities is dust. The potential for contaminated dusts and odour from excavated material to cause air quality impacts is of lesser concern. While firm links have been established between increased PM concentrations and health, e.g. Schwartz (1994), further research is required and being undertaken to determine links between particle composition and impacts on human health, e.g. Solomon et al. (2012) and CSIRO (2013). As such, at present, PM₁₀ and PM_{2.5} represent the best indicators of the potential for human health impacts from particle emissions; especially for cases where the composition is variable or unknown.

Deposited dust is an indicator of the effectiveness of site management practices and the potential for off-site nuisance dust. EPA Vic (2007) provides guidance in regard to deposited dust. The criteria for deposited dust, while typically used in Victoria to protect the amenity of populations near mines or quarries, is applied as an objective for major construction work sites where dust emissions are significant. The criteria for deposited dust are summarised in Table 3-6.

Table 3-6 EPA Vic air quality objectives – construction dust (EPA Vic, 2007)

Pollutant	Averaging period	Maximum deposition rate	Source
Dust Deposition	Monthly average	4 g/m ² /month ^{1#}	EPA Vic (2007)
		2 g/m ² /month ^{1&}	

¹ Dust is assessed as insoluble solids as defined by AS 3580.10.1–2003.

Maximum deposited dust rate

& Maximum Increase in deposited dust rate.



The SEPP (AQM) prescribes a design criterion for new sources of general odour to be the detection threshold, to be applied at and beyond a site boundary of premises. However, the odour criterion is to be applied to normal operations by a facility; e.g. typically a wastewater (sewerage) plant. The odour impacts that may be experienced during construction activities would be short-term, abnormal events and managed by on-site environmental management procedures. Further information on management of odour is covered in Sections 5.1.7 and 7.5.2.



4 Methodology

4.1 Existing Conditions

From an air quality perspective the existing conditions are characterised by the concentrations of substances in the ambient air and the local meteorology. Ambient air quality and meteorological monitoring data were reviewed in order to gain an understanding of the existing conditions.

4.2 Air Dispersion Modelling

The risk assessment in Technical Appendix B *Environmental Risk Assessment Report* identified three precincts as having potentially high risk of air quality impacts. These three precincts were selected for detailed assessment of construction dust based on the level of construction activities expected and proximity to sensitive receptors. The modelling study areas were located where TBM spoil would be extracted as these have the highest spoil volume and haulage rates. They are: Arden station precinct in the northern section, and either Domain in the southern section or an alternative design option with TBM spoil extraction simultaneously from both Domain and Fawkner Park.

The dispersion modelling methodology for this assessment was undertaken in accordance with the SEPP (AQM) with consideration given to the draft EPA guidelines for use of the regulatory model in Victoria, AERMOD. These include:

- EPA, Draft guideline, Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD), Publication 1550, October 2013 (EPA 2013b)
- EPA, Draft guideline, Guidance notes for using the regulatory air pollution model AERMOD in Victoria, Publication 1551, October 2013 (EPA 2013c).

4.2.1 AERMOD Modelling Methodology

AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. The modelling system comprises three components: (1) AERMOD (dispersion model); (2) AERMET (meteorological pre-processor); and (3) AERMAP (terrain pre-processor) (EPA, 2013c).

The AERMOD software used for this assessment was pDsAUSMOD (sourced from pDs Consultancy). pDsAUSMOD is an Australian Graphical User Interface (GUI) for AERMOD, built on the AERMOD version 12345 kernel.

The modelling domain used a uniform Cartesian grid with 25 m spacing. No terrain or building wake effects were included due to the close proximity of receptors to the emission sources and the relatively flat topography.

The main AERMOD modelling parameters are listed in Table 4-1 and Table 4-2.

Table 4-1 AERMOD model input parameters for the proposed Arden station

AERMOD parameter	Settings and notes
Grid centre	Easting 317,800, Northing 5,813,300 (MGA 94).
Domain size	1.5 km (east-west) by 1.5 km (north-south).
Grid resolution	25 m (EPA's recommended maximum is 50m).



AERMOD parameter	Settings and notes
Sources	All dust sources treated as AERMOD volume sources; i.e. EPA's recommendation for sites with high frequency of low wind speeds.
Building wake effects	Not included – clear lines of sight between dust sources and nearest sensitive receptors.
Terrain effects	Not included – flat terrain.

Table 4-2 AERMOD model input parameters for the proposed Domain station and Fawkner Park

AERMOD parameter	Settings and notes
Grid centre	Easting 320,441, Northing 5,809,370 (MGA 94).
Domain size	2.5 km (east-west) by 2.5 km (north-south).
Grid resolution	25 m (EPA's recommended maximum is 50 m).
Sources	All dust sources treated as AERMOD volume sources; i.e. EPA's recommendation for sites with high frequency of low wind speeds.
Building wake effects	Not included – clear lines of sight between dust sources and nearest sensitive receptors.
Terrain effects	Not included – flat terrain.

4.2.2 AERMOD Meteorological Data

The AERMOD modelling used surface and upper air 'profile' meteorological files produced in accordance with EPA Vic (2013b). The meteorological files were prepared by pDs Consultancy and constructed using observations from Essendon Airport for the five years spanning 2010 to 2014.

The Essendon Airport meteorological data was utilised in preference of other sources of data such as Footscray (EPA) or Melbourne Regional Office (BoM) for a number of reasons:

- Footscray meteorological data is incomplete for some key parameters such as winds, and does not monitor for some of the other required parameters.
- Melbourne Regional Office, although offering a long history of quality measurements, is potentially influenced by nearby high-rise buildings (wind channelling or blocking) and a high proportion of hard surfaced areas (heat island effects).

In comparison, the Essendon Airport meteorological monitoring site is located in an open area with predominantly natural ground cover and measures all ground based parameters required for the study. Upper air observations were obtained from Melbourne Airport. Data completeness is greater than 99 per cent for each of the five years of data obtained.

An analysis of the annual meteorological datasets and air quality parameters was undertaken to select a representative year for assessment.

From analysis of the wind observations data and air quality monitoring data the case study year 2014 was selected for the following reasons:

- The wind roses and wind speeds indicate 2014 is representative of typical conditions, i.e. the wind roses 2010-2014 are very similar with similar average wind speeds; with the exception of the 2013 data, which has some stronger northerly winds.



- While Melbourne's PM_{2.5} Ground Level Concentrations (GLCs) have been trending downwards over the past decade, (EPA, 2015), there is a slight increase in PM_{2.5} from 2012-2014, so by selecting 2014 a year with higher background for PM_{2.5} was selected.

4.2.3 Dust Mitigation Measures

The controls that are available for Melbourne Metro can be summarised in three broad categories:

- Engineering controls
- Planning controls
- Operational controls.

Engineering controls involve measures such as windbreaks, enclosing transfer points and installation of automatic spray systems on stockpiles.

Planning controls include concentrating dust-generating activities at locations such that adequate buffer distances to sensitive receptors can be maintained, or locating activities such that the handling and transport of materials is minimised.

Operational controls may include varying operations when adverse meteorological conditions occur or increasing the frequency of application of water or dust suppression agents on exposed surfaces and stockpiles.

EPA Publication 480, *Environmental Guidelines for Major Construction Sites* (EPA 1996) provides guidance on dust control measures and is given effect under the *Environment Protection Act 1970*. The key control measures for Melbourne Metro provided in the guidance document are:

- Minimise the area of land clearing required and the period of time areas remain cleared to a minimum
- Rehabilitate cleared areas promptly
- Restrict vehicles to defined roads
- Pave (seal) and/or water haul roads
- Water areas other than haul roads if they are a source of dust
- Construct wind fences if this is appropriate for the site
- Minimise the number and size of stockpiles
- Ensure that all vehicles and machinery are fitted with appropriate emission control equipment, maintained frequently and serviced to the manufacturers' specifications
- Take measures to ensure entry, exit and haul roads are kept clean. Depending on the activities and any site constraints, this may involve the installation of rumble grids and wheel washing systems or require regular road washing or the use of street sweepers.

As part of the development of the Contractor's Environmental Management Plan (EMP), site-specific dust management and monitoring plans for each precinct would be prepared by the Constructor in accordance with EPA Publication 480 (EPA 1996), prior to the commencement of construction. The dust management and monitoring plans would detail the construction methods, site activities and mitigation measures required to meet the Environmental Performance Requirements of the project. Engagement with stakeholders (e.g. EPA Victoria) would be required following preparation of the EMP.

For the purposes of the modelling study, dust mitigation measures have been applied based on reduction factors described in the National Pollutant Inventory (NPI) manuals (NPI, 2012; NPI, 1999) and are listed below:

- Water trucks used to apply Level 2 watering (2 litres/m²/hr) to all unsurfaced roads (75 per cent reduction)
- Windbreaks used to protect stockpiles and unsealed surfaces from wind erosion (30 per cent reduction)



- Water sprays used to protect stockpiles and unsealed surfaces from wind erosion (50 per cent reduction).

In cases where more than one control measure is applied, the combined reduction factor is multiplicative, i.e. in the case of water sprays used in conjunction with windbreaks on stockpiles, the combined effect is $(1 - 0.5) \times (1 - 0.3) = 0.35$ of the uncontrolled emission (reduction factor of 65 per cent).

4.2.4 Air Emissions Estimates

The main pathways for dust emissions from the proposed construction activities are spoil handling and transfer, wheel-generated dust, wind-generated dust from exposed surfaces and emissions from the on-site concrete batching plant. Emissions estimates assume truck movements are on unsealed surfaces and that the majority of the construction work site is exposed to wind erosion.

Total dust emissions due to the project have been estimated by analysing the activities taking place at each site. The emissions calculations were based on techniques set out in the following sources:

- NPI Emission Estimation Technique Manual (EETM) for Mining (NPI, 2012)
- NPI Emission Estimation Technique Manual (EETM) for Concrete Batching and Concrete Product Manufacturing (NPI, 1999)
- AP-42 (US EPA, 1995 and updates).

The assessment is based on two emissions inventory scenarios. The first covers air quality impacts assessed over 24-hour averaging periods (peak scenario), and the second over annual periods (annual scenario). In each case, the emissions inventory is based on the estimated construction truck numbers and excavated spoil volume estimates developed by MMRA for the purpose of this assessment. It should be recognised that these are estimates, and are the best information available at the time of writing this report.

The construction truck activity estimates include not only the spoil removal, but also the delivery of materials and equipment associated with the various construction activities. They do not include worker trips to/from the worksites. Table 4-3 summarises the average daily truck round trips assuming the southern TBM is launched from Domain, and Table 4-4 provides a summary assuming southern TBM launch from Domain and Fawkner Park. Indicative spoil volume estimates are summarised in Table 4-5.

Table 4-3 Construction truck numbers distributed over time (Southern TBM launch site – Domain only)

Location	Timeframe (months)	Average daily truck round trips	Months							
			1-6	7-12	13-18	19-24	25-30	31-36	37-42	43-48
Western portal	30	25	19	25	31	31	19	0	0	0
Arden station and Tunnels	48	130	78	130	156	182	156	130	104	104
Parkville station	48	50	30	50	60	70	60	50	40	40
CBD North station	48	75	45	75	90	105	90	75	60	60
CBD South station	48	75	45	75	90	105	90	75	60	60
Linlithgow Avenue Shaft	12	10	10	10	0	0	0	0	0	0
Domain station	48	50	30	50	60	70	60	50	40	40



Location	Timeframe (months)	Average daily truck round trips	Months							
			1-6	7-12	13-18	19-24	25-30	31-36	37-42	43-48
Southern TBM Site and Tunnels	24	70	56	84	84	56	0	0	0	0
Fawkner Park shaft	12	10	10	10	0	0	0	0	0	0
Eastern portal	30	25	19	25	31	31	19	0	0	0
Totals		520	342	534	602	650	494	380	304	304

Source: Advisian

Table 4-4 Construction truck numbers distributed over time (Southern TBM launch site – Domain and Fawkner Park)

Location	Timeframe (months)	Average daily truck round trips	Months							
			1-6	7-12	13-18	19-24	25-30	31-36	37-42	43-48
Western portal	30	25	19	25	31	31	19	0	0	0
Arden station and Tunnels	48	130	78	130	156	182	156	130	104	104
Parkville station	48	50	30	50	60	70	60	50	40	40
CBD North station	48	75	45	75	90	105	90	75	60	60
CBD South station	48	75	45	75	90	105	90	75	60	60
Linlithgow Avenue shaft	12	10	10	10	0	0	0	0	0	0
Domain station	48	50	30	50	60	70	60	50	40	40
Domain TBM site and tunnels	24	35	28	42	42	28	0	0	0	0
Fawkner Park TBM site and tunnels	24	35	28	42	42	28	0	0	0	0
Fawkner Park shaft	12	10	10	10	0	0	0	0	0	0
Eastern portal	30	25	19	25	31	31	19	0	0	0
Totals		520	342	534	602	650	494	380	304	304

Source: Advisian



Table 4-5 Indicative spoil volumes

Location	Approximate spoil generation timeframe (months)	Approx. Total Volume of Spoil (cubic metres)
Tunnel spoil		
Western TBM site (Arden) - Western portal to Parkville bored tunnels	25	277,000
CBD North Station to CBD South Station (mined tunnel likely to be extracted at CBD North)	11	93,000
Southern TBM site (Domain and Fawkner Park - CBD North to eastern portal bored tunnels)	22	243,000
Subtotal (tunnel spoil)		613,000
Station spoil (including roadworks)		
Arden station	17	202,000
Parkville station	15	299,100
CBD North station	15	345,000
CBD South station	17	253,100
Domain station	19	217,100
Subtotal station spoil (including roadworks)		1,316,300
Other structures spoil		
Western portal	26	57,000
Eastern portal	31	47,200
Subtotal other structures spoil		104,200
Grand Total		2,033,500

For the purposes of completing the air quality impact assessment, a worst case emissions inventory has been developed for the two time periods over which assessments are required to be completed – an annual and a daily (24 hour) worst case scenario.

For the peak daily scenario for the Arden site, the emissions inventory has been generated assuming daily emissions generated during the period of time in which the number of truck round trips are expected to be the greatest (i.e. 182 daily truck round trips per day). For the annual scenario, the highest 12 month period of average daily truck round trips is used. For Arden, this equates to the year-long period covering months 13-18 (during which time 156 daily round trips are predicted), and months 19-24 (during which time 182 daily truck round trip are predicted). Table 4-6 summarises the worst case average truck round trips utilised in the peak and annual modelling scenario.



Table 4-6 Summary of worst case average truck round trips

Location	Months	Average daily truck round trips	Average daily truck round trips
Peak scenario			
Arden station and tunnels	19-24	182	182
Domain station and tunnels (Domain TBM site)	13-18	144	144
Domain station and tunnels (Domain and Fawkner Park TBM sites)	13-18	102	102
Fawkner Park and tunnels (Domain and Fawkner Park TBM sites)	13-18	42	42
Annual scenario			
Arden station and tunnels	13-18	156	169
	19-24	182	
Domain station and tunnels (Domain TBM site)	7-12	134	139
	13-18	144	
Domain station and tunnels (Domain and Fawkner Park TBM sites)	7-12	92	97
	13-18	102	
Fawkner Park and tunnels (Domain and Fawkner Park TBM sites)	7-12	42	42
	13-18	42	

In addition to the higher average daily truck round trips used for the peak scenario, allowance is made for a higher intensity of activities on business days, and therefore in the model, this higher intensity of activities is applied for each day of the year. For this reason, emission rate estimates for the peak scenario are higher than the annual scenario estimates.

The layout of the construction work sites would be decided in the delivery phase, and assumptions were made to predict the distance travelled on unsealed surfaces and the percentage of the sites which are subject to wind erosion. For wind erosion, it is assumed that 70 per cent of the construction work site would be subject to wind erosion, and for haul roads, an estimate for distance travelled has been made based on the truck routing, the area of the site, and the assumption that the construction work site is unsealed.

In addition to spoil handling, estimation has been made for the main sources of emissions from the precast concrete batch plant to be located at the Arden construction work site. The design of the plant is not finalised and therefore emissions from the plant itself have not been estimated, however the bulk of emissions from batch plant operations would be expected to result from truck movements and materials handling. Emissions estimates have been included for these activities and are based on concrete output of 200,000 m³/yr.

Estimated emission rates for the study areas for each proposed activity are detailed in Section 4.2.4.1, Section 4.2.4.2 and Section 4.2.4.3.

4.2.4.1 Arden Station Precinct

Table 4-7 and Table 4-8 show the estimated emissions for activities proposed in the Arden station precinct for the peak and annual scenario respectively.



Table 4-7 Summary of emissions estimates for Arden station precinct – peak scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM ₁₀	PM _{2.5}
Proposed construction work site activities				
Loading and unloading spoil to construction stockpiles ¹	Windbreak 30% Water sprays 50%	867	410	62
Wheel generated dust on unsealed surfaces ²	Level 2 watering 75%	35,125	10,380	1,054
Wind erosion from exposed area ³	Windbreak 30% Water sprays 50%	12,264	6,132	920
Proposed concrete batch plant activities				
Materials handling ⁴	Windbreak 30% Water sprays 50%	2,362	1,181	177
Materials storage – wind erosion from stockpile ⁵	Windbreak 30% Water sprays 50%	2,016	1,008	151
Total		52,634	19,111	2,364

¹ Assumes 4 per cent moisture and double handling of materials i.e. unloading to stockpile and loading to truck.

² Based on worst case annual truck trips and 0.5 km round trip on unsealed road.

³ Assumes 70 per cent of the 14 ha Arden construction work site is exposed to wind erosion.

⁴ Assumes concrete production of 200,000 m³/yr, 1 per cent moisture for raw materials and concrete density 2.4 tonne/m³.

⁵ Assumes seven days of raw materials stockpiled on site.

Table 4-8 Summary of emissions estimates for Arden precinct – annual scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM ₁₀	PM _{2.5}
Proposed construction work site activities				
Loading and unloading spoil to construction stockpiles ¹	Windbreak 30% Water sprays 50%	568	269	41
Wheel generated dust on unsealed surfaces ²	Level 2 watering 75%	23,591	6,971	708
Wind erosion from exposed area ³	Windbreak 30% Water sprays 50%	12,264	6,132	920
Proposed concrete batch plant activities				
Materials handling ⁴	Windbreak 30% Water sprays 50%	2,362	1,181	177
Materials storage – wind erosion from stockpile ⁵	Windbreak 30% Water sprays 50%	2,016	1,008	151
Total		40,801	15,561	1,997



¹ Assumes 4 per cent moisture and double handling of materials i.e. unloading to stockpile and loading to truck.

² Based on worst case peak truck trips and 0.5 km round trip on unsealed road.

³ Assumes 70 per cent of the 14 ha Arden construction work site is exposed to wind erosion.

⁴ Assumes concrete production of 200,000 m³/yr, 1 per cent moisture for raw materials and concrete density 2.4 tonne/m³.

⁵ Assumes seven days of raw materials stockpiled on site.

These emission estimates show that truck movements on unsealed surfaces onto and off the site are likely to result in the highest emissions.

4.2.4.2 Domain Station Precinct

Table 4-9 and Table 4-10 show the estimated emissions for activities proposed in the Domain precinct for the peak and annual scenarios respectively.

Table 4-9 Summary of emissions estimates for Domain precinct – peak scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM ₁₀	PM _{2.5}
Proposed construction work site activities				
Loading and unloading spoil to construction stockpiles ¹	Windbreak 30% Water sprays 50%	661	313	47
Wheel generated dust on unsealed surfaces ²	Level 2 watering 75%	33,349	9,855	1,000
Wind erosion from exposed area ³	Windbreak 30% Water sprays 50%	4,292	2,146	322
Total		38,303	12,314	1,370

¹ Assumes 4% moisture and double handling of materials i.e. unloading to stockpile and loading to truck.

² Based on worst case peak truck trips and 0.6 km round trip on unsealed road.

³ Assumes 70 per cent of the 5 ha Domain construction work site is exposed to wind erosion.

Table 4-10 Summary of emissions estimates for Domain precinct – annual scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM ₁₀	PM _{2.5}
Proposed construction work site activities				
Loading and unloading spoil to construction stockpiles ¹	Windbreak 30% Water sprays 50%	466	220	33
Wheel generated dust on unsealed surfaces ²	Level 2 watering 75%	23,284	6,881	699
Wind erosion from exposed area ³	Windbreak 30% Water sprays 50%	4,292	2,146	322
Total		28,042	9,247	1,054

¹ Assumes 4 per cent moisture and double handling of materials i.e. unloading to stockpile and loading to truck.

² Based on worst case annual truck trips and 0.6 km round trip on unsealed road.

³ Assumes 70 per cent of the 5 ha Domain construction work site is exposed to wind erosion.



These emission estimates show that truck movements on unsealed surfaces onto and off the site are likely to result in the highest emissions.

4.2.4.3 Domain Station Precinct and Fawkner Park (Alternative Design Option)

Table 4-11 and Table 4-12 show the estimated emissions for activities proposed in the Domain and Fawkner Park precincts (alternative design option) for the peak and annual scenarios respectively.

Table 4-11 Summary of emissions estimates for Domain and Fawkner Park precincts – peak scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM ₁₀	PM _{2.5}
Proposed construction work site activities – Domain Precinct				
Loading and unloading spoil to construction stockpiles ¹	Windbreak 30% Water sprays 50%	620	293	44
Wheel generated dust on unsealed surfaces ²	Level 2 watering 75%	23,622	6,981	709
Wind erosion from exposed area ³	Windbreak 30% Water sprays 50%	4,292	2,146	322
Proposed construction work site activities – Fawkner Park Precinct				
Loading and unloading spoil to construction stockpiles ¹	Windbreak 30% Water sprays 50%	340	161	24
Wheel generated dust on unsealed surfaces ⁴	Level 2 watering 75%	5,083	1,502	152
Wind erosion from exposed area ⁵	Windbreak 30% Water sprays 50%	1,717	858	129
Total		35,674	11,941	1,381

¹ Assumes 4% moisture and double handling of materials i.e. unloading to stockpile and loading to truck.

² Based on worst case peak truck trips and 0.6 km round trip on unsealed road.

³ Assumes 70 per cent of the 5 ha Domain construction work site is exposed to wind erosion.

⁴ Based on worst case peak truck trips and 0.3 km round trip on unsealed road.

⁵ Assumes 70 per cent of the 2 ha Fawkner Park construction work site is exposed to wind erosion.

Table 4-12 Summary of emissions estimates for Domain and Fawkner Park precincts – annual scenario

Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM ₁₀	PM _{2.5}
Proposed construction work site activities – Domain Precinct				
Loading and unloading spoil to construction stockpiles ¹	Windbreak 30% Water sprays 50%	322	152	23
Wheel generated dust on unsealed surfaces ²	Level 2 watering 75%	16,248	4,802	487
Wind erosion from exposed area ³	Windbreak 30% Water sprays 50%	4,292	2,146	322



Proposed activity	Proposed controls	Emission rate (kg/yr)		
		TSP	PM ₁₀	PM ₂₋₅
Proposed construction work site activities – Fawkner Park Precinct				
Loading and unloading spoil to construction stockpiles¹	Windbreak 30% Water sprays 50%	232	110	17
Wheel generated dust on unsealed surfaces⁴	Level 2 watering 75%	3,518	1,040	106
Wind erosion from exposed area⁵	Windbreak 30% Water sprays 50%	1,717	858	129
Total		26,330	9,108	1,083

¹ Assumes 4 per cent moisture and double handling of materials i.e. unloading to stockpile and loading to truck.

² Based on worst case annual truck trips and 0.6 km round trip on unsealed road.

³ Assumes 70 per cent of the 5 ha Domain construction work site is exposed to wind erosion.

⁴ Based on worst case annual truck trips and 0.3 km round trip on unsealed road.

⁵ Assumes 70 per cent of the 2 ha Fawkner Park construction work site is exposed to wind erosion.

These emission estimates show that truck movements on unsealed surfaces onto and off the site are likely to result in the highest emissions.

4.3 Peer Review

This assessment has been independently peer reviewed by Mr Damon Roddis of Pacific Environment. The peer reviewer reviewed and provided feedback on drafts of this report. The peer reviewer's methodology is set out in his report, which in general terms included a review of the assumptions, methodology, assessment criteria (standards and limits) and scope applied in this report. It also addressed whether there were any additional matters which should be considered as part of the impact assessment in order to address the EES Scoping Requirements that are relevant to air quality impacts or management. The peer reviewer considered whether there are any gaps or matters where they disagreed with this assessment. The final peer review report is attached in Appendix C of this report, which sets out the peer reviewer's conclusions in relation to this report, and whether or not all of their recommendations were adopted.

4.4 Risk Assessment

4.4.1 Overview

An Environmental Risk Assessment has been completed for impacts of Melbourne Metro. The risk-based approach is integral to the EES as required by Section 3.1 of the Scoping Requirements for the EES. Importantly, an environmental risk is different from an environmental impact. Risk is a function of the likelihood of an adverse event occurring and the consequence of the event. Impact relates to the outcome of an action in relation to values of a resource or sensitivity of a receptor. Benefits are considered in impact assessment but not in risk assessment. Impact assessment must be informed by risk assessment so that the level of action to manage an impact relates to the magnitude and likelihood of an adverse impact occurring.

The overall risk assessment process adopted was based on AS/NZS ISO 31000:2009, as illustrated in Figure 4-1.

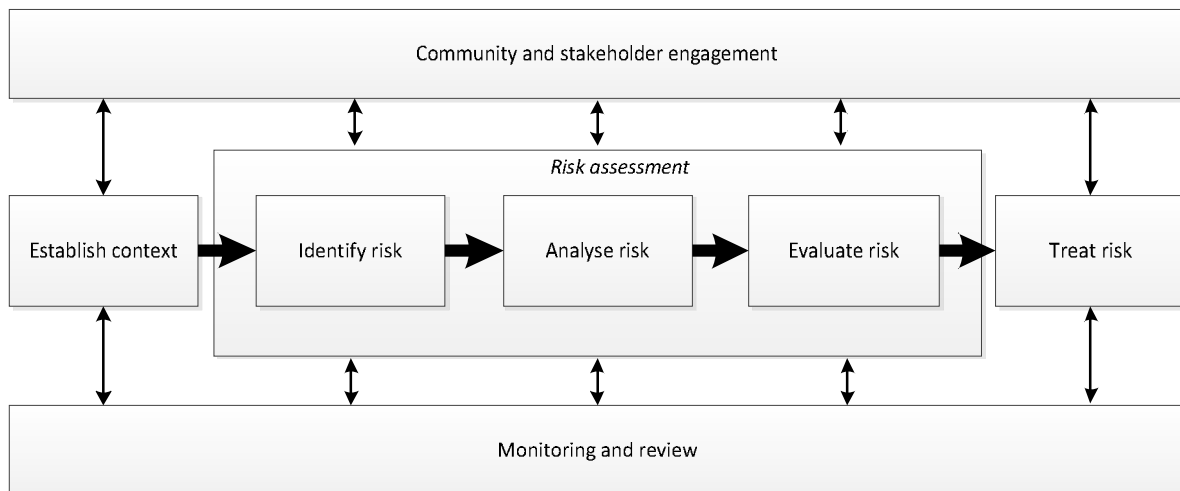


Figure 4-1 Overview of AS/NZS ISO 31000-2009 risk process

The following tasks were undertaken to determine the impact pathways and assess the risks:

- Setting of the context for the environmental risk assessment
- Development of consequence and likelihood frameworks and the risk assessment matrix
- Review of Concept Design and identification of impact assessment pathways by specialists in each relevant discipline area
- Allocation of consequence and likelihood categories and determination of preliminary initial risks
- Workshops with specialist team members from different yet related discipline areas and focussing on very high, high and moderate initial risks to ensure a consistent approach to risk assessment and to identify possible interactions between discipline areas
- Follow-up liaison with specialist team members and consolidation of the risk register.

