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Mamre Road South Precinct, 657-769 Mamre Road, Kemp's Creek

State Significant Development Stage 1 - Air Quality Impact Assessment

Addressee(s): Frasers Property Australia and Altis Property Partners

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Final Authority

This report must be regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below.



Martin Doyle

14th March 2019

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Non-Technical Summary

Northstar Air Quality was engaged by Frasers Property Australia and Altis Property Partners to perform an air quality impact assessment for the proposed construction and operation of a warehouse and distribution facility at 657-769 Mamre Road, Kemps Creek, NSW which would form the Mamre Road South Precinct.

The air quality impact assessment has been performed to support a State Significant Development application for the site, which is located within an area covered by the requirements of NSW State Environmental Planning Policy (Western Sydney Employment Area) 2009.

Construction phase activities will involve minor demolition works and earth works, construction works and associated vehicle traffic. The associated risks of impacts from demolition, construction, track-out and construction traffic, have all been assessed using the published guidance in *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (IAQM), and adapted by Northstar Air Quality for use in Australia. This methodology has been used in a similar context on numerous other, similar AQIA studies. That assessment showed there to be a low risk of health or nuisance impacts during construction works. However, a range of standard mitigation measures are available to ensure, that short-term impacts associated with construction activities are minimised.

The prediction of potential impacts associated with operational activities has been performed in general accordance with the requirements of the NSW Approved Methods (NSW EPA 2016) using an approved and appropriate dispersion modelling technique. The estimation of emissions has been performed using referenced emission factors.

It is demonstrated that the operation of the Proposal does not cause any exceedances of the air quality criteria, even with the addition of background air pollutant concentrations representative of the area.

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Units Used in the Report

All units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units. In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol. *For example*, 50 micrograms per cubic metre would be presented as 50 µg·m⁻³ and not 50 µg/m³.

Common Abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
BoM	Bureau of Meteorology
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
EETM	emission estimation technique manual
EPA	Environmental Protection Authority
m ⁻²	per square metre
m ⁻³	per cubic metre
mg·m ⁻³	milligram per cubic metre of air
mg·Nm ⁻³	milligram per normalised cubic metre of air
µg·m ⁻³	microgram per cubic metre of air

Abbreviation	Term
mE	metres East
month ⁻¹	per month
mS	metres South
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NO	nitric oxide
NO _x	oxides of nitrogen
NO ₂	nitrogen dioxide
O ₃	ozone
OEH	NSW Office of Environment and Heritage
PM	particulate matter
PM ₁₀	particulate matter with an aerodynamic diameter of 10 µm or less
PM _{2.5}	particulate matter with an aerodynamic diameter of 2.5 µm or less
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
TAPM	The Air Pollution Model
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VKT	vehicle kilometres travelled
WSEA	Western Sydney Employment Area

1. Introduction

Frasers Property Australia and Altis Property Partners have engaged Northstar Air Quality Pty Ltd (Northstar) to perform an air quality impact assessment (AQIA), to support a State Significant Development (SSD) application, associated with the proposed development of a warehouse and distribution hub, located at 657-769 Mamre Road, Kemps Creek, NSW (the Proposal Site). The Proposal Site would accommodate a number of warehouses and industrial facilities and associated office space (the Proposal). The Proposal would form Stage 1 of the larger Mamre Road South Precinct.

The AQIA presents an assessment of the risks to local air quality, associated with the construction and operation of the Proposal to support the Stage 1 SSD application and presents a range of recommended mitigation measures, to minimise those impacts where required and relevant.

The *Environmental Planning and Assessment Act* 1979 (EP&A Act) forms the statutory framework for planning approval and environmental assessment in NSW. The Development qualifies as State Significant Development (SSD) under *State Environmental Planning Policy (State and Regional Development) 2011* due to its location with land covered by *State Environmental Planning Policy (Western Sydney Employment Area) 2009* and its capital investment value.

1.1. Secretary’s Environmental Assessment Requirements

NSW Department of Planning and Environment (DPE) issued Secretary’s Environmental Assessment Requirements (SEARs) for the Proposal in September 2018. **Table 1** below identifies the SEARs relevant to this Air Quality Assessment report and the relevant sections of the report in which they have been addressed.