A more detailed description of each step in the risk assessment process is provided in Technical Appendix B *Environmental Risk Assessment Report*.

4.4.2 Context

The overall context for the risk assessment and a specific context for each specialist study is described in Technical Appendix B *Environmental Risk Assessment Report*. The context describes the setting for evaluation of risks arising from Melbourne Metro. The specific context for the air quality impact assessment is provided below:

The proposed construction of Melbourne Metro would have the potential to result in air quality impacts resulting from dust from construction work sites and emissions from construction machinery. The operation of Melbourne Metro would involve electric trains running through tunnels and station ventilation involving electric fans. There would be potential for localised air emissions associated with occasional maintenance activities during operation.

MMRA would manage potential air quality impacts during both construction and operation through the State Environment Protection Policy (SEPP) for Ambient Air Quality and the SEPP (Air Quality Management), as well as the EPA Environmental Guidelines for Major Construction Sites.

The likelihood rating criteria used in the risk assessment by all specialists is shown in shown in Table 4-13.



Table 4-13 Likelihood rating criteria

Level	Description
Rare	The event is very unlikely to occur but may occur in exceptional circumstances.
Unlikely	The event may occur under unusual circumstances but is not expected.
Possible	The event may occur once within a five-year timeframe.
Likely	The event is likely to occur several times within a five-year timeframe.
Almost Certain	The event is almost certain to occur one or more times a year.

The consequence criteria framework used in the risk assessment follows. Each specialist has used this framework to develop criteria specifically for their assessment.

Table 4-14 Consequence framework

Level	Qualitative description of biophysical / environmental consequence	Qualitative description of socio-economic consequence
Negligible	No detectable change in a local environmental setting.	No detectable impact on economic, cultural, recreational, aesthetic or social values.
Minor	Short-term, reversible changes, within natural variability range, in a local environmental setting.	Short-term, localised impact on economic, cultural, recreational, aesthetic or social values.
Moderate	Long-term but limited changes to local environmental setting that are able to be managed.	Significant and/or long-term change in quality of economic, cultural, recreational, aesthetic or social values in local setting. Limited impacts at regional level.
Major	Long-term, significant changes resulting in risks to human health and/or the environment beyond the local environmental setting.	Significant, long-term change in quality of economic, cultural, recreational, aesthetic or social values at local, regional and State levels. Limited impacts at national level.
Severe	Irreversible, significant changes resulting in widespread risks to human health and/or the environment at a regional scale or broader.	Significant, permanent impact on regional economy and/or irreversible changes to cultural, recreational, aesthetic or social values at regional, State and national levels.

The consequence rating criteria used in the risk assessment specifically for air quality are shown in Table 4-15.

Table 4-15 Consequence rating criteria

Level of consequence	Consequence criteria
Negligible	Undetected changes to ambient air quality, beyond the site boundaries.
Minor	Detected changes to air quality, but no exceedances of Melbourne Metro Air Quality Criteria detected beyond the site boundaries. Changes can be managed by mitigation measures (i.e. reversible).
Moderate	Detected changes to air quality, emissions from site cause limited exceedances of Melbourne Metro Air Quality Criteria beyond the site boundaries e.g. 24h PM ₁₀ > Criteria <= 5 times in 1 year (using the current NEPM exceedance goal for PM ₁₀).



Level of consequence	Consequence criteria
Major	Detected changes to air quality, emissions from site cause exceedances of Melbourne Metro Air Quality Criteria beyond the site boundaries e.g. 24h PM ₁₀ > Criteria > 5 times in 1 year (using current NEPM goal for PM ₁₀).
Severe	Detected changes to air quality, emissions from site cause exceedances of Melbourne Metro Air Quality Criteria beyond the site boundaries e.g. 24h PM ₁₀ > Criteria > 5 times in 1 year (using NEPM goal for PM ₁₀) Emissions from Melbourne Metro cause clearly observed air pollution that causes air quality impacts leading to increased hospital admissions.

The environmental risk assessment matrix used by all specialists to determine levels of risk from the likelihood and consequence ratings is shown in Table 4-16.

Table 4-16 Risk Matrix

		Consequence rating				
		Negligible	Minor	Moderate	Major	Severe
Likelihood rating	Rare	Very Low	Very Low	Low	Medium	Medium
	Unlikely	Very Low	Low	Low	Medium	High
	Possible	Low	Low	Medium	High	High
	Likely	Low	Medium	Medium	High	Very High
	Almost Certain	Low	Medium	High	Very High	Very High

Section 6 provides a summary of the air quality risks assessed as part of the EES.

4.5 Assumptions

The following assumptions have been made when compiling this report:

- The detailed construction layout has not yet been completed and the location and distribution of various emission sources has been based on the high-level Concept Design and assumed approximate locations only.

Additional assumptions are identified throughout this report, e.g. assumptions related to emission estimates are made in Section 4.2.4.



4.6 Stakeholder Engagement

As part of this assessment, the following specific engagement with stakeholders was undertaken.

Table 4-17 Summary of stakeholder engagement

Activity	Date	Matters discussed / issues raised	Consultation outcomes
Discussion with EPA about air quality impact assessment methodology adopted for Melbourne Metro – construction dust	16 October 2015	Assumptions of meteorological and air dispersion modelling, including the selection of meteorological data year and background air quality, were 'reasonable and conservative'; it was agreed the assessment methodology was sound.	AERMOD assessment of construction activities to proceed as planned.
		Combustion engine emissions from construction machinery expected to be insignificant in comparison with other emissions.	The assessment team to determine how combustion engine emissions would be documented in this report.
		Assumptions about quality of data associated with construction material quantities, dust controls	Data used for modelling the construction scenarios including dust controls, etc. to be detailed in this report; distinguishing between high quality data and assumptions.
		Existing industries with odour sources, e.g. mill near Arden Street.	Odour dispersion modelling not required for the assessment of emissions from construction activities, as the focus is on the highest risk air quality indicators associated with dust emissions. However, the potential for odour impacts due to excavation to be documented in this report.
		Dust emissions from existing concrete batch plant near Arden Street.	Dust emissions from concrete batch plant to be included in the assessment of dust emissions from construction activities.

In addition to the specific agency and technical review group engagement and the engagement listed in the table above, general engagement and consultation with the community was also conducted as part of this assessment. Written feedback was obtained through feedback forms and the online engagement platform, and face-to-face consultation occurred at the drop-in sessions (refer to Technical Appendix C *Community and Stakeholder Feedback Summary Report* for further information).

Feedback and concerns from the community relating to air quality was limited. The primary concern was dust generated by construction works as a general issue across the alignment. These concerns are addressed in the recommended Environmental Performance Requirements (refer to Section 16) which incorporate dust mitigation measures to manage the impacts on air quality at identified sensitive receptors.



4.7 Limitations

The limitations associated with this assessment are set out in the following points:

- The location and design of temporary tunnel or station ventilation shafts (for construction) would be determined during the delivery phase, therefore their emissions were not included
- The detailed construction layout was not finalised at the time of assessment therefore future changes to the estimated locations of various emission sources used for this assessment may alter the outcomes of this report
- This assessment was based on the Concept Design and associated alternative design options. If design details change, the report may require updating.



5 Regional Context

Given that background air quality information applies across a regional perspective (as opposed to the defined Melbourne Metro precincts), an over-arching summary of the background air quality and likely air emissions associated with the proposed Melbourne Metro is presented in Sections 5.1, 5.2 and 5.3. This includes a description of the relevant ambient air quality pollutants, potential air emissions that are likely to apply to the construction and operation phases, detailed summary of the existing air quality, and existing air emission sources in the vicinity of the proposed project boundary.

Section 5.4 summarises the meteorological conditions important for determining the direction and rate at which emissions disperse. Section 5.5 provides a summary of the possible air quality risk factors within each precinct to inform the relative risk level of air quality impacts for each site based on the proposed activities (to date) and proximity to sensitive receptors. SEPP (AQM) broadly defines sensitive receptors as environment and land uses that are sensitive to the potential impacts of air emissions on local amenity (e.g. hospitals, schools and residences).

5.1 Ambient Air Quality Pollutants

A brief summary of the origin and implications of the key air pollutants considered relevant to the emissions sources associated with the proposed construction and operation of Melbourne Metro (refer to Section 5.2) is given below. This, in turn, would inform the extent (if any) to which consideration of each of the pollutants would be incorporated into the impact assessment.

5.1.1 Sulfur Dioxide

Sulfur dioxide (SO₂) is a product of the combustion of sulfur containing compounds in fossil fuels or may be emitted from industry such as petroleum refining and smelting or ores.

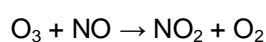
Further oxidation of SO₂, usually in the presence of a catalyst such as NO₂ may form acid rain (acid rain is not recognised as a significant environmental issue in Melbourne). Sulfur dioxide emissions are also a precursor to particulates in the atmosphere, where gaseous SO₂ can form sulphate aerosol particles.

SO₂ can trigger respiratory response in people with existing pulmonary disease (e.g. asthma) who happen to have a susceptibility to SO₂ and who are exercising or otherwise exerting themselves to the point where their respiratory function is elevated.

While the above effects of SO₂ are significant, it is not considered to present any project risks as the only likely project source of SO₂ would be liquid fuel, e.g. diesel/petrol combustion in construction vehicles, plant and equipment. The sulfur content of these fuels, which results in SO₂, is limited to 10 ppm in Australia, which is very low compared to historical values. As such, the concentration of SO₂ emitted is considered to be negligible, in comparison to other sulfur-containing fuels, e.g. fuels used in ocean-going vessels, which typically have a fuel sulfur content of up to 5 per cent or 50,000 ppm.

5.1.2 Oxides of Nitrogen

Oxides of nitrogen (NO_x) emissions produced by the burning of fuels, e.g. by road vehicle fleets associated with cities and larger towns and power stations, comprise mostly nitric oxide (NO), and smaller amounts of NO₂. In the atmosphere, NO may be converted to NO₂; e.g. through the following reaction with ozone (O₃) and in the presence of sunlight:





NO and NO₂ are commonly referred to as NO_x. NO₂ can cause damage to the respiratory tract, increasing susceptibility to infection and respiratory illnesses including asthma. NO₂ is a brown gas and on days of photochemical smog formation, may be visible in the atmosphere.

Construction plant and equipment exhaust emissions are likely to be the main sources of NO_x for Melbourne Metro. However, it would be very difficult to detect the contributions of project emissions among existing emissions due to local road vehicle traffic. Road traffic affecting local air quality would represent a much larger fleet than the construction vehicles. The use of new equipment with modern emissions control technology is an important element of NO_x emission management.

5.1.3 Ozone

Ozone (O₃) is a secondary pollutant, meaning that it is not directly emitted into the atmosphere but is formed in the atmosphere through chemical or photo-chemical reactions of primary pollutants. The formation of O₃ in the atmosphere is heavily influenced by the intensity of sunlight, temperature and the presence and concentration of NO_x and reactive hydrocarbons. O₃ may also be referred to as photochemical oxidants.



The complex chemical process which results in O₃ production, occurs over several hours and this means that the highest concentration of ozone often occur in summer afternoons, downwind from major sources of ozone precursors (NO_x and VOC).

5.1.4 Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas and is formed during incomplete combustion of fossil fuels. It is one of the most common industrial hazards, however in urban areas the major source is motor vehicles. Ambient CO concentrations have decreased significantly in recent decades due to technological advances in internal combustion engines.

For the proposed Melbourne Metro, the key CO emissions source is likely to be associated with the combustion of diesel fuel by construction plant and equipment.

5.1.5 Particulate Matter

Particulate matter in the atmosphere refers to a range of particle types and sizes. The particles may be emitted from natural sources such as windblown dust, sea spray, bush fires, and pollens; or from anthropogenic sources such as combustion of fuels, power generation, industrial activities, excavation works, unpaved roads, and the crushing and handling of materials.

The health effects of particles are strongly influenced by the size of the particles. Smaller particles can penetrate further into the respiratory tract, with the smallest particles penetrating to the gas exchange areas of the lungs (alveoli) and therefore they have a greater impact on human health. Larger particles primarily cause aesthetic impacts, usually associated with coarse particles settling on surfaces.

Particulates are therefore classified according to their size. Total suspended particulates (TSP) are defined as all airborne particles and typically range in size up to approximately 50 micrometres (particles larger than this fall out of the atmosphere relatively quickly). PM₁₀ and PM_{2.5} are defined as particles with aerodynamic diameters less than or equal to 10 and 2.5 micrometres respectively.

Exposure to particulate matter has been linked to respiratory problems including asthma, lung cancer, cardiovascular disease and respiratory illness.

Additionally, dust emissions resulting from the excavation of contaminated soil and operation of construction vehicles/equipment over existing contaminated land can give rise to contaminated dust particles potentially affecting sensitive receptors. While firm links have been established between increased PM concentrations and health, e.g. Schwartz (1994), further research is required and being undertaken to determine links



between particle composition and impacts on human health, e.g. Solomon et al. (2012) and CSIRO (2013). As such at present PM_{10} and $PM_{2.5}$ represent the best indicators of the potential for human health impacts from particle emissions; especially for cases where the composition is variable or unknown.

Generic particulate matter (dust) emissions were identified as the key air pollutant during construction of the proposed Melbourne Metro.

5.1.6 Local Visual Distance

Air pollution can impact on amenity by forming a visibility-reducing haze, which is caused by light scattering by particles. Victoria sets out an objective for a minimum visibility of 20 km (SEPP (AAQ)). This means it should be possible on a fine day to see a contrasting object against a background at a distance of 20 km.

In Victoria, compliance with the visibility objective is determined by measuring light scattering properties of ambient air. Visibility is expressed using an Airborne Particle Index (API): the lower the visibility, the higher the API.

The assessment of visibility by the Local Visual Distance benchmark of 20 km is more appropriate for open spaces, e.g. the Latrobe Valley. In any case the assessment of airborne particulate matter for the protection of human health is a good proxy for visibility protection.

5.1.7 Odour

Odour impacts may result from the emission to air of odorous compounds. In the case of Melbourne Metro, odour emissions may arise from excavation of contaminated soils and the release of gases contained within the soil or groundwater. Any odour from groundwater or TBM water is expected to be contained within the infrastructure. Water would be piped from below ground and treated within a closed treatment plant so it is expected odour would be negligible from water sources. Odour emissions are more likely to occur from exposed soil.

Contamination is often caused by historic land use management practices, particularly those related to industrial processes, waste disposal and the storage and use of chemicals. However, there is also naturally occurring contamination, such as acid sulfate soils.

An odour impact assessment undertaken in accordance with the SEPP (AQM) Design Criterion for general odour should be applied for normal operations by a facility; e.g. releases of an odorous gas such as hydrogen sulfide from a wastewater (sewerage) treatment plant. Odour impacts that occur from the excavation of odorous material can be classed as an abnormal, short-term event that would be managed using on-site construction environmental procedures; as such, odour dispersion modelling was not and could not be included in the air quality impact assessment for Melbourne Metro.

Mitigation measures to minimise odour impacts are typically similar to those used to control dust, and may include, but not necessarily be limited to:

- Watering down of surfaces
- Covering of truck loads and stockpiles with high density polyethylene (HDPE) sheeting or tarpaulins.

5.2 Identification of Air Emissions

5.2.1 Construction

Given that duration of intensive construction activities, together with the proximity to sensitive receptors and areas of high population density, there is the potential for the Concept Design to impact local air quality through dust and combustion-related emissions.



Six main pathways have been identified that might lead to air quality impacts during the proposed construction phase, as follows:

- Dust emissions from construction activities (wheel-generated dust, spoil handling and transfer, wind-generated dust from exposed surfaces, on-site concrete batching plant) and spoil disposal/management sites. This may include contaminated dusts, if contaminated soil is disturbed or excavated and becomes airborne.
- Exhaust emissions from on-site plant and equipment
- Emissions from construction traffic movements (dust and exhaust emissions)
- Increased/concentrated traffic emissions due to road closures or diversions
- Emissions from temporary ventilation stacks (dust and exhaust emissions)
- Dust and/or odour emissions from excavation, transport and disposal of contaminated or acid sulphate soils.

The precinct boundaries and proposed rail alignment are shown in the EES Map Book. An impact assessment has been carried out for each precinct.

5.2.2 Operation

Since the Concept Design is based on the use of electric trains, air emissions associated with operating trains along Melbourne Metro tunnels would be negligible in comparison to the potential construction related air emissions and impacts. Regional impacts from the operation of the proposed Melbourne Metro are considered insignificant and are beyond the scope of the EES.

As it has been assumed the proposed Melbourne Metro would use electric trains, no exhaust (combustion) emissions would be discharged from the tunnel ventilation shafts. Additionally, particulate matter within air emitted from the tunnel during normal operations is expected to be negligible; i.e. in comparison with, for example, the dust emissions from construction activities.

Routine operational emissions are likely to include:

- Exhaust emissions from plant/equipment used in permanent ancillary operations (e.g. generators, boilers, heaters), where relevant
- Exhaust emissions from transport related operations (transportation of materials, maintenance vehicles, employee travel, waste removal)
- Exhaust emissions from periodic track maintenance activities
- Thermal emissions associated with venting from tunnels, and stations (low risk for electrified rail tunnels).

Non-routine operational emissions are likely to include:

- Particulate matter within extracted air during tunnel wall cleaning which may be expected to occur every five to 10 years. The particulate matter composition and concentration during this operation (if required) is unknown, however preliminary discussions indicate this activity is unlikely to cause significant air quality impact; e.g. in comparison with dust emissions from construction activities
- Particulate matter from ventilation shafts in the event of a fire (smoke). (Normally, such events are not assessed using the SEPP (AQM) air quality assessment procedures.)

Schedule C of the SEPP (AQM) states that the modelling methods outlined for assessment of air quality do not apply to the use of 'emergency response models that are used to evaluate the impact of an accidental or emergency release of air pollutants'.



For non-routine operational emissions, limited information is available at this stage and a detailed impact assessment has not been conducted. Information gaps exist around:

- The location and design of ventilation systems
- The methods, frequency and / or necessity to conduct tunnel wall cleaning.

However, air emissions from non-routine operations are expected to be much less significant than particulate emissions during construction, which formed the key part of the air quality impact assessment for Melbourne Metro.

5.3 Existing Air Quality

5.3.1 Local Pollutant Sources

A number of industrial and non-industrial sources have the potential to impact the local air quality. These include but are not limited to:

- Emissions from vehicles in the local area
- Emissions from industrial and commercial premises
- Emissions from existing freight and commuter rail
- General domestic emissions.

These activities are likely to emit pollutants in varying degrees including, but not limited to, particulate matter (TSP, PM₁₀ and PM_{2.5}), nitrogen oxides (NO and NO₂), SO₂, CO, VOCs and heavy metals.

5.3.2 Regional Pollutant Sources

The proposed project boundary is located within the Port Phillip Air Quality Control Region, which encompasses most of Victoria's population and industry. The population of the Port Phillip Region is approximately 3.5 million people and it covers an area of approximately 24,000 km² (EPA, 2001).

In 2006, EPA prepared an air emissions inventory to characterise the main emission sources that affect air quality in the Port Phillip Region; this is the latest air emissions inventory that EPA has prepared for the Port Phillip Region. The estimates from the 2006 inventory are summarised in Figure 5-1 (EPA, 2013).

The sources of emissions of airborne particulate matter occur from a number of major contributors including industry, motor vehicles, solid fuel combustion, road-generated dust and windblown dust. The majority of NO_x emissions are from motor vehicles, with a relatively smaller contribution from industry. As described in Section 5.1, PM₁₀ and PM_{2.5} emissions are likely to be the key air pollutants during the construction of the proposed Melbourne Metro (dust emissions). Less significant emissions of CO and NO_x are likely to be associated with exhaust emissions from construction vehicles, plant and equipment.

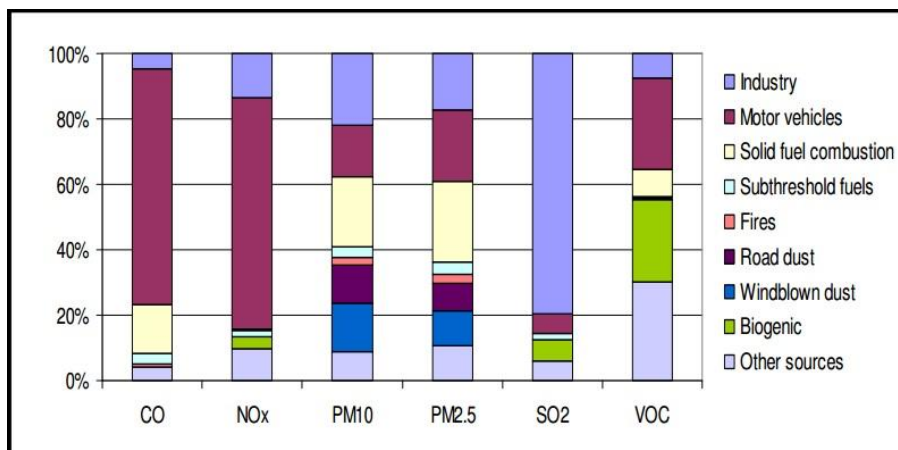


Figure 5-1 Sources of air pollution from Port Phillip region

*Sourced from 'EPA Victoria submission to Senate inquiry into the impacts on health of air quality in Australia, March 2013' and referencing the EPA's 2006 Air Emissions Inventory – unpublished.

5.3.3 Air Quality Monitoring Data

Given the large geographic area impacted by the proposed Melbourne Metro, the regional nature of the key air quality pollutants and absence of significant existing local pollutant sources in proximity to the key construction work sites, no project-specific baseline air quality investigations were undertaken. EPA air quality data was considered to be representative of air quality for the locations of the proposed Melbourne Metro.

The EPA monitors air quality, including a range of pollutants, which are assessed against the objectives and goals set out in SEPP (AAQ). The objectives and goals are set at levels that protect beneficial uses including:

- Human health and wellbeing
- Visibility
- Aesthetic enjoyment
- Local amenity.

The goals specify the maximum permissible number of exceedances of the objectives and guide the formulation of strategies for the management of human activities that may affect the environment.

The EPA monitors air quality at 10 long-term monitoring locations within the Port Phillip Air Quality Control Region, with additional monitoring undertaken on a short-term (campaign) basis at other sites. Each monitoring station is configured to capture pollutants of interest at that site and is classified as Light Industrial, Industrial, Rural, Residential or a combination of classifications.

The closest monitoring sites to the study area are Richmond, approximately 2.3 km from the proposed eastern portal and Footscray (located in West Footscray), approximately 4.5 km from the proposed western portal.

Richmond is located approximately 3 km from the CBD and is characterised predominantly by residential and commercial properties. Footscray is located a greater distance (approximately 7 km) from the CBD and supports a higher proportion of industrial businesses than Richmond. Given that the major Melbourne Metro construction work sites are predominantly located in residential and commercial districts, Richmond was considered the most representative site, being nearest to the majority of the proposed Melbourne Metro alignment and supporting similar land uses to the study area than Footscray.



Monitoring data from Richmond was therefore used to represent background air quality for Melbourne Metro, supplemented with data from Footscray where no data was available for Richmond.

The details of two monitoring sites and pollutants monitored are summarised in Table 5-1. A summary of the air quality from Richmond and Footscray air monitoring sites is provided in Table 5-2 and Table 5-3 respectively. Where the maximum reported index or concentration exceeds the respective criterion, these cells have been highlighted in grey (EPA 2012a, EPA 2013b, EPA 2014a and EPA 2015).

Table 5-1 Summary of representative EPA ambient air monitoring sites

Site	Classification	Vis	PM ₁₀	PM _{2.5}	NO ₂	CO	O ₃	SO ₂
Richmond	Residential	Y	Y	N	Y	Y	N	N
Footscray	Industrial/ Residential	Y	Y	Y	Y	Y	Y	Y

Table 5-2 Air quality summary for Richmond

Richmond	Visibility		Particulate matter PM ₁₀		NO ₂		CO	
	1 hour		24 hour		1 hour		8 hour	
Averaging period	Ave	Max	Ave	Max	Ave	Max	Ave	Max
Units	API		µg/m ³		ppb		ppm	
Annual 2011	0.57	3.56	16.9	42.4	12	57	0.3	2.6
Annual 2012	0.51	3.02	16.7	47.4	11	50	0.2	2.2
Annual 2013	0.52	5.46	16.5	41.5	11	48	0.2	2.4
Annual 2014 ¹				63.4				1.6
Criteria	2.35		50		120		9.0	
Exceedances 2011	11		0		0		0	
Exceedances 2012	3		0		0		0	
Exceedances 2013	10		0		0		0	
Exceedances 2014			4					

¹ 2014 EPA Victoria monitoring data statistics not available for all parameters.



Table 5-3 Air quality summary for Footscray

Footscray	Visibility		Particulate matter				O ₃			NO ₂		CO		SO ₂				
			PM ₁₀		PM _{2.5}													
Ave Period	1 hour		24 hour		24 hour		1 hour	4-hr		1 hour		8 hour		1 hour		24-hr		
	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Max	Ave	Max	Ave	Max	Ave	Max	Max		
Units	API		µg/m ³		µg/m ³		Ppb			ppb		ppm		Ppb				
Annual 2011	0.53	3.18	18.6	49.6	4.6	15.7	14	78	67	11	53	0.2	1.3	1	32	8		
Annual 2012	0.48	6.81	18.6	57.7	6.1	23.1	15	57	52	10	58	0.2	1.1	1	24	6		
Annual 2013	0.49	2.76	18.1	50.5	6.2	17.1	15	83	65	11	51	0.2	1.1	1	32	5		
Annual 2014 ¹				79.2	7.1	39.1		100	82	11	64							
Criteria	2.35		50		25		100			80		120		9.0		200		80
Exceedances 2011	5		0		0		0			0		0		0		0		0
Exceedances 2012	4		3		0		0			0		0		0		0		0
Exceedances 2013	3		2		0		0			0		0		0		0		0
Exceedances 2014 ¹			6		1													

¹ 2014 EPA Victoria monitoring data statistics not available for all parameters.

The NEPM air quality goals were met for all pollutants except PM₁₀ in 2014. There were exceedances of the 24-hour PM₁₀ criteria at Footscray in 2012 (3 days), 2013 (2 days) and 2014 (6 days), and Richmond in 2014 (4 days). The NEPM goal of maximum allowable exceedances of five days/year was exceeded by one day in 2014 at Footscray.

The EPA publishes annual air quality reports to test compliance with the NEPM standards and goals (EPA 2012b, EPA 2013c, EPA 2014b and EPA 2015). These annual reports summarise air quality for the previous year, assess long-term trends in air quality and infer the sources of any exceedances. Of the 11 days which exceeded the 24-hour PM₁₀ criteria at Footscray, the inferred cause for six of the days was due to fire, i.e. smoke from bushfires, planned burning or agricultural burning. Three of the days the cause was urban, i.e. particles accumulating in stable atmospheric conditions, typically from motor vehicles or domestic wood heaters, and two of the days dust (windborne crustal dust, often from distant sources). The four days of exceedance at Richmond was due to fire.

The criteria for visibility were exceeded at Richmond and Footscray in 2011, 2012 and 2013, but were not reported in the annual air quality reports. However, the visibility measurements were obtained from point measurements of light scattering by aerosols. Therefore, it is likely that the reasons for the visibility exceedances were the same as those for PM₁₀ and PM_{2.5}.



EPA publishes hourly air quality data on the Internet and calculates an air quality index to assist in interpretation of results (see Table 5-4). Using the method outlined by EPA, the existing air quality within the study area is classified as 'good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}'.

Table 5-4 Air quality index classifications

Index Range	Category
0 to 33	Very Good
34 to 66	Good
67 to 100	Fair
100 to 149	Poor
Greater than 150	Very Poor

Source: <http://www.epa.vic.gov.au/our-work/monitoring-the-environment/air-quality-bulletins/hourly-air-quality-interactive-map> (Accessed 2/11/2015)

5.3.4 Background Air Quality Data for Impact Assessment

The risk assessment has led to a quantitative assessment of key construction work sites based on the air dispersion model. A 'first pass' risk assessment of emissions from the key construction work sites has been undertaken for a selection of sites for further air dispersion modelling using the EPA regulatory model AERMOD.

In accordance with SEPP (AQM), background air quality data are required for the pollutant being assessed, in this case PM₁₀, PM_{2.5} and dust deposition. The SEPP recommends that for pollutants that adopt a 24-hour averaging period that 24-hour average background data files be used within the simulation. Or, where no appropriate 24-hour average background data exists, the 70th percentile of one year's observed 24-hour concentrations must be added as a constant value to the predicted maximum concentration from the model simulation.

A number of exceedances of the PM₁₀ and PM_{2.5} 24-hour criteria occurred during the study year and have been attributed to bushfires (EPA, 2015). Because of these exceedance events and the effects of bushfire events on air quality monitoring data, the maximum 24-hour data are not considered suitable for use as a background file, so percentile values were used instead in accordance with the SEPP (AQM). Note that the NEPM PM₁₀ air quality goal allows for five exceedances of the air quality objective each year allowing for natural events such as bushfires, but that the EPA requires AERMOD output for highest 24-hour concentration contours. Table 5-5 is a summary of the adopted background concentrations used.

Table 5-5 Summary of adopted background concentrations

Pollutant	Averaging period	Adopted background concentration		Data statistic and source
		Value	Units	
PM ₁₀	24-hour	20.9	µg/m ³	75th percentile of 24-hour average from Richmond 2014. ¹
PM _{2.5}	24-hour	7.9	µg/m ³	75th percentile of 24-hour average from Footscray 2014. ¹
	Annual	5.9	µg/m ³	Annual median from Footscray 2014. ¹



Pollutant	Averaging period	Adopted background concentration		Data statistic and source
		Value	Units	
Dust Deposition	Monthly	2.0	g/m2/month	Assumed conservative background concentration.

¹ Source: EPA Air Monitoring Report 2014 (EPA, 2015).

5.4 Meteorology

Meteorological conditions are important for determining the direction and rate at which emissions from a source would disperse. The key meteorological requirements of air dispersion models are typically, hourly records of wind speed, wind direction, temperature, atmospheric stability class and mixing layer height. For air quality assessments, a minimum of one year of hourly data is usually required, which ensures that almost all possible meteorological conditions, including seasonal variations, are considered in the simulations.

There are two meteorological monitoring sites near the proposed Melbourne Metro corridor. The EPA undertakes meteorological monitoring at the Footscray ambient air quality monitoring site, and the Bureau of Meteorology conducts measurements at the Melbourne Regional Office (site 086071), located approximately 600 m from the proposed CBD North station at the junction of Victoria Street and La Trobe Street. A long history of data is available from this site and it has been selected as representative of the climatic conditions for the proposed project boundary. Climate statistics from the periods 1855-2015 and 1955-2009/2010 were used in this analysis and are summarised in Table 5-6.

The maximum average temperature occurs in January (25.9°C), and lowest maximum average temperature in July (13.5°C). Statistically, October is the wettest month with an average rainfall of 66.0 mm compared to the driest month, January with 47.3 mm.

Table 5-6: Climatic statistics for BoM Melbourne regional office

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Temperature¹													
Maximum	25.9	25.8	23.9	20.3	16.7	14.1	13.5	15	17.3	19.7	22	24.2	19.9
Minimum	14.3	14.6	13.2	10.8	8.7	6.9	6	6.7	8	9.6	11.2	13	10.2
Rainfall¹													
Average rainfall (mm)	46.8	48	50.1	57.3	55.7	49.5	47.5	50	58	66	60.3	59.1	648.4
Decile 5 (median) rainfall (mm)	36.6	32.6	38.8	49.8	54.9	43.2	44.4	49.2	52.9	65.6	53.8	51.5	644.2
Mean no. of days of rain ≥ 1mm	5.6	5.1	6.1	7.9	9.7	9.4	9.7	10.4	10.4	10.2	8.3	7.2	100
Average 9am conditions²													
Temperature (°C)	19.1	19.1	17.5	14.7	11.7	9.4	8.7	10	12.3	14.7	16.1	17.7	14.2
Relative Humidity (%)	63	66	68	71	77	80	79	73	67	62	63	62	69
Wind Speed (km/h)	10	9.1	8.9	8.7	9.1	9.4	10.4	11.3	12.4	12.6	11.5	10.8	10.4
Average 3pm conditions²													
Temperature (°C)	24.2	24.7	22.8	19.6	16.3	13.7	13	14.3	16.1	18.3	20.4	22.4	18.8



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Relative Humidity (%)	47	48	49	52	59	63	61	56	53	50	49	47	53
Wind Speed (km/h)	14.8	14.3	13.1	12.9	12.5	12.6	14.1	15.2	15.8	15.5	14.9	15.3	14.2

¹ Climate statistics from 1855-2015.

² Climate statistics from 1955-2009/2010.

The long-term average 9am and 3pm wind roses for the Bureau of Meteorology Melbourne Regional Office are shown in Figure 5-2. The 9am winds are dominated by moderate northerly and westerly winds. By afternoon, average wind speeds have increased and are predominantly from the south. A more detailed summary of 9am and 3pm winds by month is included in Appendix B of this report.

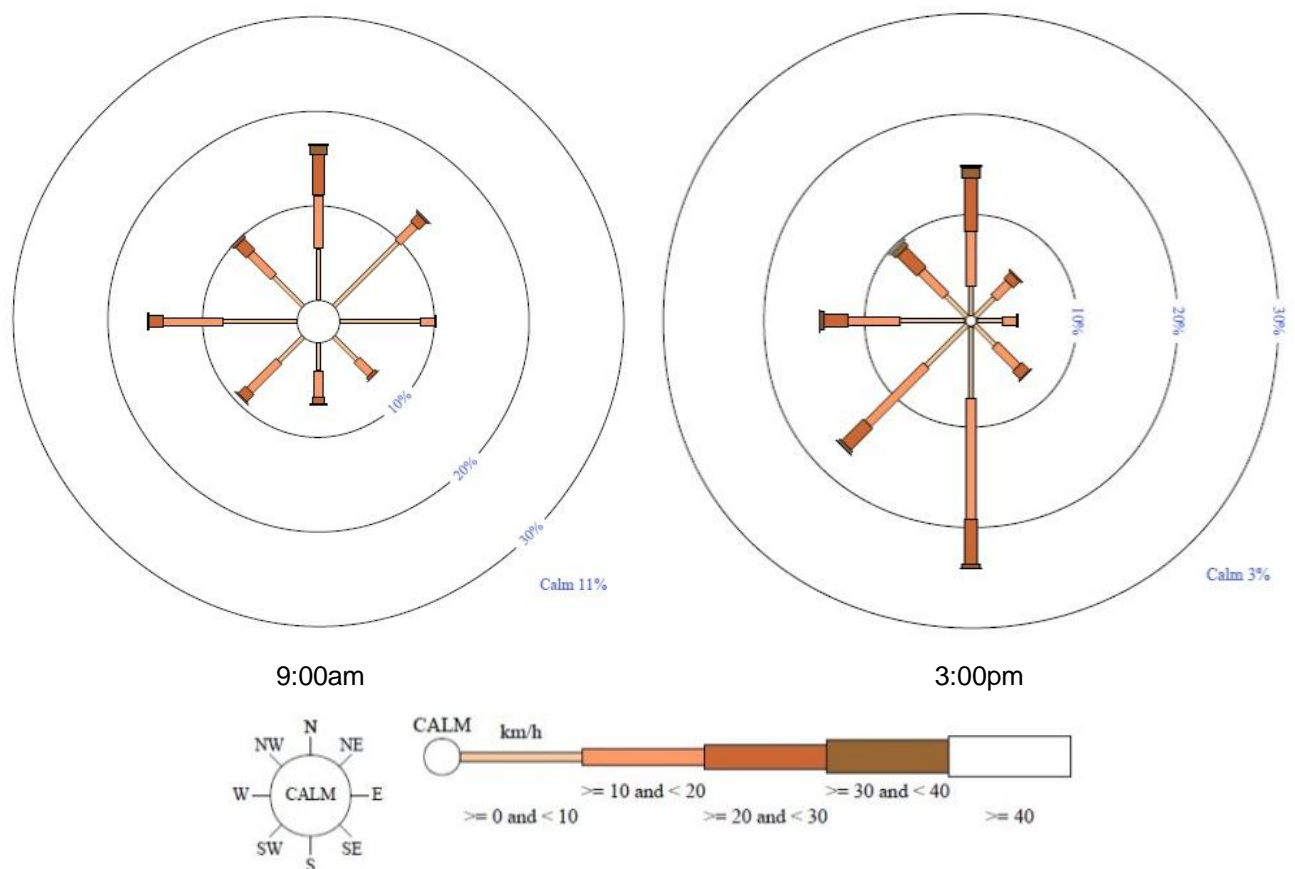


Figure 5-2 9am and 3pm wind roses for Melbourne regional office 1955 to 2009

5.5 Summary of the Existing Environment

The following conclusions have been made from the review of local meteorological and ambient air quality monitoring data:

- The key substances of potential impact are dust emissions including PM₁₀, PM_{2.5} and dust deposition
- Winds patterns in the vicinity of Melbourne Metro are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons predominantly from the south.



Dust emissions associated with construction are likely to vary in intensity and duration with the potential for air quality impacts at some sensitive receptors. The risk of elevated 24-hour PM_{2.5} and PM₁₀ impacts, and monthly dust deposition (amenity) impacts, at sensitive receptors are summarised in Table 5-7.

Table 5-7 Summary of air quality risks factors within each precinct

Precinct	Key issues	Commentary
Regional context	Nil.	<p>Potential air quality impacts and management requirements from construction activities are expected at a 'precinct' level only; adverse impacts to regional air quality are not anticipated.</p> <p>Regional impacts from the operation of Melbourne Metro are considered insignificant in comparison to construction impacts.</p>
All precincts	Receptors in very close proximity to works that have the potential for dust emission.	Dust emissions are likely to be intermittent in nature with potential for short-term impacts at sensitive receptors.
All precincts	<p>Construction works coinciding with days of high background PM_{2.5} and PM₁₀.</p> <p>Intensive construction works for extended periods in close proximity to sensitive receptors.</p>	During days of high background particulate matter (e.g. Section 5.3.3 highlighted exceedances of 24-hour PM ₁₀ and PM _{2.5} criteria), the addition of incremental impacts from construction dust emissions may exceed the PM ₁₀ or PM _{2.5} 24-hour criteria of 50 µg/m ³ and 25 µg/m ³ respectively.
All precincts	<p>Potential to encounter contaminated spoil requiring high-level dust containment.</p> <p>Intensive construction works for extended periods in close proximity to sensitive receivers.</p>	Dust and odour emissions resulting from the excavation of soil, and operation of construction vehicles/equipment over existing contaminated soils can give rise to contaminated dust particles (e.g. heavy metals) or odours, impacting at nearest sensitive receptors.



6 Risk Assessment

Table 6-1 presents the air quality risks associated with the project, based on a precinct basis. The environmental risk assessment methodology is outlined in Section 4.4.

Existing performance requirements were identified to inform the assessment of initial risk ratings. These existing performance requirements are based on standard requirements that are typically incorporated into construction contracts for rail projects.

The primary identified risk for the construction of the project relates to generation of dust as a result of construction activities. The potential magnitude of dust generation is different for different activities, and to reflect this, a dust generation risk has been captured against a number of different construction activities. The activities with potential to generate greater amounts of airborne dust include handling of spoil, wind erosion and operation of vehicles on unpaved surfaces. As such, those precincts that have been identified as the primary spoil handling facilities have been identified as having a high initial risk rating.

As a result of the risk assessment, project-specific performance requirements (recommended Environmental Performance Requirements) have been proposed to reduce risks and hence determine the Residual Risk Rating. The recommended Environmental Performance Requirements are outlined in the following sections of the impact assessment and collated in Table 16-1. All recommended Environmental Performance Requirements are incorporated into the Environmental Management Framework for the project (Chapter 23).

In addition, a series of mitigation measures have been identified that are proven techniques for dust minimisation and considered business as usual for large-scale construction work sites, including minimisation of exposed surfaces, dust suppression and air quality monitoring. Implementation of these mitigation measures, in conjunction with the recommended Environmental Performance Requirements, would reduce both the frequency and magnitude of problematic dust generation, thereby reducing the residual risks in most circumstances to medium or low. Two medium residual risks remain associated with handling, removal and storage of spoil, which is largely due to the likelihood rating that has been allocated. Given that the background PM would occasionally approach, and exceed, the relevant criteria, it is plausible that a minor exceedance may occur. Depending on the degree to which haul roads and exposed surfaces can be sealed, it may be possible to reduce residual risks to low or very low.

For further details refer to the Technical Appendix B *Environmental Risk Assessment Report* which includes the full risk register, with existing performance requirements and recommended Environmental Performance Requirements assigned to each risk.



Table 6-1 Risk register for impact assessment

Impact pathway		Precinct	Initial risk			Residual risk			Risk no.
Category	Event		C	L	Risk	C	L	Risk	
Construction									
General earthworks and construction	Increased emissions to air (dust and products of combustion) due to clearing for laydown areas; the handling of materials used for the construction of tracks; and machinery and equipment exhausts. This may result in a deterioration to the existing air quality environment.	1 - Tunnels (Fawkes Park) 2 - Western portal 3 - Arden station 4 - Parkville station 5 - CBD North station 6 - CBD South station 7 - Domain station 8 - Eastern portal	Moderate	Possible	Medium	Moderate	Unlikely	Low	AQ001
Portal, station and platform construction	Increased emissions to air (dust and products of combustion) due to the handling of materials used for the construction of portals, stations and platforms, as well as machinery and equipment exhausts. This may result in a deterioration to the existing air quality environment.	2 - Western portal 3 - Arden station 4 - Parkville station 5 - CBD North station 6 - CBD South station 7 - Domain station 8 - Eastern portal 9 - Western turnback	Minor	Possible	Low	Minor	Possible	Low	AQ002
Construction of ventilation structures and access shafts	Increased emissions to air (dust and products of combustion) due to the handling of materials used for the construction of ventilation structures and access shafts. This may result in a deterioration to the existing air quality environment.	2 - Western portal 3 - Arden station 4 - Parkville station 5 - CBD North station 6 - CBD South station 7 - Domain station 8 - Eastern portal	Minor	Possible	Low	Minor	Possible	Low	AQ003



Impact pathway		Precinct	Initial risk			Residual risk			Risk no.
Category	Event		C	L	Risk	C	L	Risk	
Handling, storage and removal of spoil	Increased dust and combustion emissions to air in the vicinity of the surface construction work sites due to handling of spoil, wind erosion and operation of vehicles on unpaved surfaces, resulting in a deterioration to the existing air quality environment.	1 - Tunnels (Fawkner Park) 3 - Arden station 7 - Domain station	Major	Likely	High	Moderate	Likely	Medium	AQ004
		1 - Tunnels (emergency access shafts) 2 - Western portal 4 - Parkville station 5 - CBD North station 6 - CBD South station 8 - Eastern portal	Moderate	Likely	Medium	Moderate	Possible	Medium	AQ005
Restoration of surface areas	Increased emissions to air (dust and products of combustion) due to restoration activities and operation of machinery. This may result in a deterioration to the existing air quality environment.	All	Minor	Possible	Low	Minor	Possible	Low	AQ006
Operation of construction ventilation shafts/exhaust fans	Increased emissions to air (dust and products of combustion) due to the discharge of underground air (occupational atmosphere) from construction ventilation shafts (exit). This may result in a deterioration to the existing air quality environment.	1 - Tunnels (Fawkner Park) 2 - Western portal 3 - Arden station 4 - Parkville station 5 - CBD North station 6 - CBD South station 7 - Domain station 8 - Eastern portal	Minor	Unlikely	Low	Minor	Unlikely	Low	AQ007



Impact pathway		Precinct	Initial risk			Residual risk			Risk no.
Category	Event		C	L	Risk	C	L	Risk	
Construction of Melbourne Metro – Boring, excavation and site works	Potential release of odour if excavation / boring works disturb contaminated soils and/or Acid Sulphate Soils (ASS), leading to potential odour impact (i.e. >1 OU) at sensitive receptors in proximity to where these materials are stockpiled.	All	Minor	Possible	Low	Minor	Possible	Low	AQ008
Operation									
Cleaning of tunnel walls	Increased particulate matter emissions at ventilation exit points (tunnel wall cleaning is anticipated on a 5 – 10 year interval). Potential for particulate residue (brake dust, airborne dust) from wall cleaning to be emitted. This may result in a deterioration to the existing air quality environment: possible elevated PM _{2.5} /PM ₁₀ ground level concentrations (GLCs) in vicinity of ventilation shafts; potential for impact at nearby sensitive receptors.	1 - Tunnels (Fawkner Park) 2 - Western portal 3 - Arden station 4 - Parkville station 5 - CBD North station 6 - CBD South station 7 - Domain station 8 - Eastern portal	Minor	Possible	Low	Minor	Possible	Low	AQ009
Fire (accident/incident) in tunnel	Increased particulate matter emissions at ventilation exit points as a result of smoke from fire in an emergency. This may result in a deterioration to the existing air quality environment: possible elevated PM _{2.5} /PM ₁₀ ground level concentrations (GLCs) in vicinity of ventilation shafts; potential for impact at nearby sensitive receptors.	1 - Tunnels (Fawkner Park) 2 - Western portal 3 - Arden station 4 - Parkville station 5 - CBD North station 6 - CBD South station 7 - Domain station 8 - Eastern portal	Moderate	Rare	Low	Moderate	Rare	Low	AQ010



7 Precinct 1: Tunnels

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

7.1 Project Components

This precinct covers the alignment of the proposed tunnels between the proposed western portal at Kensington and the proposed eastern portal at South Yarra, with the exception of the stations and portals. The precinct includes the two tunnels between the following precincts:

- Western portal to Arden station
- Arden station to Parkville station
- Parkville station to CBD North station
- CBD North station to CBD South station
- CBD South station to Domain station
- Domain station to eastern portal.

7.1.1 Infrastructure

TBM Southern launch site

There are two options in the Concept Design for the southern TBM launch site; the use of Domain only, or the use of Domain and Fawkner Park. The proposed Fawkner Park construction work site has an area of 19,800 m², and includes a TBM launch site and other construction-related activities such as material laydown, equipment storage and maintenance, site office and amenities, and spoil handling facilities. Discussion on the Domain TBM launch site is included in Section 13.

Vertical Alignment Project – Vertical Design

The majority of the precinct is proposed to be located underground and would have minimal impact on air quality. The vertical alignment is not expected to have an influence because emissions would be contained underground.

Emergency Access shafts

Two emergency access shafts are required in the southern section to provide emergency access. The proposed locations of the emergency access shafts are:

- Fawkner Park at the north eastern end of the park
- Queen Victoria Gardens, adjacent to Linlithgow Avenue.

7.1.1.1 Alternative Design Options

CityLink Tunnels Crossing – Below CityLink Tunnels

The vertical alignment is not expected to have an influence on air quality because emissions would be contained underground.

Emergency Access Shafts

The two alternative design options for the emergency access shaft locations are:

- Fawkner Park – Utilising the location of the Fawkner Park TBM launch site



- Linlithgow Avenue – Located in Tom's Block, between Linlithgow Avenue and St Kilda Road.

7.1.2 Construction

Tunnels would be excavated using TBM with the exception of the CBD North to CBD South section, which would be constructed using mined methods. Because the majority of the precinct is located underground, there would be minimal impact on air quality.

7.1.2.1 Variations

Fawkner Park TBM Launch Site

If the TBM is to be launched from the Fawkner Park construction work site, it would be the main source of emissions to air from this precinct.

An estimated 243,000 m³ of spoil could be extracted and stockpiled from the southern TBM sites (Domain and Fawkner Park). At Fawkner Park, spoil handling and material deliveries are estimated to average up to 42 truck round trips per day.

During the construction, there may be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities would present the greatest risks arising from emissions of dust and odours:

- Handling, stockpiling and transport of excavated materials (dust, and some potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

Emergency Access Shafts

The Linlithgow Avenue emergency access shaft site would have identical construction activities as the Concept Design site at Queen Victoria Gardens and would have considerably smaller construction intensity than the Fawkner Park TBM launch site.

The co-location of the Fawkner Park emergency access shaft at the Fawkner Park TBM launch site would eliminate an additional construction work site at the north-east corner of the park.

7.1.3 Operation

During proposed operation, there would be minimal air quality impacts as trains operating on the network would be electric and emit few pollutants, resulting in low probability of air quality impacts under normal operating conditions.

Ventilation for the tunnel would be required at each of the stations but would require no energy input, i.e. unforced ventilation, and would occur via natural convection or by pressure generated by the train movements. Ventilation rates would therefore be expected to be low and given that electric trains emit few pollutants, there is a low probability of air quality impacts under normal operating conditions. The majority of ventilation facilities would be located within other precincts.

Under non-routine conditions, emissions to air might occur during the following conditions:

- In emergency conditions where there is fire in the tunnel, smoke would be emitted from the ventilation shafts
- During maintenance activities such as tunnel wall or track cleaning (expected at 5–10 year intervals), particulates may be emitted from the ventilation shafts.

The final design of the ventilation systems has not been completed at this time and has not been considered in the assessment. Air emissions from non-routine operations are expected to be much less significant than particulate emissions during construction of Melbourne Metro.



7.2 Existing Conditions

The majority of the precinct is located underground, however, in areas on the surface at which there may be air quality impacts due to the regional nature of air quality and the absence of significant air pollutant point sources in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, winds patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}.

7.3 Key Issues

Fawkner Park TBM Launch Site

The alternative TBM launch site would be located adjacent to Fawkner Park Community Centre (Child Care Centre and Kindergarten, Senior Citizens Centre, Tennis Centre, Kiosk and Tea Rooms, Maternal and Child Health Centre). Other key sensitive receptors include residences along the northern side of Toorak Road West, commercial and residential properties on the eastern side of St Kilda Road and other park users south, west and east of the construction work site.

The key issue associated with the Fawkner Park TBM launch site is the predicted high number of truck movements, therefore possible high intensity of dust-generating activities (**Risks #AQ004 and #AQ005**). There would be potential for nearby receptors to be impacted from dust emissions for all wind directions. Residences immediately to the north of the proposed TBM launch site along Toorak Road West are at a higher risk of impact due to a tendency of stronger southerly winds during afternoon periods.

Key sensitive receptors for the proposed Fawkner Park emergency access shaft site include residences along the north side of Toorak Road West, Christ Church Grammar School to the east and other park users south, west and east of the construction work site.

Key sensitive receptors for the Queen Victoria Gardens emergency access shaft include the Arts Centre Melbourne on the southern side of St Kilda Road, commercial and residential properties on the southern side of St Kilda Road and Royal Botanic Gardens users to the north and west of the proposed works site.

There would be potential for nearby receptors to be impacted from dust emissions for all wind directions.

The key issues associated with the Concept Design are identified in Table 7-1.

Table 7-1 Key issues associated with the Concept Design

Concept Design	Issue	Risk #
Ventilation Shaft (permanent or temporary)	Potential for receptors to be in close proximity to downwind PM emissions from ventilation shaft. Quantum of PM ₁₀ and PM _{2.5} emissions within exhausted air yet to be determined.	AQ001 AQ007
Emergency access shaft	Receptors in close proximity to works: potential for dust impacts.	AQ003

7.3.1.1 Alternative Design Options

Emergency Access Shafts (Risk #AQ003)

The alternative proposed emergency access shaft location at Tom's Block has identical key receptors as the Queen Victoria Gardens emergency access shaft site, with almost identical separation distances. This alternative design option therefore offers no advantage or disadvantage over the Concept Design.



The alternative emergency access shaft location at the proposed Fawkner Park TBM launch site has identical key receptors as the TBM launch site. If Fawkner Park is selected as a TBM launch site, given the scale of works occurring at the site, minimal additional impacts would be expected beyond those outlined for the Fawkner Park TBM launch site. Co-location of the emergency access shaft at the Fawkner Park TBM launch site may offer some advantage over the Concept Design due to the elimination of an additional construction work site and associated amenity impacts.

The key issue associated with the alternative design options would be the close proximity of receptors to works and the potential for dust impacts.

7.4 Benefits and Opportunities

If Fawkner Park is selected as a TBM launch site in tandem with Domain, the construction time for the tunnels in the southern section would be reduced, minimising the length of time sensitive receptors may be impacted. However, the additional major construction work site would occupy public space with associated amenity impacts on additional sensitive receptors, possibly outweighing any benefits.

If Fawkner Park is selected as a TBM launch site, a benefit associated with Melbourne Metro in the Tunnels precinct is the co-location of the emergency access shaft at the Fawkner Park TBM launch site. This would eliminate one of the construction work sites and reduce associated amenity impacts.

7.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 7-2 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to the recommended Environmental Performance Requirements and proposed mitigation measures.

7.5.1 Results of Modelling Assessment

Fawkner Park is an alternative launch site being considered for the TBM and would operate in tandem with the Domain TBM launch site in the southern section. If this alternative design option is implemented, TBM tunnelling spoil would be removed from the Fawkner Park construction work site as well as from the Domain



site. There would be a high intensity of dust-generating activities including spoil management and truck movements at this site, and consequently the site was included in the dispersion modelling study.

Modelling assumed that truck movements occur on unsealed haul roads and a majority of the site is exposed to wind erosion. Mitigation measures for dust emissions were incorporated in the modelling and include the application of water to stockpiles, unsealed roads and exposed surfaces subject to wind erosion, and the use of windbreaks for stockpiles and exposed surfaces. The methodology for this assessment is described in more detail in Section 4.2.

The dispersion model results are presented in Section 13.5.2 along with the Domain construction work site, which also has a high intensity of dust-generating activity. The two sites are less than 500 m apart and given that they would be operating in tandem, were assessed concurrently; i.e. within the same cumulative air quality impact assessment.

7.5.2 Impact Assessment

The majority of the precinct is located underground, therefore would be expected to have a minimal impact on ambient air quality. Dust generated underground would be expected to be managed in situ, e.g. using water, filtered or extracted to one of the other precincts.

Above ground construction work would occur only at the proposed emergency access shaft sites.

Fawkner Park TBM Launch Site

This alternative to the TBM launch site at Domain only would create an additional major construction work site at Fawkner Park, which would be the TBM launch site, in tandem with Domain, for the southern section of the proposed project boundary. Spoil removal from Fawkner Park would include material from TBM tunnelling works, both from the Fawkner Park to Domain station and Fawkner Park to eastern portal, and from excavation of the TBM launch shaft.

During the proposed construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for the Fawkner Park site include:

- < 50 m east to Fawkner Park Community Centre (Child Centre and Kindergarten, Senior Citizens Centre, Tennis Centre, Kiosk and Tea Rooms, Maternal and Child Health Centre)
- < 50 m north to residential properties along the northern side of Toorak Road
- 50 – 100 m west to residential and commercial properties along the eastern side of St Kilda Road
- < 50 m east, west and south to other park users.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for all wind directions.

Mitigation Measures

Dispersion modelling results for construction dust indicated that in order to comply with SEPP (AAQ) criteria, dust mitigation measures at the site would be needed including:

- Installation of windbreaks around stockpiles and exposed surfaces
- Spraying of exposed surfaces and stockpiles with water
- Level 2 watering (2 litres/m²/hr) on unsealed roads.

In addition to the mitigation measures listed, temporary ventilation facilities would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and location of such systems would be determined in the delivery phase, and are therefore not considered in this assessment.



Dispersion modelling has shown that with management, construction activities are unlikely to result in air quality impacts at sensitive receptor locations and consequently, air quality being maintained within SEPP criteria. However, given that background particulate concentrations can occasionally approach and exceed SEPP criteria, there would still be the potential for exceedances on days when background particulate concentrations are high.

The adoption of best practice mitigation measures is required under legislation and is necessary in order to minimise the risks of exceedances, particularly on those days with high background concentrations. Construction activities would be managed to minimise dust and other emissions in accordance with EPA Publication 480 (EPA 1996).

The major contributors to dust emissions are truck movements on unsealed surfaces and wind erosion of open areas. Best practice would be to minimise the potential for dust generation by reducing or eliminating these sources of emissions where possible. This would be achieved by reducing the distance travelled by trucks on unsealed surfaces, by planning stockpile locations and haul road routing to minimise the distance travelled, and by sealing haul roads where possible. Wind erosion from exposed areas would be minimised by sealing or establishing vegetation on exposed surfaces or by enclosure with sheds if practicable. Technical Appendix I *Noise and Vibration* proposes the possible use of acoustic enclosures (sheds) at some precincts which would assist in reducing the area of exposed surfaces subject to wind erosion, and consequently the volume of dust emission from the work site.

Contaminated Soils and Odour

It is known that contaminated soils or sediments would be encountered during construction. These would include natural sediments which contain high amounts of degrading organic matter which can naturally generate gases such as methane, hydrogen sulphide and carbon dioxide. During construction, pockets of gas might be encountered and might result in a short-term release of gas and consequential odour generation. Heavy metals or vapours such as petroleum and solvents from contaminated soil and groundwater might also be encountered, with associated odour and health risks.

Odour from groundwater or TBM water would be expected to be contained within the infrastructure. Water would be piped from below ground and then treated within a closed treatment plant so it is expected odour would be negligible. Odour emissions are more likely to occur from exposed soil and would be short-term, abnormal events, and managed by on-site environmental management procedures.

The potential for human health impacts from contaminated particle emissions is discussed in Section 5.1.5 and for variable or poorly defined particulate compositions, the best indicators for human health impacts are the SEPP PM₁₀ and PM_{2.5} ambient air quality criteria defined in Section 3.2.

Mitigation measures for contaminated soil and odour are similar to those used for general dust management (**Risk #AQ008**). In most cases, odour and contaminated soil can be managed using well-tried, yet effective mitigation methods such as wetting down of materials and/or covering of trucks and stockpiles with high density polyethylene sheeting or tarpaulins, i.e. typical construction dust mitigation methods.

Technical Appendix Q *Contaminated Land and Spoil Management* impact assessment provides further detail of the risks and nature of currently known contaminated sites. Prior to commencing excavation works, further sampling may be required by the contractors in order to finalise spoil waste categorisation and management plans. During construction, it is anticipated that data gathering (and monitoring) would be ongoing for the duration of the project. In the event where a contaminant is identified and ascertained to require additional mitigation, an appropriate strategy would be developed and implemented by the contractor. This would be documented in the contaminated land management plan.

Air Quality Monitoring

Given the proximity of sensitive receptors to proposed earthworks and dust-generating activity at the site, dust monitoring at key sensitive receptors would be likely to be required to demonstrate compliance with



SEPP air quality criteria and to provide an input for the reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions.

Melbourne Metro Operations

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (**Risk #AQ009**) or fire (**Risk #AQ010**) are unknown at this stage and, as such, could not be assessed by air dispersion modelling; however, air emissions from non-routine operations would be expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

Fawkner Park Emergency Access Shaft

Key sensitive receptor locations for the Fawkner Park emergency access shaft include:

- < 50 m north to residences along the northern side of Toorak Road
- < 100 m east to Christ Church Grammar School
- < 50 m east, south and west to other park users.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for all wind directions.

Dispersion modelling results for construction dust indicates dust mitigation measures at the site would be needed including those listed for Fawkner Park in Section 7.5.2.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

Queen Victoria Gardens Emergency Access Shaft

Key sensitive receptor locations for the Queen Victoria Gardens emergency access shaft include:

- < 50 m west to the Victorian College of the Arts
- 50–100 m south west to residential and commercial properties
- < 50 m north and west to Royal Botanic Gardens users.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for all wind directions.

Dispersion modelling results for construction dust indicates dust mitigation measures at the site would be needed including those listed for Fawkner Park in Section 7.5.2.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

7.5.2.1 Alternative Design Options

Emergency Access Shafts

Impacts for all alternative design options are similar to the Concept Design, with only minor changes to the proximity of sensitive receptors to dust generating activities. Mitigation measures would be identical for all alternative design options.



7.6 Environmental Performance Requirements

Table 7-3 provides the recommended Environmental Performance Requirements and proposed mitigation measures for the precinct.

Table 7-3 Environmental Performance Requirements for the tunnels precinct

Asset / value	Impact	Environmental Performance Requirements	Proposed mitigation measures	Risk no.
Air Quality	Exceedance of air quality criteria. Deterioration of perceived amenity.	<p>Develop and implement plan(s) for dust management and monitoring, in consultation with EPA, to minimise and monitor the impact of construction dust.</p> <p>The plan must address monitoring requirements for key sensitive receptors including, but not limited to:</p> <ul style="list-style-type: none"> Residential and commercial properties Hospitals and research facilities within the Parkville precinct Universities, including The University of Melbourne and RMIT Schools, including Melbourne Grammar School (Wadhurst Campus) and Christ Church Grammar School Public parks including the Shrine of Remembrance Reserve and JJ Holland Reserve. <p>Undertake air modelling for construction to inform the dust management plan.</p>		<p>AQ001</p> <p>AQ004</p> <p>AQ005</p> <p>AQ006</p> <p>AQ007</p> <p>AQ008</p>
		<p>Manage construction activities to minimise dust and other emissions in accordance with EPA Publication 480, Environmental Guidelines for Major Construction Sites (EPA 1996).</p>	<p>Minimise the distance travelled on unsealed surfaces by planning haul road routing to minimise the travel distance and by sealing haul roads where possible.</p> <p>Manage the size and siting of stockpiles to minimise risk to sensitive receivers and the local environment.</p> <p>Manage unstable stockpiles with appropriate cover and/or fencing.</p>	<p>AQ001</p> <p>AQ004</p> <p>AQ005</p> <p>AQ006</p> <p>AQ007</p>



Asset / value	Impact	Environmental Performance Requirements	Proposed mitigation measures	Risk no.
			Cover material that may create hazard or nuisance dust during transport. Use water trucks for the watering of unsealed and soiled roads. Use water sprays to protect stockpiles and unsealed surfaces from wind erosion. Use windbreaks to protect stockpiles and unsealed surfaces from wind erosion. Implement a high standard of engine maintenance to minimise vehicle emissions. Progressive re-vegetation of disturbed areas.	AQ008
		Control the emission of smoke, dust, fumes and other pollution into the atmosphere during construction and operation in accordance with the SEPPs for Air Quality Management and Ambient Air Quality.	Minimise the distance travelled on unsealed surfaces by planning haul road routing to minimise the travel distance and by sealing haul roads where possible. Implement a high standard of engine maintenance to minimise vehicle emissions.	AQ001 AQ004 AQ005 AQ006 AQ007 AQ008



8 Precinct 2: Western Portal (Kensington)

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

8.1 Project Components

8.1.1 Infrastructure

The Concept Design has the TBM retrieval box located adjacent to the railway reserve on the eastern side of Tennyson Street in the 50 Lloyd Street Business Estate. The Melbourne Metro tracks would connect to the existing Sunbury line between the Maribyrnong River and adjacent to the South Kensington station.

8.1.1.1 Alternative Design Option

The alternative design option from the Concept Design is TBM retrieval box opposite the pavilion on Childers Street and a longer decline structure including the widening and rebuilding of Kensington Road Bridge.

8.1.2 Construction

The construction of the decline structure would be by cut-and-cover method at the eastern end of Childers Street. The TBM retrieval would occur from this site after completion of the proposed Arden to western portal excavation works. A services and relief shaft would be located in the west corner of the 50 Lloyd Street Business Estate.

To support construction activities, it is proposed to locate a major construction work site at 1–39 Hobsons Road in Kensington. This site has good access to truck routes and is in an industrial area. It would be used for site offices and facilities, laydown areas and materials and equipment storage.

Existing car parking in Childers Street would be occupied during construction to provide room for construction traffic.

An estimated 57,000 m³ of spoil could be extracted from the western portal precinct. Peak spoil handling and material deliveries are estimated to average up to 31 truck round trips per day.

During construction, there may be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks arising from emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

8.1.2.1 Alternative Design Option

Construction methods would be the same as the Concept Design, except that the location of the portal would be approximately 200 m west and additional works would be required to widen the rail bridge across Kensington Road, including construction of a new bridge.

8.1.3 Operation

During proposed operation, there would be minimal air quality impacts as the majority of the precinct is underground and any above ground structures do not have emissions to air.



Ventilation for the tunnels would be required at each of the stations but would require no energy input, i.e. un-forced ventilation, and would occur via natural convection or by pressure generated by the train movements. Ventilation rates would therefore be expected to be low and given that electric trains emit few pollutants, there is a low probability of air quality impacts under normal operating conditions. Under non-routine conditions, emissions to air might occur during the following conditions:

- In emergency conditions where there is fire in the tunnel, smoke would be emitted
- During maintenance activities such as tunnel wall or track cleaning (expected at 5–10 year intervals), particulates might be emitted.

The design and location of the ventilation systems would be determined in the delivery phase and have not been considered in this assessment.

8.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, winds patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM_{10} and $PM_{2.5}$.

8.3 Key Issues

The decline structure is located adjacent to J.J. Holland Park on Childers Street, residences on Childers Street, Ormond Street and Tennyson Avenue, and commercial properties in the Lloyd Street Business Park. These receptors are located from the north-east to the north-west from the proposed portal location.

There would be potential for nearby receptors to be impacted from dust emissions for southerly or south-westerly winds. Residences and sporting facilities immediately to the north of the site along Childers Street, Ormond Street and Tennyson Street are at a higher risk of impact due to a tendency of stronger southerly winds during afternoon periods.

The key issue associated with the Concept Design is the potential for receptors to be impacted from dust emissions during prevailing afternoon southerly/south-westerly winds. The potential impact on the activities to occur in this precinct are captured by **Risks #AQ001 - #AQ003** and **#AQ005 - #AQ008**.

8.3.1.1 Alternative Design Option

The location of the decline structure and portal are approximately 200 m west of the Concept Design location and provides a greater separation distance to residences on Childers Street, Ormond Street and Tennyson Avenue, and commercial properties in the 50 Lloyd Street Business Estate. The Melbourne Seafood Centre and other food industries are to the south and west of the Kensington Road Bridge.

Sporting facilities immediately to the north of the site along Childers Street, Ormond Street and Tennyson Street would be at a higher risk of impact due to a tendency of stronger southerly winds during afternoon periods.

The key issue associated with the alternative design option would be the potential for receptors to be impacted from dust emissions during prevailing afternoon southerly/south-westerly winds.

8.4 Benefits and Opportunities

The benefit of the alternative design option is greater separation distance to residential properties along Childers Street, Ormond Street and Tennyson Street. However, the alternative design option would require



construction of a new rail bridge over Kensington Road which is in close vicinity to the Melbourne Seafood Centre and other food industry, possibly outweighing any benefits.

8.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 8-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to mitigation measures and performance requirements.

During construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:

- < 50 m north to JJ Holland Park
- < 50 m north to residences on Childers Street, Ormond Street and Tennyson Avenue
- < 50 m to commercial properties in the 50 Lloyd Street Business Estate.
- < 50 m south and west to Melbourne Seafood Centre and other food industry from Kensington Road Bridge (alternative design option).

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for southerly and south-westerly winds. Properties immediately to the north of the proposed decline structure and TBM retrieval site are at a higher risk of impact due to a tendency of stronger southerly winds during afternoon periods. Proposed construction traffic access to the site would be from Childers Street adding to this risk, and dust suppression for construction traffic would be particularly important given the proximity to northerly located sensitive receptors.

Mitigation measures at the site would be needed including those listed for Fawkner Park in Section 7.5.2.

In addition to the mitigation measures listed, temporary ventilation facilities (if installed) would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and location of such systems would be determined in the delivery phase, and are therefore not considered in this assessment.

The estimated frequency of truck movements at the western portal (31/day) are approximately 17–22 per cent of the frequency at the higher risk construction work sites of Arden station (182/day) and Domain station (144/day). In addition, the construction area footprint is smaller at the western portal reducing the potential distance travelled on unsealed surfaces when compared to the higher risk sites.



Modelling of emission at the higher risk construction work sites has demonstrated that with appropriate mitigation, air quality can be maintained within SEPP criteria even for a conservative assessment scenario with unsealed haul roads and a majority of the site exposed to wind erosion. Given that the frequency of truck movements and the distance travelled on unsealed surfaces is shown to be the greatest contributor to dust emissions (refer to Section 4.2.4), the lower intensity of these activities at the western portal is expected to lead to air quality being maintained within SEPP criteria. The sealing of haul roads in line with best practice principles, would further reduce the likelihood of exceedances.

It is likely that contaminated soils or sediments would be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (AQ009) or fire (AQ010) are unknown at this stage, however, air emissions from non-routine operations are expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

8.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels and as shown in Table 7-3.



9 Precinct 3: Arden Station

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

9.1 Project Components

9.1.1 Infrastructure

A primary construction work site for the northern section would be located adjacent to Arden station. A number of potentially significant activities would be undertaken from the Arden construction work site such as materials laydown, equipment storage and maintenance, site office and amenities, spoil handling facilities and a proposed concrete batching plant. It would be the TBM launch site for tunnelling operations in the northern section and may also serve as a staging ground for truck movements to other precincts and would also house a substation to provide power for the proposed TBM.

9.1.2 Construction

The Arden station precinct would be the proposed launch site for the TBM in the northern section and would employ a 'bottom up' construction method for the station. This method would allow for a more rapid excavation of the station and earlier launch of the TBM for the tunnelling works.

An estimated 479,000 m³ of spoil could be extracted and stockpiled at the proposed Arden site. Peak spoil handling and material deliveries are estimated to average up to 182 truck round trips per day.

During construction, there might be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks insofar as emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Handling, stockpiling and transport of raw materials for concrete batch plant
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

9.1.3 Operation

Operational impacts would be the same as those described in Section 8.1.3 and are not repeated here.

9.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, wind patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}.



9.3 Key Issues

The site is surrounded by the Craigieburn rail lines and CityLink to the west and south, which are not considered to be sensitive in terms of air quality impacts. To the north and east is a mix of industrial, commercial and residential properties.

The key sensitive receptors for the Arden precinct are residential property on the corner of Lauren Street and Queensberry Street and North Melbourne Recreation Centre to the north.

There would be potential for nearby receptors to be impacted from dust emissions for southerly and westerly winds.

The key issue associated with the Concept Design would be the high number of truck movements and the high intensity of dust-generating activities which are predicted at this precinct. There is potential for receptors to be impacted during prevailing afternoon southerly and south-westerly winds. The potential impact on the activities to occur in this precinct are captured by **Risks #AQ001 - #AQ004 and #AQ006 - #AQ008.**

9.4 Benefits and Opportunities

There are no benefits or opportunities associated with the Concept Design.

9.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 9-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to proposed mitigation measures and the recommended Environmental Performance Requirements.

9.5.1 Results of Modelling Assessment

The proposed Arden construction work site is one of two construction areas considered to have the highest risk of air quality impacts based on the expected level of construction activities and proximity to sensitive receptors.

Modelling was performed for the Concept Design and assumes that truck movements occur on unsealed haul roads and a majority of the site is exposed to wind erosion. Mitigation measures for dust emissions were incorporated in the modelling and include the application of water to stockpiles, unsealed roads and



exposed surfaces subject to wind erosion, and the use of windbreaks for stockpiles and exposed surfaces. The methodology for this assessment is described in more detail in Section 4.2. Results of the dispersion modelling study are summarised in the following sections.

9.5.1.1 Dispersion Model Results for Arden Precinct PM10

The AERMOD results for maximum 24 hour average PM₁₀ GLCs, including the background concentration of 20.9 µg/m³, are provided in Figure 9-1. These results show a potential exceedance of the SEPP (AAQ) criterion of 50 µg/m³ to the south-west of the site, near the existing rail corridor indicated by the red contour in Figure 9-1. Therefore it can be concluded that the proposed construction activities at the proposed Arden station are unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of PM₁₀ concentrations.

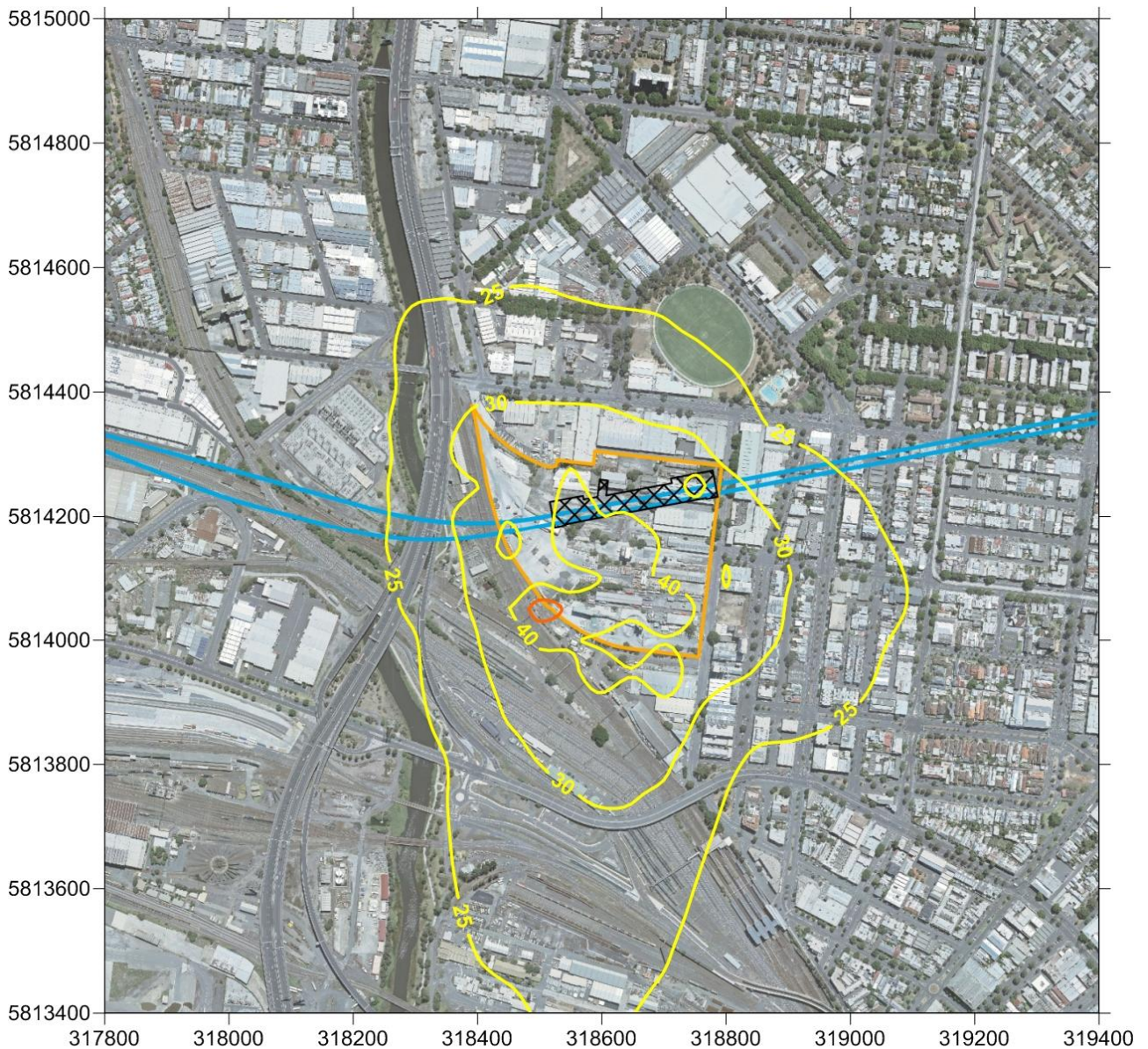


Figure 9-1 AERMOD results for maximum 24 hour average PM₁₀ GLC

9.5.1.2 Dispersion Model Results for Arden Precinct PM2.5

The AERMOD results for maximum 24-hour average PM_{2.5} GLCs, including the background concentration of 7.9 µg/m³, are provided in Figure 9-2. There were no predicted exceedances of the corresponding



Melbourne Metro criterion of $25 \mu\text{g}/\text{m}^3$. It can therefore be concluded that the proposed construction activities at the proposed Arden station are unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of maximum 24 hour $\text{PM}_{2.5}$ concentrations.

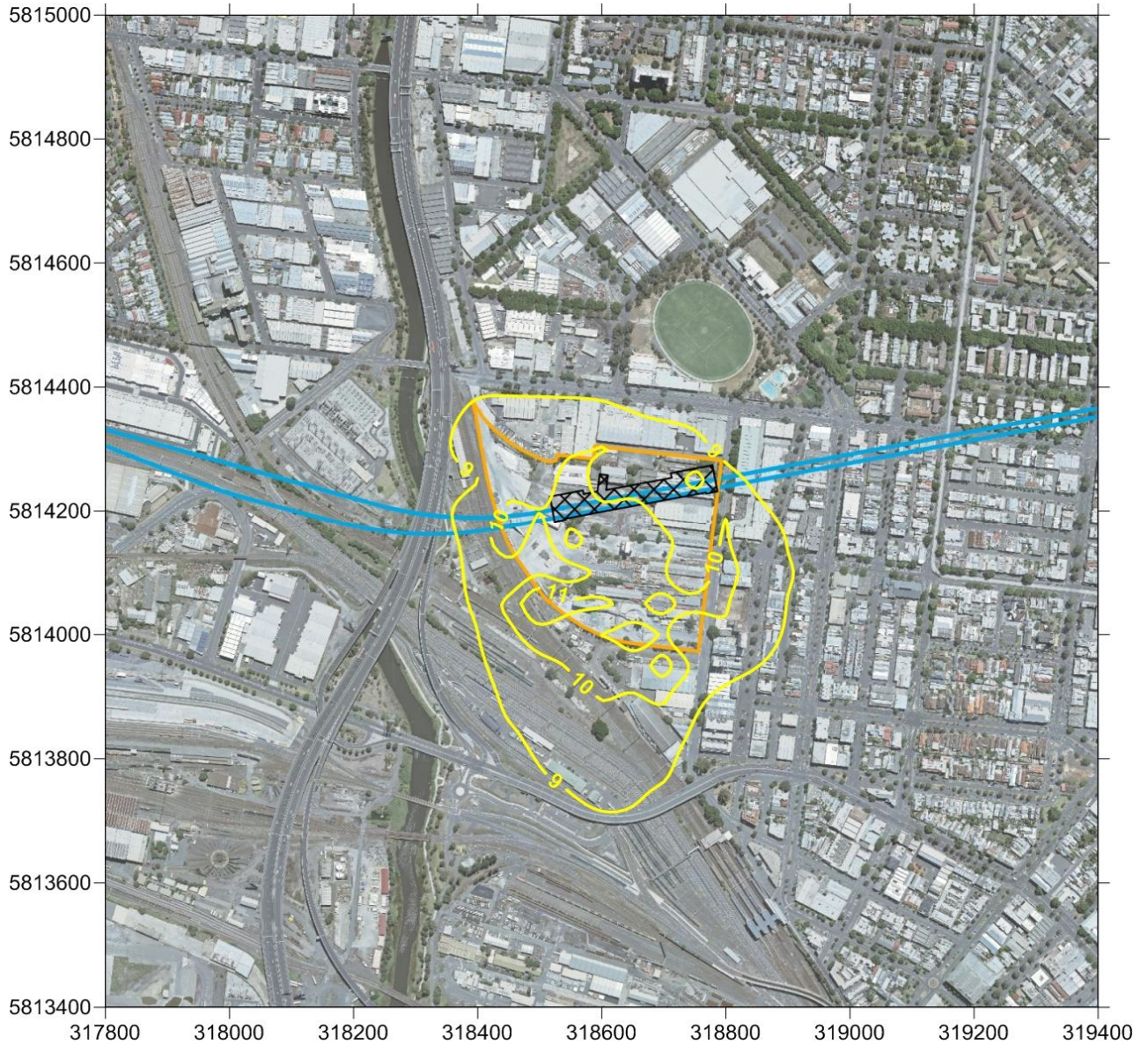


Figure 9-2 AERMOD results for maximum 24-hour average $\text{PM}_{2.5}$ GLC



The AERMOD results for maximum annual average $PM_{2.5}$ GLCs, including the background concentration of $5.9 \mu\text{g}/\text{m}^3$, are provided in Figure 9-3. There were no predicted exceedances of the corresponding Melbourne Metro criterion of $8 \mu\text{g}/\text{m}^3$. Therefore it can be concluded that the proposed construction activities at Arden station are unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of annual $PM_{2.5}$ concentrations.

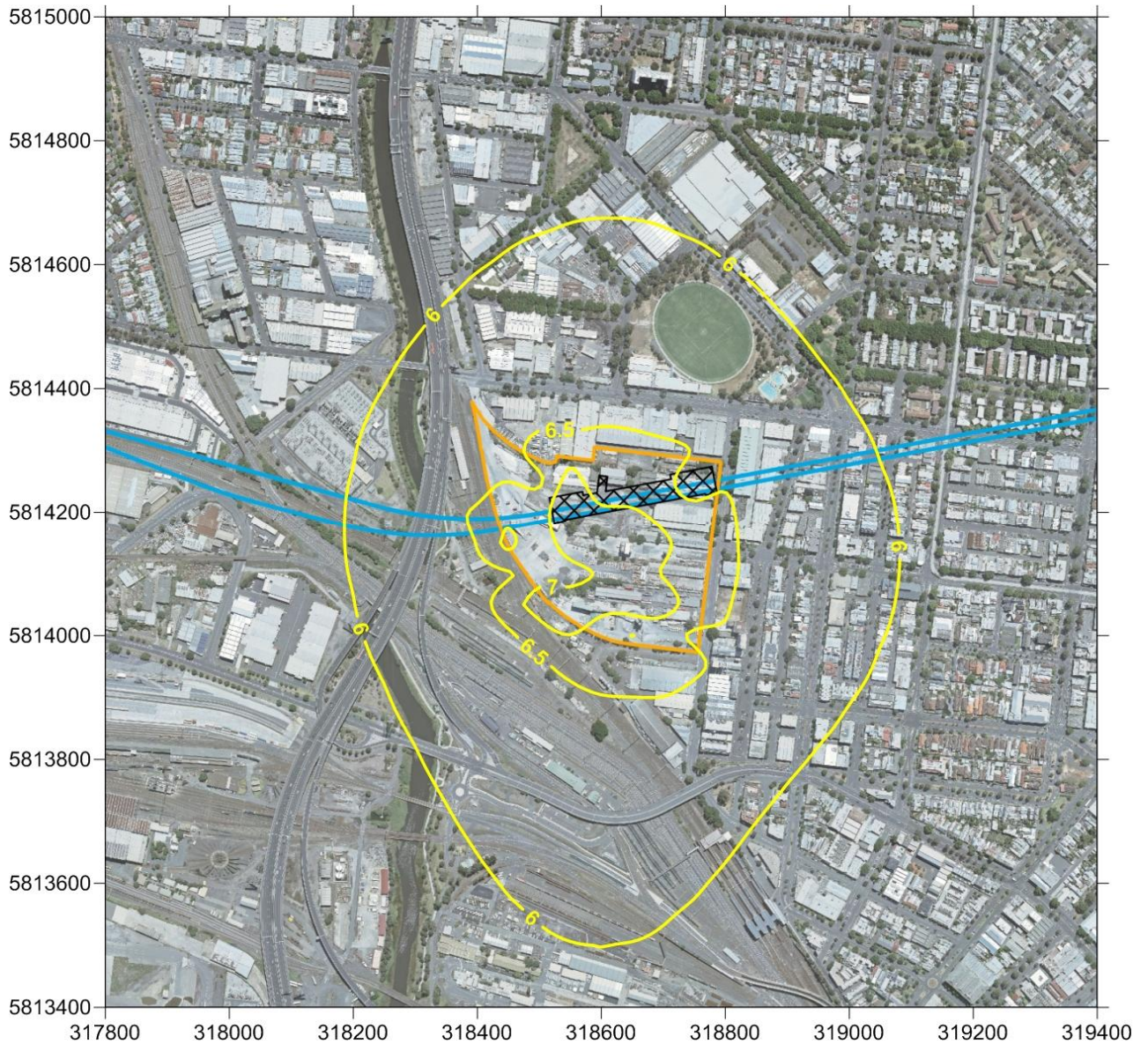


Figure 9-3 AERMOD results for annual $PM_{2.5}$ GLC



9.5.1.3 Dispersion Model Results for Arden Precinct Dust Deposition

The AERMOD results for maximum monthly dust deposition, including the background concentration of $2 \text{ g/m}^2/\text{month}$, are provided in Figure 9-4. There were no predicted exceedances of the corresponding Melbourne Metro criterion of $4 \text{ g/m}^2/\text{month}$. Therefore it can be concluded that the proposed construction activities at Arden station would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of maximum dust deposition.

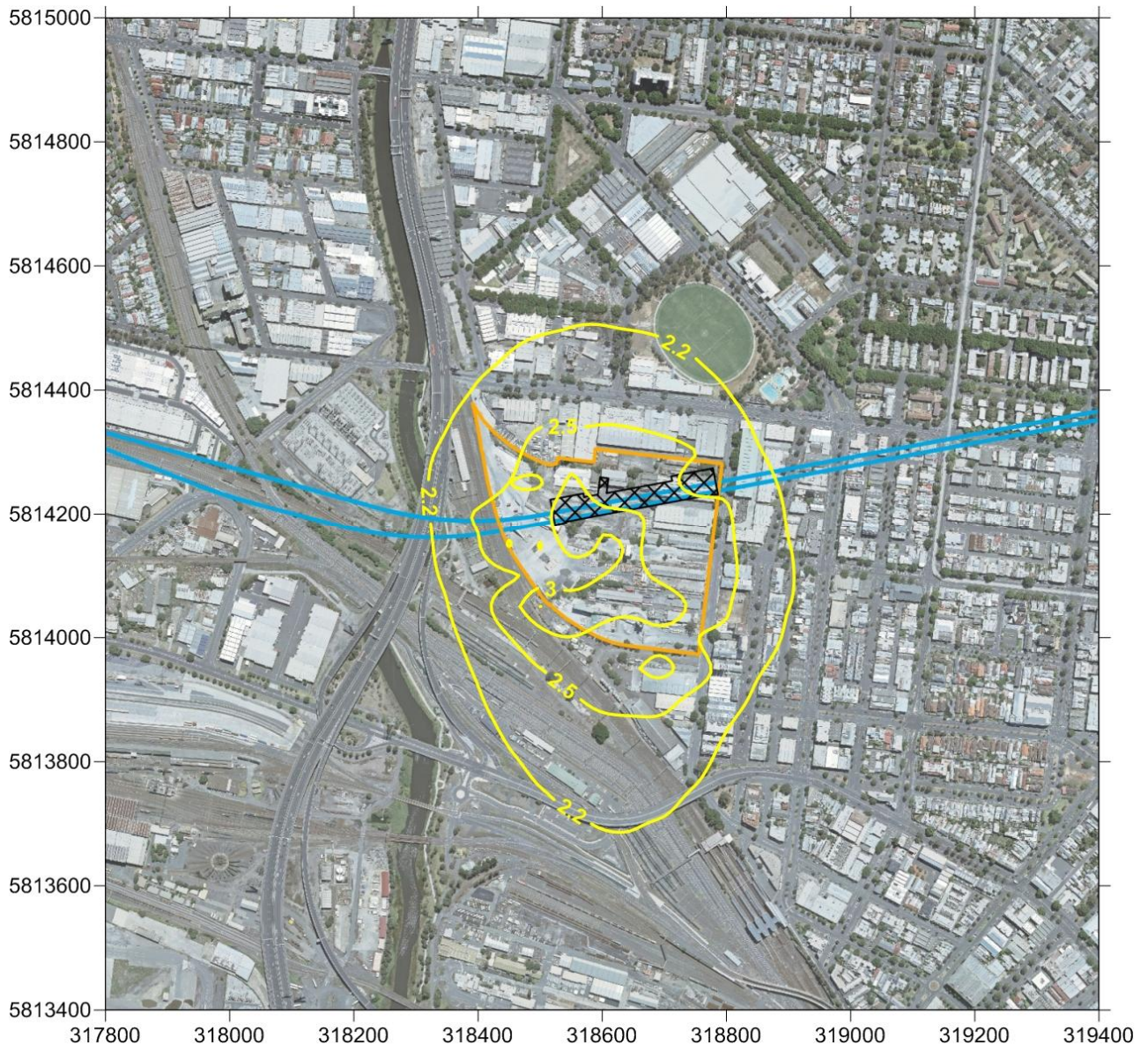


Figure 9-4 AERMOD results for monthly average dust deposition.

9.5.2 Impact Assessment

The proposed Arden construction work site is the primary construction work site for the northern section of the proposed Melbourne Metro and would also host a concrete batching plant for the duration of construction. Spoil removal would include spoil from both TBM tunnelling works and excavation of the Arden station box. During construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:



- < 50 m east to a residential property on the corner of Lauren Street and Queensberry Street
- 100 m north to North Melbourne Football Club.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for southerly and westerly winds. Properties immediately to the north of the site are at a higher risk of impact due to a tendency of stronger southerly winds during afternoon periods. Proposed construction traffic access to the site would be from Laurens Street increasing the risk of impacts to properties to the west. Dust suppression for construction traffic would be particularly important given the proximity of access routes to sensitive receptors.

Dispersion modelling results for construction dust indicates dust mitigation measures at the site would be needed, including those listed for Fawkner Park in Section 7.5.2.

In addition to the mitigation measures listed, temporary ventilation facilities would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and location of such systems would be determined in the delivery phase and are therefore not considered in this assessment.

Dispersion modelling has shown that with management, construction activities would be unlikely to result in air quality impacts at sensitive receptor locations and consequently, air quality would be maintained within SEPP criteria. The modelling has assessed a conservative scenario with unsealed haul roads and a majority of the site exposed to wind erosion and typical mitigation measures applied. The sealing of haul roads, in line with best practice principles, would further reduce the likelihood of exceedances as would construction of acoustic sheds over the station box.

It is likely that contaminated soils or sediments would be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

Given the proximity of sensitive receptors to proposed earthworks and dust-generating activity at the site, dust monitoring at key sensitive receptors would be required to demonstrate compliance with SEPP air quality criteria and to provide an input for the reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions.

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (AQ009) or fire (AQ010) are unknown at this stage, however, air emissions from non-routine operations would be expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

9.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels as shown in Table 7-3.



10 Precinct 4: Parkville Station

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

10.1 Project Components

10.1.1 Infrastructure

It is proposed to locate Parkville station under the Grattan Street road reserve, to the east of Royal Parade. The station's footprint occupies the full width of Grattan Street and extends from the intersection of Grattan Street and Royal Parade to University Square.

A temporary construction work site is proposed at 750 Elizabeth Street, currently housing the City Ford car dealership, and at the northern section of University Square.

10.1.2 Construction

The proposed station structural works and station entrance connections across Royal Parade would be constructed using cut and cover, top-down construction method and would seek to quickly reinstate the roof slab and re-open Grattan Street for construction traffic.

An estimated 299,000 m³ of spoil could be extracted from the Parkville station works. Peak spoil handling and material deliveries are estimated to average up to 70 truck round trips per day.

During construction, there might be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks insofar as emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

10.1.3 Operation

Operational impacts would be the same as those described in Section 8.1.3 and are not repeated here.

10.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, wind patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}.

10.3 Key Issues

The station is located in close proximity to numerous health and educational facilities including Peter Doherty Institute and The University of Melbourne to the north and south, Royal Melbourne Hospital, Royal Women's Hospital, Royal Children's Hospital to the west and commercial and residential properties to the south-east.



Given the nature of the surrounding properties, there is a possibility of impacts to sensitive medical and research equipment from construction activities. There is potential for nearby receptors to be impacted from dust emissions for all wind directions and atypical wind conditions due to the surrounding buildings are likely to affect the dispersion of dust and emissions. However, well-policed dust mitigation measures such as the use of water carts and water sprays should be significant in reducing this potential risk of air quality impact. The potential impact on the activities to occur in this precinct are captured by **Risks #AQ001 - #AQ003 and #AQ005 - #AQ008**.

10.4 Benefits and Opportunities

There are no benefits or opportunities associated with the Concept Design in this precinct.

10.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 10-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to mitigation measures and performance requirements.

During construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:

- < 50 m south to Peter Doherty Institute and University of Melbourne School of Health Sciences
- < 50 m north to The University of Melbourne Faculty of Medicine, Dentistry and Health Sciences
- < 50 m south east to commercial and residential properties
- 100 m west to Royal Melbourne Hospital and Royal Women’s Hospital.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for all wind directions. In any case, air quality impacts from any direction should be anticipated due to the complexity of buildings and infrastructure, modifying wind flows in the study area.

Mitigation measures at the site would be needed, including those listed for Fawkner Park in Section 7.5.2.

In addition to the mitigation measures listed, temporary ventilation facilities would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and location of



such systems would be determined in the delivery phase and are therefore not considered in this assessment. The sealing of haul roads, in line with best practice principles, would further reduce the likelihood of exceedances.

The estimated frequency of truck movements at the Parkville station (70/day) are approximately 38–49 per cent of the frequency at the higher risk construction work sites of Arden station (182/day) and Domain station (144/day). In addition, the construction area footprint at Parkville is estimated to be approximately three hectares, compared to Arden and Domain with 14 and five hectares respectively. Emissions due to wind erosion of exposed surfaces and by wheel-generated dust on unsealed surfaces would be lower than for the larger Arden and Domain construction work sites.

Modelling of emission at the higher risk construction work sites has demonstrated that with appropriate mitigation, air quality could be maintained within SEPP criteria even for a conservative assessment scenario with unsealed haul roads and a majority of the site exposed to wind erosion. Given that the frequency of truck movements and the distance travelled on unsealed surfaces is shown to be the greatest contributor to dust emissions (refer to Section 4.2.4), the lower intensity of these proposed activities at the Parkville station is expected to result in air quality being maintained within SEPP criteria.

It is assumed that existing precautions for sensitive medical and research equipment against ingress of dust would be sufficient to prevent impacts from any incremental increase in particulates due to construction related emissions.

It is likely that contaminated soils or sediments may be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

Given the proximity of sensitive receptors to the proposed earthworks and dust-generating activity at the site, and the highly sensitive nature of nearby properties, dust monitoring at key sensitive receptors is likely to be required to demonstrate compliance with SEPP air quality criteria and to provide an input for the reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions.

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (AQ009) or fire (AQ010) are unknown at this stage, however, air emissions from non-routine operations are expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

10.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels as shown in Table 7-3.



11 Precinct 5: CBD North Station

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

11.1 Project Components

11.1.1 Infrastructure

The proposed CBD North station is located directly beneath Swanston Street, from La Trobe Street to the north of Franklin Street.

Entrances are proposed to be located on the:

- East side of Franklin Street
- Corner of Swanston and La Trobe Streets
- Underground connection to Melbourne Central station.
- The plant room is proposed to be located under Franklin Street, between Swanston and Bowen Streets.

11.1.2 Construction

The station is proposed to be constructed under Swanston Street using the mined cavern construction method. Mined cavern stations are proposed at CBD North and CBD South. The public entrance structures at both stations would be used as an access shaft to enable construction of the station cavern from underground.

The caverns would be excavated using the heading and bench method. This is a sequential technique, whereby the upper section (heading) is excavated first, followed by the middle section (bench) and finally the lower section (invert). Roadheaders have a boom-mounted cutting head mounted on a crawler travelling track and are used as the primary excavation equipment

Construction of station entrances would be by cut-and-cover technique and a connection to Melbourne Central station would be provided from the northern entrance.

Several areas adjacent to the proposed station site are proposed for use as construction work sites for the station entry and ventilation footprints. Where these areas are not in existing road reserves, buildings would need to be demolished prior to construction commencing.

An estimated 438,000 m³ of spoil could be extracted from the CBD North station. Peak spoil handling and material deliveries are estimated to average up to 105 truck round trips per day.

During construction, there might be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks insofar as emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

11.1.3 Operation

Operational impacts would be the same as those described in Section 8.1.3 and are not repeated here.



11.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, wind patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}.

11.3 Key Issues

The proposed station would be located in close proximity to educational and residential properties on the east and west sides of Swanston Street, the State Library to the south-east, City Baths to the north and a variety of commercial properties including restaurants and bars.

There would be potential for nearby receptors to be impacted from dust emissions for all wind directions and atypical wind conditions due to the surrounding buildings being likely to affect the dispersion of dust and emissions. The potential impact on the activities to occur in this precinct are captured by **Risks #AQ001 - #AQ003 and #AQ005 - #AQ008**.

11.4 Benefits and Opportunities

There are no benefits or opportunities associated with the Concept Design in this precinct.

11.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 11-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to the recommended Environmental Performance Requirements and proposed mitigation measures.

During the proposed construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:

- < 50 m east and west to educational and residential properties
- < 50 m north to Melbourne City Baths and commercial properties



- 100 m south-east to the State Library.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for all wind directions. In any case, air quality impacts from any direction should be anticipated due to the complexity of buildings and infrastructure-modifying wind flows in the study area.

Mitigation measures at the site would be needed, including those listed for Fawkner Park in Section 7.5.2.

In addition to the mitigation measures listed, temporary ventilation facilities would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and location of such systems would be determined in the delivery phase, and are therefore not considered in this assessment.

The estimated frequency of truck movements at the CBD North station (105/day) are approximately 58–73 per cent of the frequency at the higher risk construction work sites of Arden station (182/day) and Domain station (144/day). In addition, the CBD North construction area is limited in size by the constrained nature of the CBD and lack of available land. The construction area surface footprint at CBD North is estimated to be less than one hectare, compared to Arden and Domain with 14 and five hectares respectively. This would necessitate that the handling of spoil and the movement of trucks is carefully managed since the possibility to stockpile materials would be restricted. Consequently, emissions due to wind erosion of exposed surfaces and by wheel-generated dust on unsealed surfaces would be significantly lower than for the larger Arden and Domain construction work sites.

Modelling of emission at the higher risk construction work sites has demonstrated that with appropriate mitigation, air quality can be maintained within SEPP criteria even for a conservative assessment scenario with unsealed haul roads and a majority of the site exposed to wind erosion. Given that the frequency of truck movements and the distance travelled on unsealed surfaces is shown to be the greatest contributor to dust emissions (refer to Section 4.2.4), the lower intensity of these activities at CBD North station would be expected to result in air quality being maintained within SEPP criteria. The sealing of haul roads, in line with best practice principles, would further reduce the likelihood of exceedances as would construction of acoustic sheds over the station box.

It is likely that contaminated soils or sediments might be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

Given the proximity of sensitive receptors to proposed earthworks and dust-generating activity at the site, dust monitoring at key sensitive receptors would be likely to be required to demonstrate compliance with SEPP air quality criteria and to provide an input for the reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions.

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (AQ009) or fire (AQ010) are unknown at this stage, however, air emissions from non-routine operations are expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

11.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels and shown in Table 7-3.



12 Precinct 6: CBD South Station

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

12.1 Project Components

12.1.1 Infrastructure

The proposed CBD South station is located at the southern edge of the CBD directly beneath Swanston Street running between, and partially under, Flinders and Collins Streets.

Entrances are located at

- Collins Street entrance at City Square
- Flinders Street entrance including Port Phillip Arcade with underground connection to Flinders Street Station
- Underground entrance connection to Federation Square.

12.1.2 Construction

It is proposed to construct the station under Swanston Street using the mined cavern construction method. Mined cavern stations are proposed at CBD South and CBD North. The public entrance structures at both stations would be used as an access shaft to enable construction of the station cavern from underground.

The caverns would be excavated using the heading and bench method. This is a sequential technique, whereby the upper section (heading) is excavated first, followed by the middle section (bench) and finally the invert. Roadheaders have a boom-mounted cutting head mounted on a crawler travelling track and are used as the primary excavation equipment

Construction of station entrances would be by cut and cover technique and underground connections to Flinders Street Station and Federation Square.

A construction work site is proposed to be located at City Square, currently occupied by a public plaza and a café and a car park in the basement below. Another site would be located along Swanston Street, currently occupied by retail outlets and commercial space. The existing buildings on both sites would be demolished prior to construction commencing.

An estimated 253,000 m³ of spoil could be extracted from the CBD South Station. Peak spoil handling and material deliveries are estimated to average up to 105 truck round trips per day.

During activities there might be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks insofar as emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

12.1.3 Operation

Operational impacts would be the same as those described in Section 8.1.3 and are not repeated here.



12.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, wind patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}.

12.3 Key Issues

The station is located in close proximity to The Westin Hotel, restaurants at City Square, Melbourne Town Hall and St Paul's Cathedral to the east. To the west are multi-use medium to high-rise retail and office properties.

There is potential for nearby receptors to be impacted from dust emissions for all wind directions and atypical wind conditions due to the surrounding buildings are likely to affect the dispersion of dust and emissions. The potential impact on the activities to occur in this precinct are captured by **Risks #AQ001 - #AQ004** and **#AQ006 - #AQ008**.

12.4 Benefits and Opportunities

There are no benefits or opportunities associated with the Concept Design in this precinct.

12.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 12-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.	Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases. Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.
	Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase Indicator – Changes in air quality aspects of amenity for: <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure. • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to the recommended Environmental Performance Requirements and proposed mitigation measures.

During construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:

- < 50 m west to multi-use medium to high-rise retail and office properties



- < 50 m east to The Westin Hotel, restaurants at City Square, the Melbourne Town Hall and St Paul's Cathedral.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for all wind directions. In any case air quality impacts from any direction should be anticipated due to the complexity of buildings and infrastructure-modifying wind flows in the study area.

Mitigation measures at the site would be needed, including those listed for Fawkner Park in Section 7.5.2.

In addition to the mitigation measures listed, temporary ventilation facilities would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and location of such systems would be determined in the delivery phase, and are therefore not considered in this assessment.

The estimated frequency of truck movements at the CBD South station (105/day) are approximately 57–73 per cent of the frequency at the higher risk construction work sites of Arden station (182/day) and Domain station (144/day). In addition, the CBD South construction area is limited in size by the constrained nature of the CBD and lack of available land. The construction area surface footprint at CBD South is estimated to be less than one hectare, compared to Arden and Domain with 14 and five hectares respectively. This would necessitate that the handling of spoil and the movement of trucks is carefully managed since the possibility to stockpile materials would be restricted. Consequently, emissions due to wind erosion of exposed surfaces and by wheel-generated dust on unsealed surfaces would be significantly lower than for the larger Arden and Domain construction work sites.

Modelling of emission at the higher risk construction work sites has demonstrated that with appropriate mitigation, air quality could be maintained within SEPP criteria even for a conservative assessment scenario with unsealed haul roads and a majority of the site exposed to wind erosion. Given that the frequency of truck movements and the distance travelled on unsealed surfaces is shown to be the greatest contributor to dust emissions (refer to Section 4.2.4), the lower intensity of these activities at CBD South station would be expected to result in air quality being maintained within SEPP criteria. The sealing of haul roads, in line with best practice principles, would further reduce the likelihood of exceedances as would construction of acoustic sheds over the station box.

It is likely that contaminated soils or sediments might be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

Given the proximity of sensitive receptors to proposed earthworks and dust-generating activity at the site, dust monitoring at key sensitive receptors is likely to be required to demonstrate compliance with SEPP air quality criteria and to provide an input for the reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions.

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (AQ009) or fire (AQ010) are unknown at this stage, however, air emissions from non-routine operations would be expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with draft EES evaluation objectives amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

12.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels and shown in Table 7-3.



13 Precinct 7: Domain Station

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

13.1 Project Components

13.1.1 Infrastructure

Domain station is proposed to be located under St Kilda Road, adjacent to Albert and Domain Roads. There would be three station entrances – one to the east into the Shrine Parklands, one to the west in the South African Soldiers War Memorial, and one entrance to the Domain tram interchange in the centre of St Kilda Road.

The TBM launch site for the southern section of tunnels would be either at Domain only or at Domain and Fawkner Park. The tunnels would be excavated from Domain towards CBD South, and from Domain to the eastern portal (or from Fawkner Park to the eastern portal and Fawkner Park to Domain). Spoil from tunnelling would be extracted and handled at the Domain construction work site (or at both the Domain and Fawkner Park construction work sites).

13.1.2 Construction

The station is proposed to be constructed using the cut-and-cover construction method and would include an excavation area of approximately 19,400 m². The TBM would be launched from Domain for excavation of the Domain to CBD South and Domain to eastern portal tunnels.

Two construction work sites would be required, one on each side of St Kilda Road, for site offices, amenities, equipment storage and materials laydown. The parklands immediately adjacent to the station entrances are the most suitable locations for these sites specifically, the Shrine Parklands adjacent to the proposed eastern station entrance and South African Soldiers Memorial Reserve adjacent to the western entrance. Using these sites would require the temporary relocation or protection of memorials and trees, and the reinstatement of these areas at the end of construction. The project is proposing the use of Edmund Herring Oval, further east along Domain Road, for spoil management to minimise the footprint into the Shrine grounds.

An estimated 460,000 m³ of spoil could be extracted from the Domain precinct works. Peak spoil handling and material deliveries are estimated to average up to 144 truck round trips per day.

During construction, there might be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks insofar as emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

13.1.2.1 Alternative TBM launch arrangement

The Fawkner Park TBM launch site working in tandem with Domain would reduce the volume of spoil handled at the Domain construction work site, albeit that the total spoil from the Southern TBM launch facility would remain unchanged. Peak spoil handling and material deliveries from the respective locations are



predicted to be 102 round truck trips from the Domain construction work site, and 42 truck round trips from the Fawkner Park construction work site.

The duration of spoil handling operations at Domain would be reduced; however other aspects of the Concept Design would remain unchanged.

13.1.3 Operation

Operational impacts would be the same as those described in Section 8.1.3 and are not repeated here.

13.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, wind patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM_{10} and $PM_{2.5}$.

13.3 Key Issues

The station would be located in close proximity to residential and commercial properties to the south and west, the Melbourne Grammar School, Wadhurst Campus to the south-east and public parks to the east, including the Shrine of Remembrance Reserve.

There is potential for nearby receptors to be impacted from dust emissions for all wind directions. The potential impact on the activities to occur in this precinct are captured by **Risks # AQ001 - #AQ004** and **#AQ006 - #AQ008**.

The key issues associated with the alternative design option would be the same as those identified for the Concept Design.

13.4 Benefits and Opportunities

The alternative design option would reduce the duration of spoil-handling works and reduce the total volume of spoil extracted at Domain. An additional major construction work site and spoil-handling facility would be required at Fawkner Park, potentially offsetting any benefit gained at Domain.

13.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.



Table 13-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to the recommended Environmental Performance Requirements and proposed mitigation measures.

13.5.1 Results of Modelling Assessment – Concept Design

The Domain construction work site would be the major construction work site in the southern section and the extraction point for removal of spoil from TBM tunnelling works in the southern section of the project. There is a high intensity of dust-generating activities and truck movements at this location and a quantitative dispersion modelling assessment was conducted to assess the impacts of dust emissions from this site.

Modelling was performed for the Concept Design and assumes that truck movements occur on unsealed haul roads and a majority of the site is exposed to wind erosion. Mitigation measures for dust emissions were incorporated in the modelling and include the application of water to stockpiles, unsealed roads and exposed surfaces subject to wind erosion, and the use of windbreaks for stockpiles and exposed surfaces. The methodology for this assessment is described in more detail in Section 4.2.

Results of the dispersion modelling study are summarised in the following sections.

13.5.1.1 Dispersion Model Results for Domain PM10

The AERMOD results for maximum 24-hour average PM₁₀ GLCs, including the background concentration of 20.9 µg/m³, are provided in Figure 13-5. There were no predicted exceedances of the corresponding Melbourne Metro criterion of 50 µg/m³. It can therefore be concluded that the proposed construction activities at Domain station would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of maximum 24-hour PM₁₀ concentrations.



Figure 13-1 AERMOD results for maximum 24-hour average PM₁₀ GLC

13.5.1.2 Dispersion Model Results for Domain PM_{2.5}

The AERMOD results for maximum 24-hour average PM_{2.5} GLCs, including the background concentration of 7.9 µg/m³, are provided in Figure 13-6. There were no predicted exceedances of the corresponding Melbourne Metro criterion of 25 µg/m³. It can therefore be concluded that the proposed construction activities at Domain station would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of maximum 24-hour PM_{2.5} concentrations.



Figure 13-2 AERMOD results for maximum 24-hour average PM_{2.5} GLC

The AERMOD results for maximum annual average PM_{2.5} GLCs, including the background concentration of 5.9 µg/m³, are provided in Figure 13-7. There were no predicted exceedances of the corresponding Melbourne Metro criterion of 8 µg/m³. It can therefore be concluded that the proposed construction activities at Domain station and Fawkner Park would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of annual PM_{2.5} concentrations.



Figure 13-3 AERMOD results for annual PM_{2.5} GLC

13.5.1.3 Dispersion Model Results for Domain Dust Deposition

The AERMOD results for maximum monthly dust deposition, including the background concentration of 2 g/m²/month, are provided in Figure 13-8. There were no predicted exceedances of the corresponding Melbourne Metro criterion of 4 g/m²/month. It can therefore be concluded that the proposed construction activities at Domain station would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of dust deposition.



Figure 13-4 AERMOD results for monthly average dust deposition.

13.5.2 Results of Modelling Assessment – Alternative Design Option

The alternative design option would require the Domain construction work site and Fawkner Park operating concurrently and would be the major construction work sites and the extraction points for removal of spoil from TBM tunnelling works in the southern section of the project. The two sites are less than 500 m apart and were therefore assessed concurrently. However, the impact assessment for Fawkner Park is also discussed separately in Section 7.5. There is a high intensity of dust-generating activities and truck movements at these locations and a quantitative dispersion modelling assessment was conducted to assess the impacts of dust emissions from these sites.



Modelling was performed for the alternative design option and assumes that truck movements occur on unsealed haul roads and a majority of the site is exposed to wind erosion. Mitigation measures for dust emissions were incorporated in the modelling and include the application of water to stockpiles, unsealed roads and exposed surfaces subject to wind erosion, and the use of windbreaks for stockpiles and exposed surfaces. The methodology for this assessment is described in more detail in Section 4.2.

Results of the dispersion modelling study are summarised in the following sections.

13.5.2.1 Dispersion Model Results for Domain and Fawkner Park PM10

The AERMOD results for maximum 24-hour average PM10 GLCs, including the background concentration of $20.9 \mu\text{g}/\text{m}^3$, are provided in Figure 13-5. There were no predicted exceedances of the corresponding Melbourne Metro criterion of $50 \mu\text{g}/\text{m}^3$. It can therefore be concluded that the proposed construction activities at Domain and Fawkner Park would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of maximum 24-hour PM₁₀ concentrations.

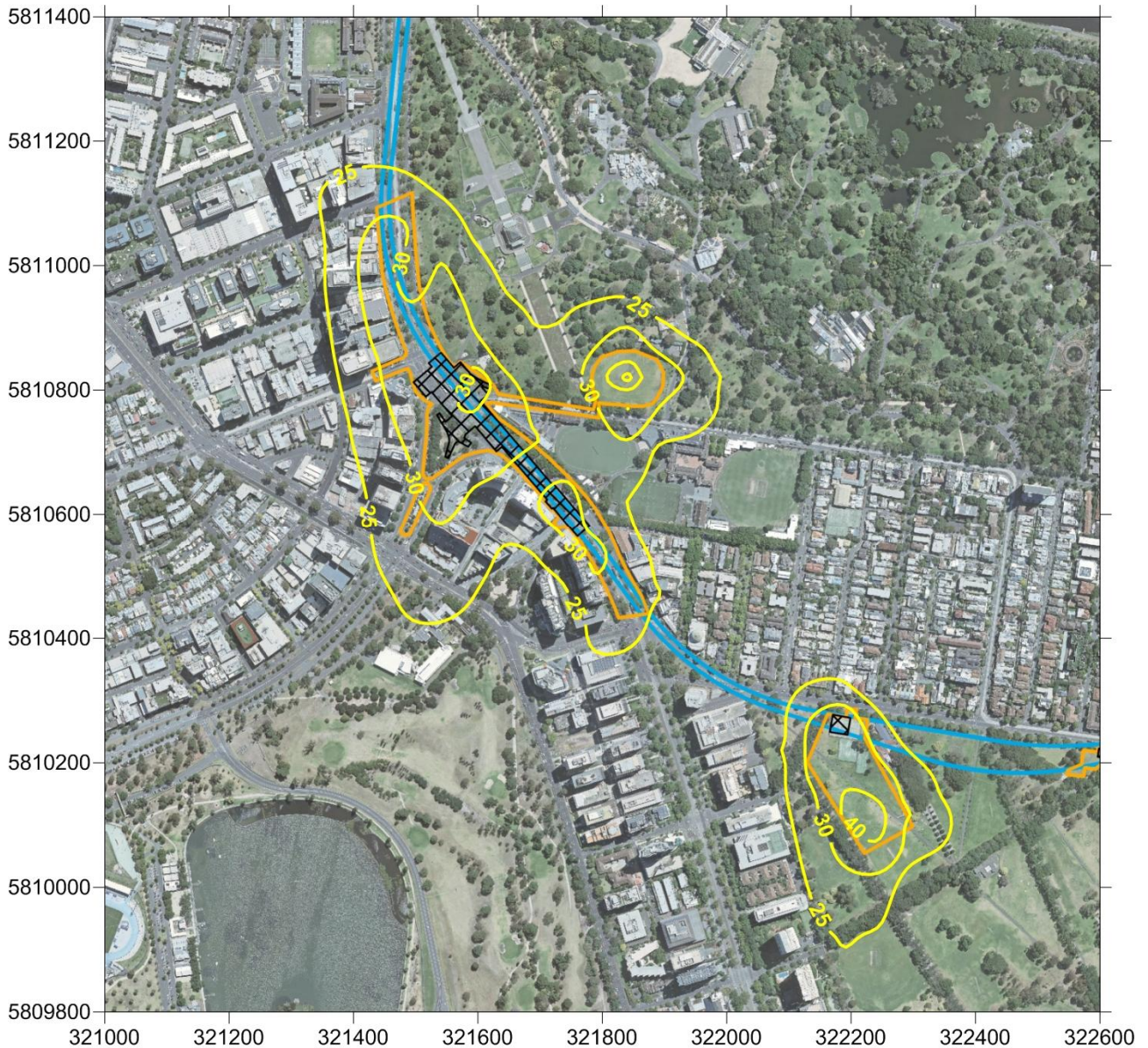


Figure 13-5 AERMOD results for maximum 24-hour average PM₁₀ GLC



13.5.2.2 Dispersion Model Results for Domain and Fawkner Park PM_{2.5}

The AERMOD results for maximum 24 hour average PM_{2.5} GLCs, including the background concentration of 7.9 µg/m³, are provided in Figure 13-6. There were no predicted exceedances of the corresponding Melbourne Metro criterion of 25 µg/m³. It can therefore be concluded that the proposed construction activities at Domain station and Fawkner Park would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of maximum 24-hour PM_{2.5} concentrations.

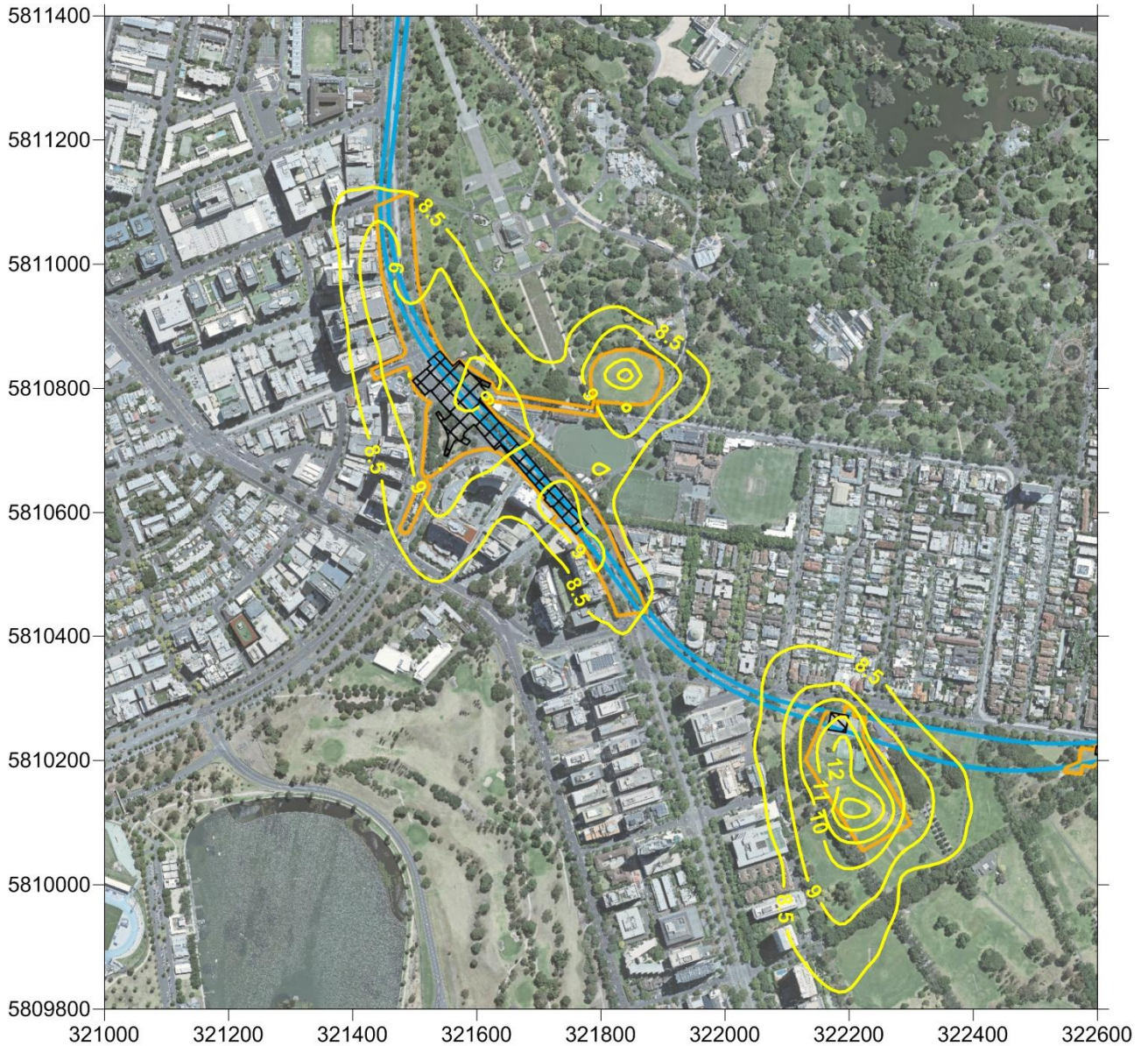


Figure 13-6 AERMOD results for maximum 24 hour average PM_{2.5} GLC



The AERMOD results for maximum annual average $PM_{2.5}$ GLCs, including the background concentration of $5.9 \mu\text{g}/\text{m}^3$, are provided in Figure 13-7. There were no predicted exceedances of the corresponding Melbourne Metro criterion of $8 \mu\text{g}/\text{m}^3$. It can therefore be concluded that the proposed construction activities at Domain station and Fawkner Park would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of annual $PM_{2.5}$ concentrations.



Figure 13-7 AERMOD results for annual $PM_{2.5}$ GLC



13.5.2.3 Dispersion Model Results for Domain and Fawkner Park Dust Deposition

The AERMOD results for maximum monthly dust deposition, including the background concentration of 2 g/m²/month, are provided in Figure 13-8. There were no predicted exceedances of the corresponding Melbourne Metro criterion of 4 g/m²/month. It can therefore be concluded that the proposed construction activities at Domain station and Fawkner Park would be unlikely to result in any adverse air quality impacts at sensitive receptor locations, in terms of dust deposition.



Figure 13-8 AERMOD results for monthly average dust deposition.



13.5.3 Impact Assessment

During proposed construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:

- < 50 m south and west to medium to high rise residential, commercial properties and restaurants
- < 50 m south-east to Melbourne Grammar School, Wadhurst Campus
- < 50 m east to public parks including the Shrine of Remembrance Reserve.

Using the wind speed and direction analysis defined in Section 5.4, there is potential for nearby receptors to be impacted from dust emissions for all wind directions. In any case, air quality impacts from any direction should be anticipated due to the complexity of buildings and infrastructure-modifying wind flows in the study area.

Dispersion modelling results for construction dust indicates dust mitigation measures at the site would be needed, including those listed for Fawkner Park in Section 7.5.1.

In addition to the mitigation measures listed, temporary ventilation facilities would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and location of such systems would be determined in the delivery phase, and are therefore not considered in this assessment.

Dispersion modelling has shown that with management, construction activities would be unlikely to result in air quality impacts at sensitive receptor locations and consequently, air quality would be maintained within SEPP criteria. The modelling has assessed a conservative scenario with unsealed haul roads and a majority of the site exposed to wind erosion. The sealing of haul roads in line with best practice principles, would further reduce the likelihood of exceedances as would construction of acoustic sheds over the station box.

It is likely that contaminated soils or sediments would be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

Given the proximity of sensitive receptors to proposed earthworks and dust-generating activity at the site, dust monitoring at key sensitive receptors is likely to be required to demonstrate compliance with SEPP air quality criteria and to provide an input for the reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions.

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (AQ009) or fire (AQ010) are unknown at this stage, however, air emissions from non-routine operations would be expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

13.5.3.1 Alternative Design Option

The impact assessment for the Domain precinct component of the alternative design option would be the same as for the Concept Design. The impact assessment for the Fawkner Park (Precinct 1 - Tunnels) component of the alternative design option is discussed in Section 7.5.2.

13.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels and shown in Table 7-3.



14 Precinct 8: Eastern Portal (South Yarra)

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

14.1 Project Components

14.1.1 Infrastructure

The eastern portal precinct is proposed to connect the two tunnels to the existing Dandenong rail corridor just west of Chapel Street. The proposed portal includes the approach to the tunnel and the tunnel works that connect to the tunnel precinct.

14.1.2 Construction

The proposed construction would include a cut-and-cover structure under the Sandringham line, Frankston line and freight and regional lines, and a decline structure (open to air), which would bring Melbourne Metro tracks to the same vertical level as the existing rail corridor.

The South Yarra Siding Reserve and Osborne Street Reserve, generally bordered by William Street to the east and Osborne Street to the west, would be occupied as major construction work sites for the eastern portal construction. This area would house site offices, amenities, and materials laydown and equipment storage. An area in Osborne Street to the south of the portal site would also be required for materials laydown and manoeuvring of equipment. A TBM retrieval box would be located in the rail reserve adjacent to Osborne Street.

An estimated 47,000 m³ of spoil could be extracted from the eastern portal precinct works. Peak spoil handling and material deliveries are estimated to average up to 31 truck round trips per day.

During construction, there may be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks arising from emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

14.1.3 Operation

Operational impacts would be the same as those described in Section 8.1.3 and are not repeated here.

14.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, wind patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}.



14.3 Key Issues

The proposed eastern portal is located in a highly urbanised area and is in close proximity to residential properties to the west on Osborne Street, to the south on Arthur Street and west on William Street.

There would be potential for nearby receptors to be impacted from dust emissions for all wind directions.

The key issue associated with the Concept Design is the potential for receptors to be impacted from dust emissions, particularly for residences immediately adjacent to the construction work site on Osborne, Arthur and William Streets. The potential impact on the activities to occur in this precinct are captured by **Risks #AQ001 - #AQ003** and **#AQ005 - #AQ008**.

14.4 Benefits and Opportunities

There are no benefits or opportunities associated with the Concept Design in this precinct.

14.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 14-1 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to the recommended Environmental Performance Requirements and proposed mitigation measures.

During proposed construction, there would be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:

- < 50 m west to residential properties on Osborne Street
- < 50 m east to residential properties on William Street
- < 50 m south to residential properties on Arthur Street.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for all wind directions.

Mitigation measures at the site would be needed including those listed for Fawkner Park in Section 7.5.2.

In addition to the mitigation measures listed, temporary ventilation facilities (if installed) would require suitable dust extraction and filtration systems where dust is being extracted to the surface. The design and



location of such systems would be determined in the delivery phase, and are therefore not considered in this assessment.

The estimated frequency of truck movements at the eastern portal (31/day) are approximately 17–22 per cent of the frequency at the higher risk construction work sites of Arden station (182/day) and Domain station (144/day). In addition, the construction area footprint would be smaller at the eastern portal reducing the potential distance travelled on unsealed surfaces when compared to the higher risk sites.

Modelling of emission at the higher risk construction work sites has demonstrated that with appropriate mitigation, air quality could be maintained within SEPP criteria even for a conservative assessment scenario with unsealed haul roads and a majority of the site exposed to wind erosion. Given that the frequency of truck movements and the distance travelled on unsealed surfaces is shown to be the greatest contributor to dust emissions (refer to Section 4.2.4), the lower intensity of these activities at the eastern portal is expected to result in air quality being maintained within SEPP criteria. The sealing of haul roads, in line with best practice principles, would further reduce the likelihood of exceedances.

It is likely that contaminated soils or sediments may be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

During routine operations, there are few sources of emissions and the potential for air quality impacts is low. The potential for impacts due to non-routine and emergency events such as tunnel wall cleaning (AQ009) or fire (AQ010) are unknown at this stage, however, air emissions from non-routine operations are expected to be much less significant than particulate emissions during construction.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

14.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels as shown in Table 7-3.



15 Precinct 9: Western Turnback

This section describes the project components, existing conditions, the key issues, benefits and opportunities, findings of the impact assessment for the Concept Design and alternative design options (if present).

15.1 Project Components

15.1.1 Infrastructure

The Concept Design includes a western turnback to be located in West Footscray, with a third platform and track at West Footscray station, and modifications to the existing concourse.

15.1.2 Construction

The proposed works would have a site area of approximately 15,000 m² within the publicly owned (VicTrack) land. The works location is proposed to be adjacent to a commercial and industrial area to the south and residential areas and recreation facilities (including the Whitten Oval) to the north.

A small (but as yet unknown) volume of material potentially containing contamination would be excavated.

During construction, there may be short-term increases in local dust (particulate matter) and other emissions such as exhaust fumes generated by the operation of construction equipment. The following activities present the greatest risks arising from emissions of odours and dust:

- Handling, stockpiling and transport of excavated materials (dust, and potential for odour)
- Wheel-generated dust from daily truck movements, both on unsealed site roads and local sealed roads
- Windborne erosion arising from exposed surfaces.

15.1.3 Operation

Trains using the proposed western turnback would be electric and emit few pollutants resulting in low probability of air quality impacts under normal operating conditions.

15.2 Existing Conditions

Due to the regional nature of air quality and the absence of significant point sources of air pollutants in the study area, the existing air quality and meteorological conditions are characterised by the regional summaries in Section 5.3 (existing air quality) and Section 5.4 (meteorology).

In summary, wind patterns are dominated by moderate westerly and northerly winds in the mornings, with increasing average wind speeds in the afternoons, predominantly from the south. Existing air quality is good to fair with possibility of occasional exceedance of PM₁₀ and PM_{2.5}.

15.3 Key Issues

The West Footscray turnback is located in proximity to commercial and industrial areas to the south and residential areas and recreation facilities (including the Whitten Oval) to the north.

Given the lower intensity of works proposed at this site and greater separation distances, the risk of air quality impacts is reduced.

The key issue associated with the Concept Design is identified in Table 15-1.



Table 15-1 Key issue associated with the Concept Design

Concept Design	Issue
West Footscray – a third platform and track at Footscray station, with modifications to existing concourse	Potential for receptors to be impacted from dust emissions.

15.4 Benefits and Opportunities

There are no benefits or opportunities associated with the Concept Design.

15.5 Impact Assessment

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Table 15-2 Draft EES evaluation objectives and assessment criteria

Draft EES evaluation objectives	Assessment criteria
Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.	Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases. Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.
	Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase. Indicator – Changes in air quality aspects of amenity for: <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to the recommended Environmental Performance Requirements and proposed mitigation measures.

During construction, there may be short-term, localised impacts on air quality. Key sensitive receptor locations for this site include:

- < 50 m north to residential properties on Cross Street
- < 50 m south to commercial and industrial properties.

Using the wind speed and direction analysis defined in Section 5.4, there would be potential for nearby receptors to be impacted from dust emissions for northerly or southerly wind directions.

Mitigation measures at the site would be needed including those listed for Fawkner Park in Section 7.5.2.

It is likely that contaminated soils or sediments may be encountered during construction. Potential impacts and likely mitigation methods from contaminated dust and odour are the same as discussed for Fawkner Park in Section 7.5.2.

Modelling of emission at the higher risk construction work sites has demonstrated that with appropriate mitigation, air quality could be maintained within SEPP criteria even for a conservative assessment scenario with unsealed haul roads and a majority of the site exposed to wind erosion. Given that no significant excavation works are required for the western turnback, and that construction activities would be



considerably lower in intensity than at the major construction work-sites of Arden station, Domain station and the other stations, air quality is expected to be maintained within SEPP air quality criteria.

The Concept Design is consistent with the draft EES evaluation objectives for amenity, as:

- The Concept Design would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

15.6 Environmental Performance Requirements

The recommended Environmental Performance Requirements and proposed mitigation measures for this precinct are the same as for Precinct 1 - Tunnels, and as shown in Table 7-3.



16 Environmental Performance Requirements

This section provides a comprehensive list of the recommended Environmental Performance Requirements and proposed mitigation measures identified as a result of this impact assessment. Table 16-1 below provides the recommended Environmental Performance Requirements which apply across the project and on a precinct basis, linked to the draft EES evaluation objective.

Table 16-1 Environmental Performance Requirements

Draft EES evaluation objective	Impact	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk #
Amenity: - To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.	Exceedance of air quality criteria. Deterioration of perceived amenity.	Develop and implement plan(s) for dust management and monitoring, in consultation with EPA, to minimise and monitor the impact of construction dust. The plan must address monitoring requirements for key sensitive receptors including, but not limited to: <ul style="list-style-type: none"> Residential and commercial properties Hospitals and research facilities within the Parkville precinct Universities, including The University of Melbourne and RMIT Schools, including Melbourne Grammar School (Wadhurst Campus) and Christ Church Grammar School Public parks including the Shrine of Remembrance Reserve and JJ Holland Reserve. Undertake air modelling for construction to inform the dust management plan.		All	Construction	AQ001 AQ002 AQ003 AQ004 AQ005 AQ006 AQ007 AQ008
		Manage construction activities to minimise dust and other emissions in accordance with	Minimise the distance travelled on unsealed surfaces by planning haul road routing to		Construction	



Draft EES evaluation objective	Impact	Environmental Performance Requirements	Proposed mitigation measures	Precinct	Timing	Risk #
		<p>EPA Publication 480, Environmental Guidelines for Major Construction Sites (EPA 1996).</p>	<p>minimise the travel distance and by sealing haul roads where possible.</p> <p>Manage the size and siting of stockpiles to minimise risk to sensitive receivers and the local environment.</p> <p>Manage unstable stockpiles with appropriate cover and/or fencing.</p> <p>Cover material that may create hazard or nuisance dust during transport.</p> <p>Use water trucks for the watering of unsealed and soiled roads.</p> <p>Use water sprays to protect stockpiles and unsealed surfaces from wind erosion.</p> <p>Use windbreaks to protect stockpiles and unsealed surfaces from wind erosion.</p> <p>Implement a high standard of engine maintenance to minimise vehicle emissions.</p> <p>Progressive re-vegetation of disturbed areas.</p>			
		<p>Control the emission of smoke, dust, fumes and other pollution into the atmosphere during construction and operation in accordance with the SEPPs for Air Quality Management and Ambient Air Quality.</p>	<p>Minimise the distance travelled on unsealed surfaces by planning haul road routing to minimise the travel distance and by sealing haul roads where possible.</p> <p>Implement a high standard of engine maintenance to minimise vehicle emissions.</p>	All	Construction / Operation	



17 Conclusion

This report documents the outcomes of an assessment of the risks to air quality from activities associated with construction and operation of the proposed Melbourne Metro.

The focus for the assessment is health and amenity issues associated with construction dust.

17.1 Relevant EES objectives

The following draft EES evaluation objectives and assessment criteria (and indicators where relevant) are relevant to this assessment.

Draft EES evaluation objectives	Assessment criteria
<p>Amenity: To minimise adverse air quality effects on the amenity of nearby residents and local communities, as far as practicable, especially during the construction phase.</p>	<p>Criterion – Meet Melbourne Metro air quality criteria during construction and operation phases.</p> <p>Indicator – Air quality management using reactive air quality management systems and air quality monitoring during construction and operations such that Melbourne Metro air quality indicators are met as determined by the monitoring program.</p> <hr/> <p>Criterion – Minimise impacts on amenity for residents and places of employment and maintain community amenity and safety during the construction phase.</p> <p>Indicator – Changes in air quality aspects of amenity for:</p> <ul style="list-style-type: none"> • Residences • Places of employment • Social infrastructure • Valued spaces.

The two assessment criteria are strongly interrelated and are therefore addressed jointly in respect to the recommended Environmental Performance Requirements and proposed mitigation measures.

The project is consistent with the draft EES evaluation objectives for amenity, as:

- The project would be expected to meet air quality criteria
- Air quality impacts would be minimised with mitigation measures to reduce dust and plant emissions.

17.2 Impact Assessment Summary

The assessment addresses the specified EES scoping requirements and specifically evaluates potential impacts to air quality based on the assessment criteria.

A risk assessment process was adopted that identified potential construction and operational hazards, impact pathways, consequences to values, air quality and likelihood of impacts. Risk to values was determined as the combination of consequence and likelihood. Where possible, mitigation measures were identified to reduce risks.

To inform the risk assessment, air quality, a quantitative assessment of selected construction activities and a qualitative assessment of operational activities were completed.

Dust emissions from construction activities were identified as the main risk to air quality.

An impact assessment was conducted based on the Concept Design and operational scope and consisted of:



- (1) A quantitative air quality impact assessment was undertaken for air emissions from construction, focussing on dust emissions
- (2) A qualitative air quality impact assessment was undertaken for air emissions associated with the operational phase.

The risk assessment identified three sites with a high risk rating and these sites were selected for detailed dust dispersion modelling using EPA Victoria's regulatory model, AERMOD.

The Concept Design would involve excavation and handling of large volumes of spoil and the two high risk sites are the locations with the highest spoil volume and haulage rates and correspond with the location where extraction and handling of TBM tunnelling spoil occurs. They are: Arden station precinct in the northern section and Domain station precinct in the southern section. An alternative design option of the Concept Design utilises both Domain and Fawkner Park as TBM launch and spoil-handling sites, working concurrently.

Modelling was conducted assuming truck movements were on unsealed surfaces and that the majority of the construction site was exposed to wind erosion. Mitigation methods were applied in the emissions inventory to reduce, but not remove, emissions from these sources.

Modelling results showed that exceedance of the SEPP criteria is unlikely at sensitive receptor locations. There was one small area of predicted exceedance for 24-hour average PM_{10} at Arden, located within the construction work site and extending a short distance into the adjoining rail corridor. There were no predicted exceedances of 24-hour $PM_{2.5}$, annual $PM_{2.5}$ or dust deposition.

The modelling has demonstrated that with appropriate mitigation, activities at the Arden, Domain and Fawkner Park construction work sites can be managed within SEPP criteria for sensitive receptor locations, however, on days when background particulate concentrations are high there would still be the potential for exceedances of air quality criteria.

Historical air quality statistics show that there are occasional exceedances of air quality criteria within metropolitan Melbourne. To minimise the contribution by construction activities on days with high background concentrations, which could potentially lead to an exceedance of air quality criteria, the adoption of best practice mitigation measures is necessary.

The major contributors to dust emissions are truck movements on unsealed surfaces and wind erosion of open areas. Best practice would be to minimise the potential for dust generation from these processes by reducing and minimising the sources of the emissions. This would be achieved by reducing the distance travelled by trucks on unsealed surfaces by planning stockpile locations and haul road routing to minimise the distance travelled, and by sealing haul roads where possible. Wind erosion from exposed areas would be minimised through sealing or establishing vegetation on exposed surfaces or by enclosure with sheds if practicable.

Maintenance of sealed haul roads and open areas may require the use of rumble grids or wheel washing for haul trucks and regular street sweeping or road washing. Where it is not possible to remove the source of the emissions, mitigation measures would be required including the use of windbreaks and water sprays on stockpiles and exposed surfaces, and dust suppression on unsealed roads by water trucks.

Dust monitoring at key sensitive receptors sites would be required to demonstrate compliance with SEPP air quality criteria. In addition to providing a record of compliance, the monitoring program would provide the basis of a reactive air quality management system allowing site activities to be modified in response to adverse meteorological and environmental conditions.

Performance measures were identified that in all instances minimise impacts to air quality and on this basis all project risks to air quality are considered medium.



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Appendices



Appendix A

Relevant Legislation



Commonwealth

The *National Environment Protection Council Act 1994* (Cwlth), and complementary State and Territory legislation allow the National Environment Protection Council (NEPC) to make National Environment Protection Measures (NEPMs).

NEPMs are a special set of national objectives designed to assist in protecting or managing particular aspects of the environment.¹ The NEPMs relevant to air quality are the National Environment Protection (Ambient Air Quality) Measure (NEPC, 2003); and the National Environment Protection (Air Toxics) Measure (NEPC, 2011).

National standards for ambient air quality were set in 1998 for six primary air pollutants: carbon monoxide, nitrogen dioxide, ozone, sulphur dioxide, lead and particles less than 10 microns in diameter (PM₁₀). The ambient air quality NEPM was varied in March 2003 to add an advisory reporting standard for particles less than 2.5 microns in diameter (PM_{2.5}).

In December 2015 the Australian Government announced a National Clean Air Agreement (Agreement) (CoA, 2015). This Agreement aims to reduce air pollution and improve air quality via the following main actions:

- The introduction of emission standards for new non-road spark ignition engines and equipment.
- Measures to reduce air pollution from wood heaters.
- Strengthened ambient air quality reporting standards for particle pollution.

Only the strengthening ambient air quality reporting standards for particle pollution is relevant to the Concept Design and the Agreement confirms the following:

'Taking into account the latest scientific evidence of health impacts, Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles. Ministers agreed to adopt reporting standards for annual average and 24-hour PM_{2.5} particles of 8 µg/m³ and 25 µg/m³ respectively, aiming to move to 7 µg/m³ and 20 µg/m³ respectively by 2025. Ministers also agreed to establish an annual average standard for PM₁₀ particles of 25 µg/m³. Victoria and the Australian Capital Territory will set, and South Australia will consider setting, a more stringent annual average PM₁₀ standard of 20 µg/m³ in the state, while ensuring nationally consistent monitoring and reporting against the agreed National Environment Protection Measure standards. The decision was also taken to review PM₁₀ standards in 2018. The review will be co- led by the NSW and Victorian governments, in discussion with other jurisdictions.'

On the 25th February 2016, the proposed amendments announced in the National Clean Air Agreement came into force as an amendment to the NEPM(AAQ) (NEPC, 2016)

While all jurisdictions have agreed to this action, no States (including the EPA Vic) have prescribed a change to their air quality objectives to be used for the assessment of specific projects. As such, the criteria contained in the SEPP AAQ and discussed in Section 3.2 remain current for the assessment of potential impacts. However, EPA Victoria have signalled their intentions and stated that 'the Environment Protection Authority Victoria and Victoria's Department of Environment, Land, Water and Planning (DELWP) will vary the State Environment Protection (Ambient Air Quality) Policy within six months of the NEPM variation date, to give the new AAQ NEPM standards statutory effect in Victoria.'²

The Air Toxics NEPM was established to facilitate a consistent approach to monitoring and reporting of five key hydrocarbons that impact on human health: i.e. benzene, toluene, formaldehyde, xylenes and poly aromatic hydrocarbons (PAHs). The concentration of these hydrocarbons within urban areas are relatively low and elevated levels are only expected in proximity to significant sources such as major industrial sites,

¹ <http://www.scew.gov.au/nepms>

² Source: <http://www.epa.vic.gov.au/your-environment/air/review-of-national-ambient-air-quality-standards> accessed 12/4/2016



heavily used roads and areas affected by wood smoke. No significant sources of air toxics have been identified in close proximity to the proposed project boundary and there are no significant emitters of air toxics associated with Melbourne Metro. As such, air toxics are not discussed further in this report.

State

Air quality in Victoria is managed primarily through the *Environment Protection Act 1970* and associated regulations. Pursuant to the *Environment Protection Act 1970*, a works approval is required for works at scheduled premises that will or are likely to alter or increase the discharge of air emissions to the environment.

Approvals and licence requirements are prescribed in the *Environment Protection (Scheduled Premises and Exemptions) Regulations 2007*. Provided emissions remain below the thresholds listed in Provision L01 of the Regulations (General emissions to air), construction phase air emissions associated with Melbourne Metro would not trigger the requirement to prepare a works approval. Further investigation would be required during the impact assessment to confirm that a works approval would not be required for operational air emissions (e.g. from tunnel ventilation; refer to Section 5.2.2).

The key documents used for assessment are the:

- State Environmental Protection Policy (Ambient Air Quality) (SEPP (AAQ)) (VG, 1999), and
- State Environmental Protection Policy (Air Quality Management) (SEPP (AQM)) (VG, 2003).

A purpose of SEPP (AAQ) is to adopt the objectives and goals set out in the original version of the Ambient Air Quality NEPM, which commenced in July 1998. SEPP (AAQ) also includes a separate objective for visibility reducing particles not included in the Ambient Air Quality NEPM.

In order to meet the SEPP (AAQ) air quality objectives, SEPP (AQM) establishes a framework for managing emissions into the air environment from all sources of air pollutants. The management framework and attainment program for protection of the air environment contained in SEPP (AQM), addresses ambient (or regional) air quality as well as the management of particular sources, e.g. industry, motor vehicles and open burning, and local air quality impacts including air toxics, odorous pollutants, greenhouse gases and ozone depleting substances. For the construction and operation of Melbourne Metro, criteria air pollutants including particulate matter are likely to be the key focus of the air emissions and impact assessment. Greenhouse gases and ozone depleting substances would be assessed as part of the Greenhouse Gas Impact Assessment.

SEPP (AQM) includes appropriate clauses to vary environmental quality objectives in SEPP (AAQ), such that they are consistent with national air quality measures, policies or strategies at that time, i.e. the Ambient Air Quality NEPM prior to the February 2016 amendments.

In Schedule A of the SEPP (AQM), the policy prescribes design criteria for new or expanded sources of emissions such as industrial premises. However, for PM₁₀, PM_{2.5} and nuisance dust, the design criteria 'applies to point sources only. For area-based sources and roads, applicable criteria are specified in the relevant industry PEM'.

A PEM for construction or road projects has not been issued, however a PEM for mining and extractive industries has been finalised and includes detailed assessment criteria for particulates including nuisance dust. The EPA Protocol for Environmental Management (PEM), Mining and Extractive Industries (EPA Vic, 2007) supports the interpretation of SEPP (AQM) and sets out the statutory requirements for the management of emissions to the air environment arising from activities undertaken in the operation of mining and extractives sites. Although Melbourne Metro is not directly addressed under the mining and extractive industries PEM, the main activities resulting in emissions to air are primarily the result of the extraction and handling of spoil, and are therefore closely related to those of the mining and extractive industries.



The PEM also confirm that 'The SEPP AAQ incorporates the Ambient Air Quality National Environment Protection Measure (NEPM) standards and the associated goals and monitoring and reporting protocols. In addition the requirements of the Ambient Air Quality NEPM varied in 2003 to include advisory reporting standards for PM_{2.5} also apply in Victoria under the provisions of the NEPC Act 1994.'

The PEM emphasises that emissions should not contribute to a deterioration of air quality in urban centres, and in occasions where impacts from an operation extends into urban areas, the assessment should apply the 'air quality standards contained in the Ambient Air Quality NEPM. For particles these standards are:

- PM₁₀ 50 µg/m³ 24-hour average
- PM_{2.5} 25 µg/m³ 24-hour average; 8 µg/m³ annual average'

As the SEPP (AAQ) adopts the objectives and goals of the NEPM (prior to the February 2016 NEPM amendment), and is the key policy enforced in Victoria under the Environment Protection Act 1970, Melbourne Metro air quality assessment has adopted the SEPP (AAQ) for the assessment criteria.

The impact of nuisance dust as a result of dust deposition is not addressed in SEPP (AAQ), SEPP (AQM) and the Ambient Air Quality NEPM. However, the potential for nuisance dust impacts can be significant for construction projects in residential areas. To assist with the management of nuisance dust, the PEM provides standards for annual dust deposition, which have been adopted for this project.

Schedule A of the SEPP (AQM) prescribes design criteria for individual odorous compounds. For Melbourne Metro, potential odour impacts are likely to be short-term and due to a complex mixture of odorous compounds. The SEPP (AQM) odour criterion is applied to normal operations by a facility; e.g. typically a wastewater (sewerage) plant. The odour impacts that may be experienced during Melbourne Metro construction activities are considered to be an abnormal emission from construction activities and would be managed by on-site environmental management procedures.

Best practice is the main guiding principle in controlling air emissions and meeting the requirements of the SEPP (AQM) and must be applied to the management of emissions from new sources. Best practice, as identified within Part IV of SEPP (AQM), is defined as:

'the best combination of eco-efficient techniques, methods, processes or technology used in an industry sector or activity that demonstrably minimises the environmental impact of a generator of emissions in that industry sector or activity'.

Measures to minimise environmental impacts and eliminate health risks and nuisance to residents should be implemented with reference to the EPA Vic Best Practice Environmental Guidelines for Major Construction Sites (EPA Vic, 1996). The guideline recommends a dust prevention strategy be developed at the project planning stage and outlines a range of dust control and suppression measures.

Local Government

The proposed Melbourne Metro would pass through five local government areas: Melbourne, Port Phillip, Stonnington and Maribyrnong. Management of air emissions from the Concept Design are expected to be regulated by State legislation, however local government regulations are included here for guidance. Typically, local authorities defer to the expertise of EPA Vic in relation to air pollution matters, including complaints associated with major projects.

City of Melbourne

The City of Melbourne (Council) has the power to request a Construction Management Plan under the Activities Local Law (City of Melbourne, 2009). For the duration of construction, an approved Construction Management Plan is deemed to be an Environmental Management Plan under the requirements of the Environment Local Law 1999 (City of Melbourne, 1999).



While typically part of the planning approval for a site, the issues required to be addressed in this plan would be addressed via the EMF and the Performance Requirements prepared for the project. The management of air quality is commonly part of a Construction Management Plan.

The City of Melbourne Construction Management Plan Guidelines (City of Melbourne, 2006) addresses a range of issues including air quality management due to construction activities such as excavation and demolition works. The objective is that airborne dust and pollutants in and around a construction work site are maintained at acceptable levels throughout the construction period.

City of Port Phillip

The City of Port Phillip manages and regulates land uses through Local Law No. 1 (Community Amenity) 2013 (City of Port Phillip, 2013), which supersedes the previous Local Laws 3 and 7 and the associated procedures and protocols manual. A purpose of the Local Law No. 1 is to protect public assets, improve the health and safety of residents and visitors to the City of Port Phillip.

City of Stonnington

The City of Stonnington describes the management of dust in Section 716 of its General Local Law 2008 (No.1), amended 2011 (City of Stonnington, 2011).

For larger scale developments, the City of Stonnington generally applies permit conditions requiring a Construction Management Plan.

City of Maribyrnong

The City of Maribyrnong has a number of policy documents relating to the environment and sustainability. However, there does not appear to be any policy directly related to air quality or emissions from construction projects. The council has made a submission to the Federal Government's National Clear Air Agreement (City of Maribyrnong, 2013a) and makes reference to reducing truck pollution in its Council Plan 2013-17 (City of Maribyrnong 2013b).

On the council website, issues relating to air quality are directed to the EPA Vic Pollution Watch hotline.

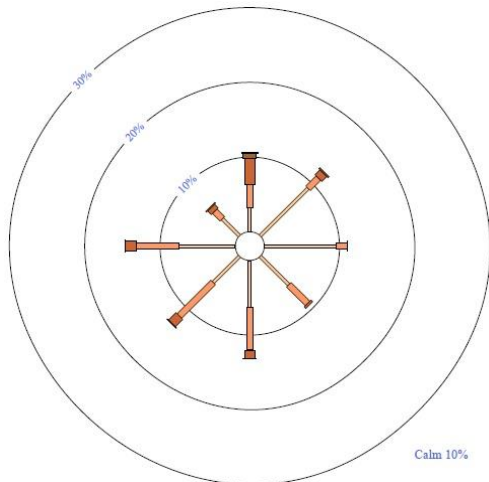


Appendix B

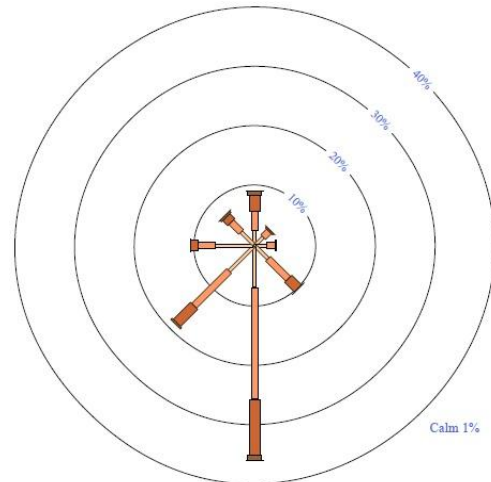
BoM Melbourne Regional Office Wind Roses



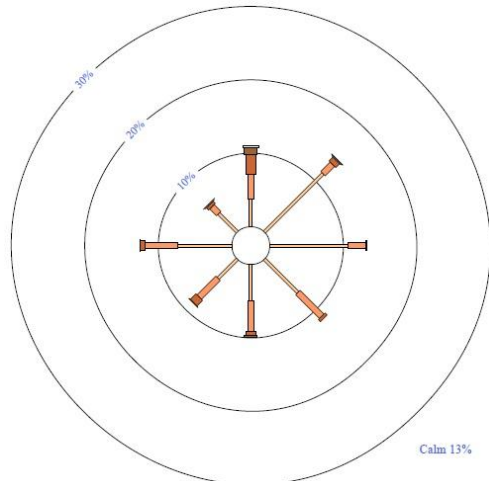
BoM Melbourne regional office 9am and 3pm wind roses Jan–Mar 1955–2009



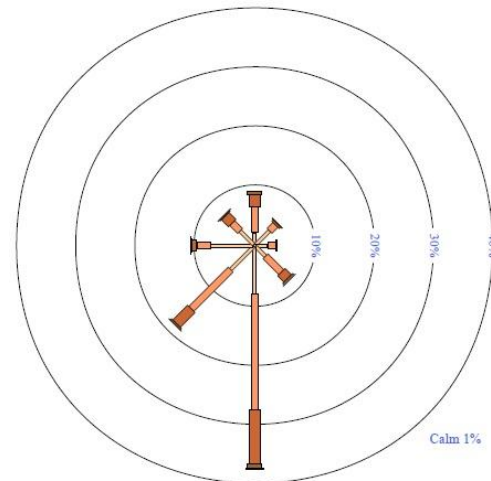
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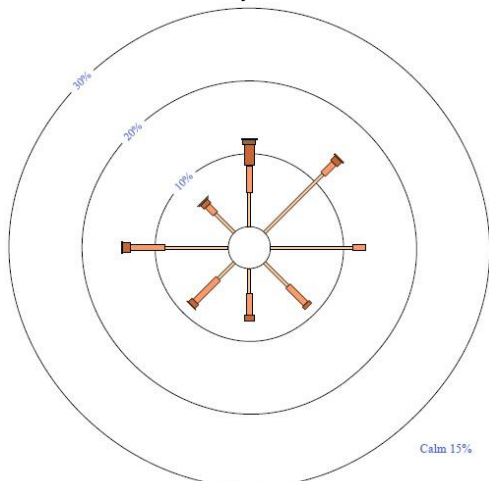
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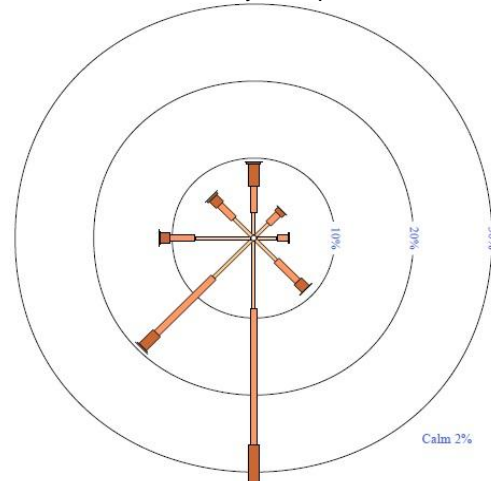
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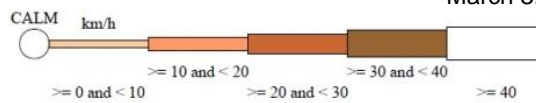
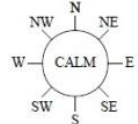
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March 9:00 am

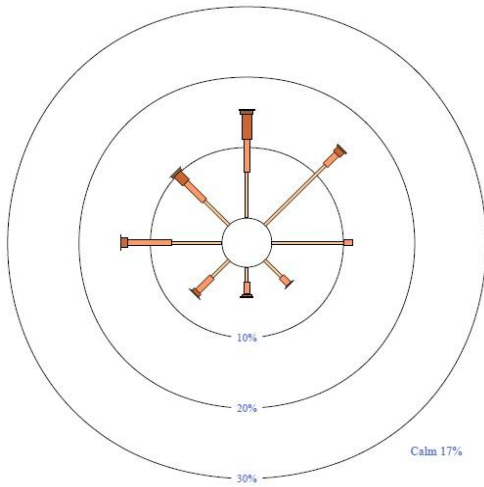


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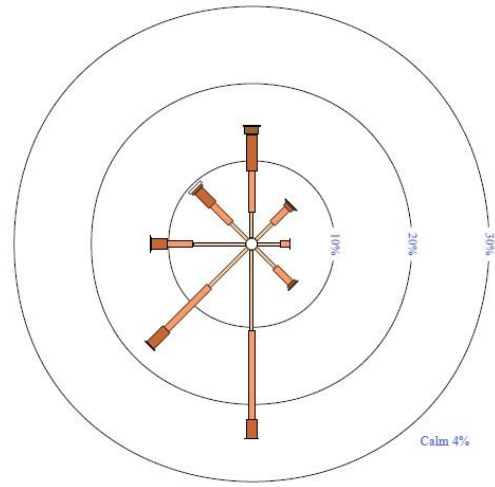




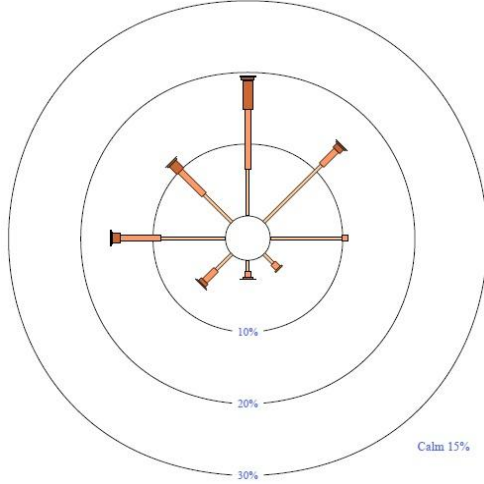
BoM Melbourne regional office 9am and 3pm wind roses Apr-Jun 1955–2009



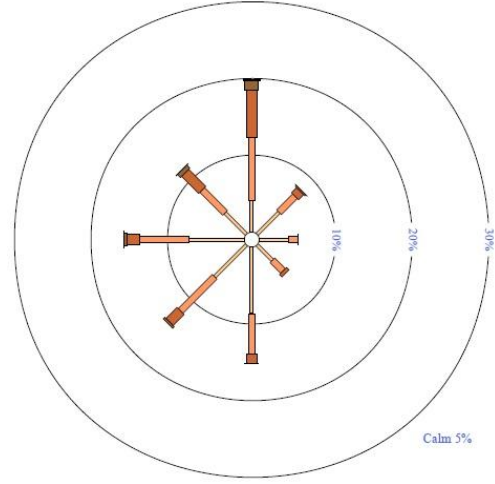
April 9:00 am



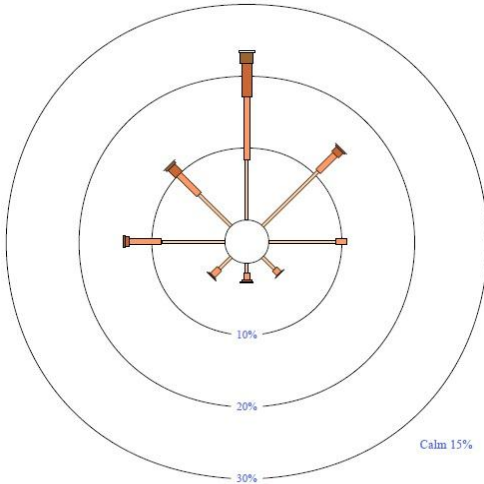
April 3:00 pm



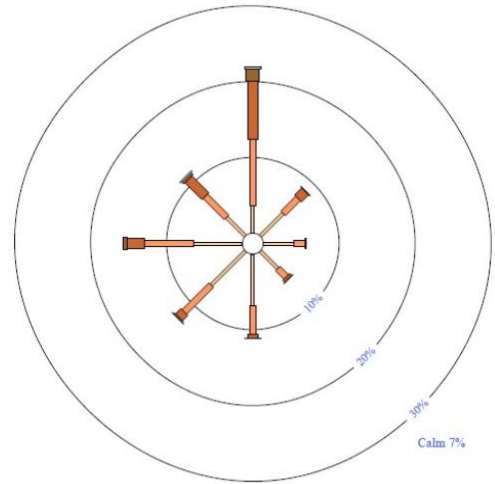
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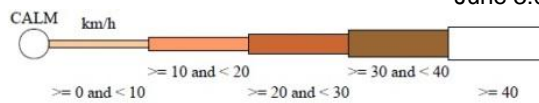
May 3:00 pm



June 9:00 am

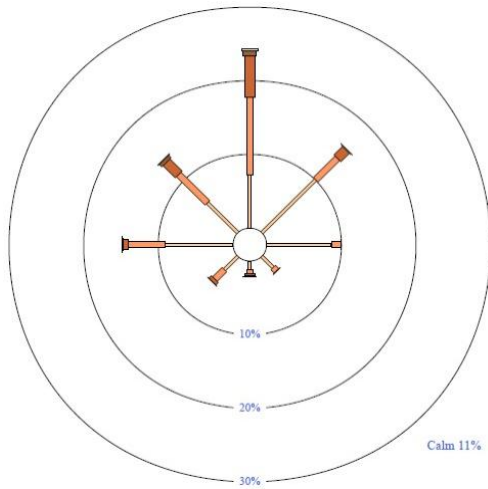


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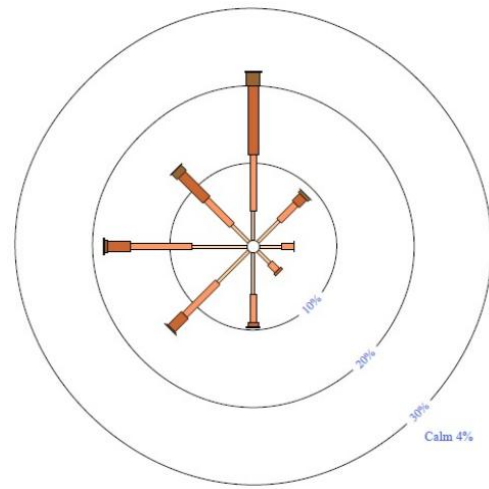




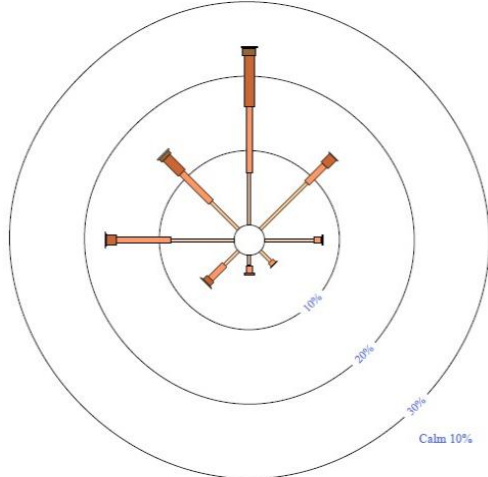
BoM Melbourne regional office 9am and 3pm wind roses Jul-Sep 1955–2009



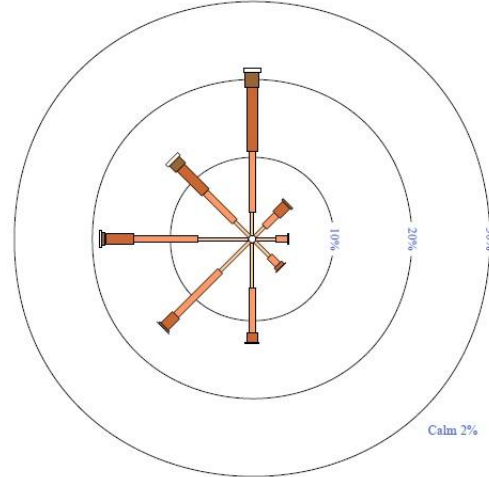
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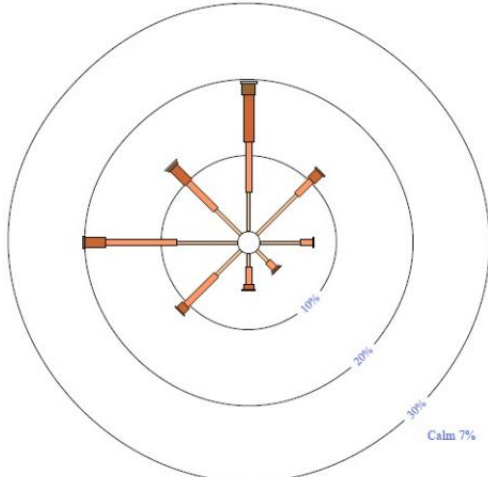
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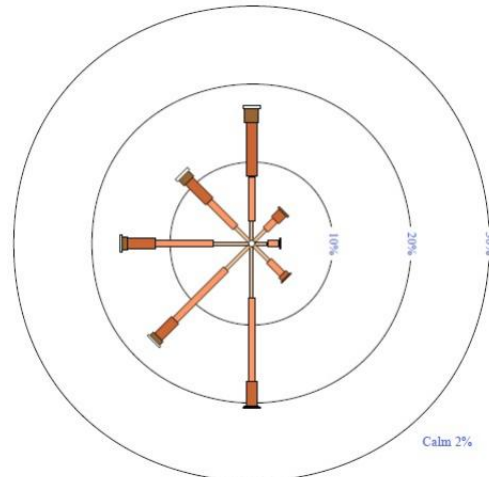
August 9:00 am



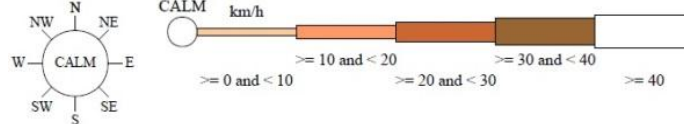
August 3:00 pm



September 9:00 am

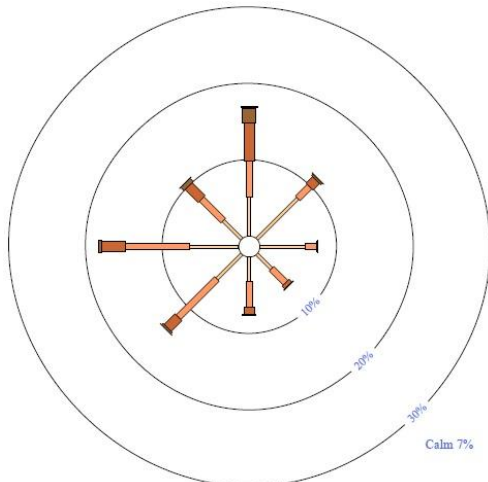


September 3:00 pm

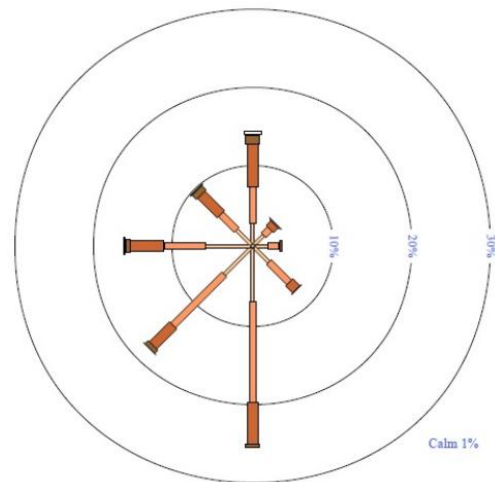




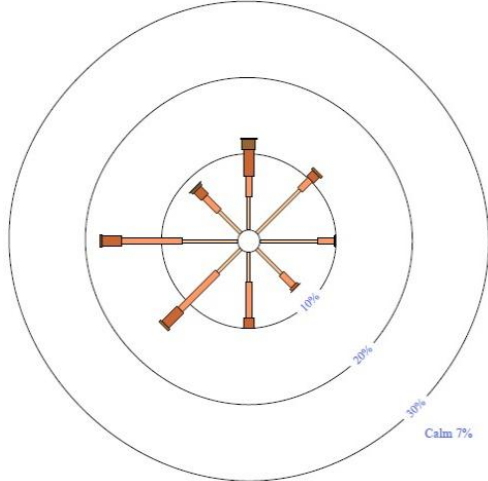
BoM Melbourne regional office 9am and 3pm wind roses Oct-Dec 1955–2009



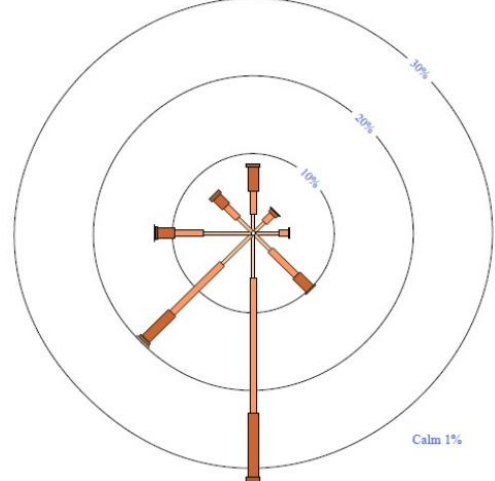
October 9:00 am



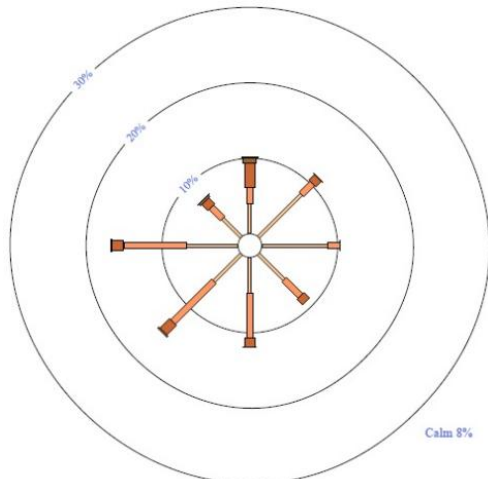
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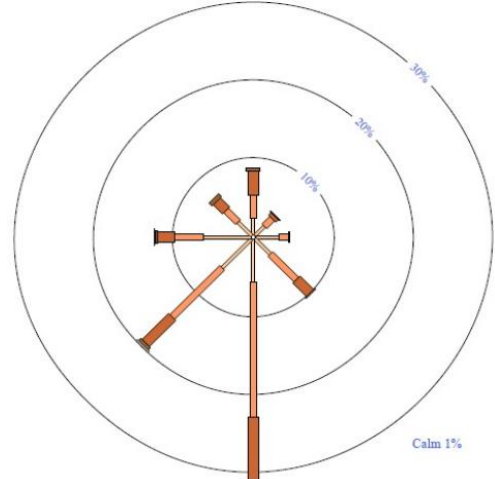
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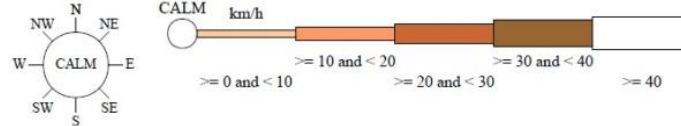
November 3:00 pm



December 9:00 am



December 3:00 pm





Appendix C

Peer Review Report

21 April 2016

Tim Power, Partner
Herbert Smith Freehills
101 Collins Street
Melbourne Vic 3000

Dear Tim,

Re: Peer Review of AJM Air Quality Impact Assessment report for the Melbourne Metro Rail Project

1 INTRODUCTION

I have been retained by Herbert Smith Freehills (HSF) on behalf of the Melbourne Metro Rail Authority ('the Authority') to provide advice in accordance with the scope outlined below. The advice provided is required so that HSF can give legal advice to the Authority in relation to air quality issues associated with the Melbourne Metro Rail Project (MRPP; 'the Project').

2 PEER REVIEW ADVICE SCOPE

Under my current engagement, I have been requested to complete the following:

- a) Review and comment on the assumptions, methodology, assessment criteria (standards and limits) and scope applied by the AJM joint venture in their Draft Air Quality Impact Assessment report.
- b) Advise whether there are any additional matters which should be considered as part of the impact assessment, in order to address the Environment Effects Statement (EES) Scoping Requirements that are relevant to air quality issues; and
- c) Provide a peer review of the report (this document), including advice as to whether there are any gaps or matters where there is disagreement with the assessment which should be addressed.

It is understood that this peer review document may be included as an appendix to the EES.

I have previously provided peer review comments on earlier drafts of the Air Quality Assessment report.

I have now been provided with an updated document (Version P5.1, dated 24 March 2016, document ID MMR-AJM-PWAA-RP-NN-000819, referred to hereafter as 'the P5.1 AQ Assessment').

I have provided commentary by exception only, and include a brief conclusion. I have also noted where I have provided feedback on previous versions of the AQ Assessment, and how this has been addressed within the P5.1 AQ Assessment. I have appended a copy of my curriculum vitae, summarising my relevant experience, to this document.

3 LEGISLATION, POLICY AND GUIDELINES

Previous versions of the AQ Assessment summarised proposed amendments to the ambient air quality National Environment Protection Measure (NEPM, referring to a draft variation of the NEPM and Impact Statement released in July 2014).

It was previously recommended that the AQ Assessment be updated to include the latest information related to the variation to the ambient air quality NEPM.

This included recommendation to acknowledge that the amendment to the National Environment Protection (Ambient Air Quality) Measure entered into force on 25 February 2016 (<https://www.legislation.gov.au/Details/F2016C00215>).

The most significant recent changes in the NEPM relevant to the Project are as follows:

- Amending the status of the annual average and 24-hour average PM_{2.5} 'advisory reporting standards' to 'standards'
- Including an annual average PM₁₀ standard of 25 µg/m³
- Including an aim to move to annual average and 24-hour PM_{2.5} standards of 7 µg/m³ and 20 µg/m³ by 2025
- Replacing the five-day exceedance form of the 24-hour PM₁₀ standard with an exceptional event rule (for PM₁₀ and PM_{2.5})

Section 3 of the P5.1 AQ Assessment has now been updated to include reference to the variation to the ambient air quality NEPM on 25 February 2016, as well as the relevant changes for the Project.

4 METHODOLOGY

Section 4.2.4 of the P5.1 AQ Assessment describes air emission estimates made for both a 'peak' and 'annual' emission scenario. While the logic of these estimates appears sound, Table 4-6 shows two columns with the same title ("Average daily truck round trips"). While it is understood that the last column provides an average of two time periods, it is recommended that the column titles are amended to make this explicit and avoid confusion.

Section 4.5 of the P5.1 AQ Assessment notes:

The detailed construction layout has not yet been completed and the location and distribution of various emission sources has been based on the high-level project description and assumed approximate locations only.

In view of the above, it is acknowledged that at this stage in the project design it is difficult to reliably quantify dust emissions from construction activities. Further, due to the variability of the weather it is impossible to predict what the weather conditions would be when specific construction activities are undertaken. Any effects of construction on airborne particle concentrations would also generally be temporary and relatively short-lived. Moreover, mitigation should be straightforward, as most of the necessary measures are routinely employed as 'good practice' on construction sites. It is therefore usual to provide a qualitative assessment of potential construction dust impacts.

Notwithstanding the above, it is acknowledged that a dispersion modelling exercise is a valid approach to identify risks and to recommend appropriate mitigation measures which may be incorporated within a construction air quality management plan.

It is acknowledged that the MMRP proposes to operate on electric trains only, and therefore any local air emissions associated with routine operation of the MMRP are likely to be negligible in comparison to construction-related air emissions and impacts. In reality, emissions associated with operations will be located at power stations geographically removed from population centres. As such, it is agreed that the P5.1 AQ Assessment should focus on issues relevant to construction-related air emissions.

5 METEOROLOGY

It was previously recommended that the AQ Assessment report should state the reasons why three meteorological monitoring sites near the proposed MMRP corridor (Richmond and Footscray (EPAV) and Melbourne Regional Office (BoM)) were not referenced in the development of meteorological modelling files.

Section 4.2.2 of the P5.1 AQ Assessment now includes the following:

The Essendon Airport meteorological data was utilised in preference of other sources of data such as Footscray (EPA) or Melbourne Regional Office (BoM) for a number of reasons:

- *Footscray meteorological data is incomplete for some key parameters such as winds, and does not monitor for some of the other required parameters.*
- *Melbourne Regional Office, although offering a long history of quality measurements, is potentially influenced by nearby high-rise buildings (wind channelling or blocking) and a high proportion of hard surfaced areas (heat island effects).*

In comparison, the Essendon Airport meteorological monitoring site is located in an open area with predominantly natural ground cover and measures all ground based parameters required for the study.

It is considered that the value of the dispersion modelling is principally to identify risks and to recommend appropriate mitigation measures during construction (refer **Section 4**). On this basis, it is anticipated that the choice of meteorological input file is non-critical. As such, the above justification is deemed adequate.

It was recommended during previous review of the Draft AQ Assessment that additional detail as to how the third party (pDsConsultancy) meteorological input files were produced. This includes detail as to the specific software used, data availability, approach to gap filling, and what they contain, should be provided.

It is not considered that this has been comprehensively addressed in the P5.1 AQ Assessment. However, given the comments above about the choice of meteorological file being non-critical, this is not deemed a material information gap.

6 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

As noted above, the key benefit of the AQ Assessment is to identify risks and to recommend appropriate mitigation measures which may be incorporated within a Construction Air Quality Management Plan.

It was recommended during a review of a previous draft of the AQ Assessment that a comprehensive summary of environmental performance requirements be summarised within a single table / report section, along with where and under what circumstances these are considered applicable.

It is understood from the P5.1 AQ Assessment that all recommended Environmental Performance Requirements are incorporated into the Environmental Management Framework for the project (Chapter 23). This is therefore considered to have been adequately addressed.

The review of a previous draft of the AQ Assessment report noted that there was no detail provided on the appropriate management protocol when encountering potentially contaminated material.

Section 7.5.2 of the P5.1 AQ Assessment notes that Technical Appendix Q Contaminated Land and Spoil Management impact assessment provides further detail of the risks and nature of currently known contaminated sites. Further, it notes that prior to commencing excavation works, additional sampling may be required by the contractors to finalise spoil waste categorisation and management plans. The P5.1 AQ Assessment notes that during construction, it is anticipated that data gathering (and monitoring) would be ongoing for the duration of the project. In the event where a contaminant is identified and ascertained to require additional mitigation, an appropriate strategy would be developed and implemented by the contractor. This would be documented in the contaminated land management plan. The above approach is considered appropriate.

7 MINOR ISSUES

Minor typographical and formatting issues previously identified have been addressed in the P5.1 AQ Assessment report.

8 CONCLUSION

It is considered that AJM has adequately addressed the Environment Effects Statement (EES) Scoping Requirements that are relevant to air quality issues in the P5.1 Air Quality Impact Assessment report. Further, it is anticipated that the P5.1 AQ Assessment may be relied upon for the development of appropriate mitigation strategies during the construction phase of the project.

The modelling within the P5.1 AQ Assessment demonstrates that with appropriate mitigation, activities at the Arden, Domain and Fawkner Park construction work sites can be managed within SEPP criteria for sensitive receptor locations. It is noted, however, that on days when background particulate concentrations are high there would still be the potential for exceedances of air quality criteria.

Appropriate mitigation techniques have been identified, including maintenance of sealed haul roads and open areas, use of rumble grids or wheel washing for haul trucks, regular street sweeping or road

washing and ongoing construction dust monitoring at key sensitive receptor locations. Additional mitigation may include the use of windbreaks and water sprays on stockpiles and exposed surfaces, and dust suppression on unsealed roads.

I trust that the above provides appropriate feedback and review of the P5.1 AQ Assessment report.

Do not hesitate to contact the undersigned if you need to discuss (or require clarification on) any aspect of the above.

Yours Faithfully



Damon Roddis
Principal / General Manager (NSW), Pacific Environment

Attachment 1: Curriculum Vitae – Damon Roddis

Curriculum Vitae

Damon Roddis

Principal Scientist and General Manager (NSW)

- Telephone: +612 9870-0900
- Mobile: +61410 598 949
- Email: damon.roddis@pacific-environment.com

AREAS OF EXPERTISE

- Air Quality Management
- Atmospheric Dispersion Modelling
- Emissions Estimation
- Odour Assessment
- Carbon / Energy Management
- Expert Witness Services

QUALIFICATIONS & PROFESSIONAL AFFILIATIONS

- BSc. with Honours Environmental Science, University of East Anglia, UK
- Certified Environmental Practitioner (CEnvP)
- Branch Committee Member of the Clean Air Society of Australia and New Zealand (CASANZ)

PROFESSIONAL EXPERIENCE

Damon has extensive experience in the field of environmental science, specialising in air quality modelling / monitoring. He provides technical guidance during the production of air quality impact assessments, and has considerable experience in atmospheric dispersion modelling techniques. Damon designs and implements air quality monitoring campaigns for a variety of clients and applications and additionally consults with respect to energy and carbon management issues.

He has completed a secondment to the NSW Environment Protection Authority Air Policy Unit where he acted as Principal Technical Policy Advisor. During this time he assisted in the development of air pollution policy and provided a technical review role for a variety of complex specialist air quality reports.

Damon has acted as both technical peer reviewer and Project Director for many complex air quality related projects during his twenty year experience in this field. He has been an air quality practitioner in NSW for over a decade and enjoys excellent professional relationships with his regulatory colleagues.

Key roles that have shaped Damon's experience for this project include:

- Twenty years of experience in the assessment of major transport and infrastructure projects for air quality impact.
- Extensive liaison with the regulator (NSW EPA and Office of Environment and Heritage) to develop and achieve consensus on the technical scope for photochemical assessment of a major new NO_x source in Western Sydney (2014).
- Project Director for numerous relevant major projects including those on behalf of the state and federal governments.

- Presentation to regulatory stakeholders on a state-of-the-art approach to local and regional air quality assessment of a second Sydney airport (2014).
- Contributing author to the latest update of the National Pollutant Inventory Emission Estimation Technique Manual for Airports (2008) and a Tiered Procedure for Estimating Ground-Level Ozone Impacts from Stationary Sources for the NSW Office of Environment and Heritage (2011).

PROJECT EXPERIENCE (SELECTED PROJECTS)

Transportation and Infrastructure Assessments

- Project director for air quality assessment and monitoring services for the M4 East, Stage 2 and Stage 3 of WestConnex. Provision of strategic advice for the WestConnex EIS, including a supporting investigation of portal emissions at the Lane Cove Tunnel (LCT).
- Air quality assessment of construction and operation impacts associated with the Albury-Wodonga Bypass (External Route) environmental assessment.
- Quantification of air quality impacts associated with the construction phase of the Parramatta-Chatswood Rail Link.
- Operation phase impact assessment of the Fairbairn Avenue Duplication project, Canberra, ACT.
- Evaluation of air quality impacts (construction and operation) associated with the Brisbane Urban Corridor roadway, Qld.
- Air quality assessment of the operation phase of the Gladstone Port Access Road, Qld using the CALINE line source dispersion model.
- Construction and operation phase assessment of the proposed Sydney – Melbourne rail passing lanes project (Victorian sites).

Mining and Extractive Industry Assessments

- Co-author of the *Independent Review of Cumulative Dust Impacts – Camberwell Village* completed on behalf of NSW Department of Planning
- Completion of multiple operational dust management improvement consultancies, including Pollution Reduction Programs, Air Quality Management Plans, design of ambient air quality monitoring and management systems for the mining industry.
- On-going consultancy advice to Glencore Bulga mine regarding management of air quality impacts associated with the Bulga Optimisation Project.
- Expert evidence relating to an adverse dust event in the Upper Hunter Valley on behalf of a confidential mining client in the Upper Hunter Valley.
- Air quality impact assessment of Lead-Zinc mine in central Broken Hill, NSW. Preparation of inputs to Health Risk Assessment, recommendations / design of Best Practice dust controls.
- impact assessments for Hanson Quarry Products including the proposed Guyong Hard Rock Quarry and Kulnura Quarry.
- Air quality impact assessment of the Elizabeth Farm Quarry including provision of Expert Witness services to the NSW Land and Environment Court.

Industrial Emissions Assessments

- Completion of the first extensive photochemical assessment to be conducted for a major new combustion source (Energy from Waste facility) in the Sydney basin in the past decade. Tasks included the characterisation of regional ozone concentrations over a five year period. Photochemical modelling of all ozone precursor emission sources across the Sydney basin

using TAPM-CTM. Evaluation of the changes in ozone concentrations with the respect to the Significant Impact Level criteria for the study area. Extensive negotiation conducted with the NSW Office of Environment and Heritage and Environment Protection Authority as to the appropriate assessment protocol for this novel process. Agreement as to the best technical approach including model selection, project scope and validation. Cooperation with CSIRO to ensure comprehensive technical peer review to the satisfaction of regulatory stakeholders.

- Three-year project to quantify, rank and prioritise pollution control associated with atmospheric emissions from in excess of 120 / fugitive emission sources associated with BlueScope Steel's Port Kembla, NSW operations.
- Atmospheric dispersion modelling to derive the emission characterisation and impacts associated with accidental release of Cr(VI) from Orica's Kooragang Island facility, NSW. Liaison with regulatory stakeholders, and explanation of outcomes to a lay audience.
- Air quality assessment of the operation of a benchmark bio-diesel facility in NSW producing fuel grade diesel from tallow feedstock. .
- Air quality / odour impact assessment of the Boral Parallel Drum Mix Plant located at Greenacre, NSW. Atmospheric dispersion modelling was conducted using site-specific monitoring results to establish appropriate odour control techniques.

Odour Impact Assessments

- Odour impact assessment relating to upgrade and expansion of an existing waste water treatment plant. Comprehensive literature review conducted to establish appropriate odour emission rates for components of the site. Odour dispersion modelling completed using the CALMET/CALPUFF atmospheric dispersion modelling suite.)
- Odour / air quality impact assessment for the proposed Hub waste reprocessing facility, Molong, NSW. Impact Assessment included a comprehensive literature review of odour emission rates from waste reprocessing / landfilling activities, fugitive dust assessment and greenhouse gas quantification.
- Odour impact assessment in support of the Mackay Effluent Resource Project, involving a treated effluent application to sugar cane agriculture. Assessment included the modelling of potentially odorous aerosols generated from spray irrigation and site specific odour monitoring.
- Odour / fugitive dust assessment of the Woodlawn Bioreactor Alternative Waste Treatment Plant Operations on behalf of Veolia.
- Odour assessment of the Wirong Dairy, near Orange, NSW. Evaluation of odour modelling using both conventional Ausplume model and the advanced TAPM model.
- Odour assessment of a poultry farm to aid the strategic planning process for land release in south-west Sydney.
- Odour monitoring and modelling conducted on behalf of Dairy Farmers, Wetherill Park, NSW. Assessment focused on the operation of the facility's Dissolved Air Flotation (DAF) process to establish appropriate odour mitigation techniques / technologies for the site.

Power Generation Assessments

- Air quality impact assessment for a proposed gas turbine power station at Bamarang, NSW. Atmospheric dispersion modelling was conducted using the TAPM v3 model, with the potential impacts on regional photochemistry being of particular focus. Turbulent plume rise impact assessment conducted to Civil Aviation Safety Authority requirements.
- Air quality / odour impact assessment for a variety of desalination plant options and locations within NSW. Detailed assessment of the emissions attributable to dedicated on-site power stations was undertaken using the TAPM model.
- Air quality impact assessment undertaken of a methane capture power station servicing a landfill operation. CALPUFF modelling of 18 reciprocating engine generators in a region of

complex meteorology and topography.

- Air quality impact assessment of a coal bed methane power plant located in Narrabri, NSW on behalf of Eastern Star Gas.

Greenhouse Gas Quantification and Carbon Management

- Greenhouse Gas Protocol Initiative Scope 1 - 3 assessment for the proposed Narrabri Coal Project. This quantified both direct and indirect greenhouse gas emissions, including onsite power and fuel, coal bed methane, product transport and combustion.
- Greenhouse assessment for the Belmont Coal Mine project – a major new coal mine operation proposed within northern NSW.
- Quantification of greenhouse footprint associated with the Somersby Fields Quarry operation.
- Greenhouse gas assessment on behalf of Hanson for the Eastern Creek Industrial Precinct, a major industrial park including asphalt, cement batching, and concrete block plants.
- Quantitative greenhouse gas assessment on behalf of Gindalbie Metals for the Karara Iron Ore Project, comprising two stand-alone iron ore mines, product transportation and port activities.
- Completion of accredited assessor course for the Australian Building Greenhouse Rating (ABGR) for commercial buildings.
- Energy Savings audits undertaken on behalf of an International manufacturing client in Australia, Thailand, China and the Philippines.

Regulatory Compliance Audits

- Ongoing independent expert review role for a major existing coal mine operation in the Southern Coal Fields. Air Quality Compliance Auditing on behalf of NSW Department of Planning.
- Auditor under the NSW Greenhouse Gas Abatement Scheme (GGAS) and Energy Savers Scheme (ESS).
- Previously acted as Authorised Officer on behalf of seven UK Local Governments with respect to the UK Local Air Pollution Control (LAPC) Regulations. This involved regular inspection of over 90 industrial processes for air quality legislative compliance.

Ambient Air Quality Monitoring Studies

- Specification, procurement, installation and maintenance of twelve comprehensive air quality and meteorological monitoring stations associated with Sydney's Westconnex project. Recruitment and training of air quality monitoring field staff.
- Specification and design of real-time monitoring station for sulfur dioxide and PM_{2.5} at the White Bay Cruise Terminal on behalf of NSW Ports Authority.
- Review, recommissioning and ongoing maintenance of a comprehensive ambient air quality monitoring station. Real-time monitoring of NO_x (chemiluminescence), CO (Infra-red) and PM₁₀ / PM_{2.5} using TEOM monitors.
- Environmental monitoring on behalf of the NSW Roads and Traffic Authority during the removal of lead based paint from the Sydney Harbour Bridge. Regular monitoring of soil, dust, noise and ambient air quality for environmental compliance.
- Design advice provided to Rio Tinto regarding augmentation of their ambient air quality monitoring plan for the Northparkes mine, NSW.
- Numerous construction phase dust management plans provided for a range of infrastructure projects.
- Design of air quality monitoring plans for all industries.
- Previously part of a team responsible for all ambient air quality monitoring undertaken within

Greater London, managing over 120 monitoring sites within the London Air Quality Network.

EXPERT WITNESS EXPERIENCE

- Expert witness services in relation to dust related impacts from the Warkworth mine on behalf of Rio Tinto Coal Australia.
- Expert witness services in relation to PM10, PM2.5 and crystalline silica impacts associated with operation of the Calga Sands Quarry on behalf of Rocla.
- Expert witness services related to air quality impacts associated with the proposed Champions Quarry.
- Expert witness services provided to the NSW Land and Environment Court relating to greenhouse gas impacts associated with the proposed Hub resource recovery / landfill facility at Molong, NSW.
- Served as an expert witness in relation to air quality impacts associated with the expansion of the Albion Park Quarry, NSW
- Expert witness advice provided regarding air quality impacts associated with operation of the Alexandria Landfill, NSW.
- Expert witness services provided with respect to fugitive dust emissions associated with the operation of the Elizabeth Farm Quarry, Eurobodalla, NSW
- Expert witness testimony provide in relation to Lismore City Council vs Champions Quarry NSW Land & Environment Court proceedings.
- Expert witness advice provided regarding sustainability issues relating to the proposed reuse of the Mercure Hotel, Parramatta, NSW.
- Completion of Joint Australian Property Institute and University of Sydney Training Course - Associate Professional Certificate in Expert Evidence for the Land and Environment Court (2005).

PUBLISHED REPORTS, PAPERS AND TECHNICAL PRESENTATIONS

- Contributing author to many technical publications across a broad range of topics: mobile air quality monitoring techniques, development of Australian-specific particulate emission factors for mines, air quality health impacts, use of Computational Fluid Dynamics, application of the CALMET/CALPUFF modelling suite, remote sensing applications in air quality, odour assessment of poultry farms, dispersion model performance and quantification of dust control efficiencies.
- Presentations at the CASANZ Biannual Conference in Hobart, Tas. (2005), International Union of Air Pollution and Prevention Associations Conference in Brisbane, Qld (2007) and CASANZ Biannual Conferences in Perth, WA (2009), Newcastle (2011), Sydney (2013) and Melbourne (2015).
- Co-chair of CASANZ Biannual Conference in Sydney, 2013.
- Training modules delivered to CASANZ "Introduction to Stack Testing" Course (2007) and "Introduction to Air Quality" Course (2011).
- Training modules delivered during "Introduction to AERMOD" Course (2009).



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