Table 1 Secretary’s Environmental Assessment Requirements (SSD 9522)

Issue	Requirement	Addressed
Air Quality	Including: <ul style="list-style-type: none"> an assessment of the air quality impacts (including dust) during construction and operation of the development, in accordance with the relevant Environment Protection Authority guidelines; and details of proposed mitigation, management and monitoring measures. 	Section 6 and Section 7 Section 8

This AQIA has also been performed with due reference to a general list of requirements, which are often outlined by the NSW Environmental Protection Authority (EPA). Those broad requirements have been adopted as part of this assessment. These requirements are reproduced in **Table 2** and have been given due consideration within the performance of this assessment. The section of the report where each general requirement has been addressed is provided in **Table 2** overleaf.

Table 2 NSW Environment Protection Authority general requirements for an AQIA

Issue	Requirement	Addressed
The Project	<ul style="list-style-type: none"> • Identify all sources of air emissions from the development. • Provide details of the project that are essential for predicting and assessing air impacts including: <ul style="list-style-type: none"> – The quantities and physio-chemical parameters (e.g. concentration, moisture content, bulk density, particle sizes etc.) of materials to be used, transported, produced or stored. – An outline of procedures for handling, transport, production and storage. – The management of solid, liquid and gaseous waste streams with potential for significant air impacts. 	Section 2.3 Section 5.2.2, Appendix C Section 2.2 & 2.3 Section 8
The Location	<ul style="list-style-type: none"> • Describe the topography and surrounding land uses. Provide details of the exact locations of dwellings, schools and hospitals. Where appropriate, provide a perspective view of the Study Area such as the terrain file used in dispersion models. • Describe surrounding buildings that may affect plume dispersion. • Provide and analyse site representative data on the following meteorological parameters: <ul style="list-style-type: none"> – Temperature and humidity; – Rainfall, evaporation and cloud cover; – Wind speed and direction; – Atmospheric stability class; – Mixing height; – Katabatic air drainage; and – Air re-circulation. 	Section 4.1, Section 4.2 N/A Appendix B

Table 2 - Continued

Issue	Requirement	Addressed
The Environmental Issues	<p>Describe baseline conditions</p> <ul style="list-style-type: none"> • Provide a description of existing air quality and meteorology, using existing information and site-representative ambient monitoring data. This description should include the following parameters <ul style="list-style-type: none"> – TSP – PM₁₀ – PM_{2.5} <p>Assess impacts</p> <ul style="list-style-type: none"> • Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point. • Estimate the resulting ground level concentrations of all pollutants. Where necessary (e.g. potentially significant impacts and complex terrain effects), use an appropriate dispersion model to estimate ambient pollutant concentrations. Discuss choice of model and parameters with the EPA. • Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals. • Describe the contribution that the development will make to regional and global pollution, particularly in sensitive locations. • For potentially-odorous emissions, provide the emission rates in terms of odour units (determined by techniques compatible with EPA procedures). Use sampling and analysis techniques for individual or complex odours and for point and diffuse sources, as appropriate. <p>Describe management and mitigation measures.</p> <ul style="list-style-type: none"> • Outline specifications of pollution control equipment (including manufacturer’s performance guarantees where available) and management protocols for both point and fugitive emissions. Where possible, this should include cleaner production processes. 	<p>Section 4.4</p> <p>Section 5.2.2</p> <p>Section 5</p> <p>Section 6</p> <p>Section 7</p> <p>Section 7</p> <p>Section 7</p> <p>Section 2.3</p> <p>Section 8</p>

1.2. Purpose of the Report

The purpose of this report is to examine and identify whether the impacts of the construction and operation of the Proposal may adversely affect local air quality.

To allow assessment of the level of risk associated with the Proposal in relation to air quality, the AQIA has been performed in accordance with and with due reference to:

- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2016);
- Technical Framework - Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006);
- Technical Notes - Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006);
- *Protection of the Environment Operations Act 1997*;
- Protection of the Environment Operations (Clean Air) Regulation 2010; and
- State Environmental Planning Policy (Western Sydney Employment Area) 2009.

1.3. Scope of Assessment

This report presents data that summarises and characterises the existing environmental conditions, identifies the potential emissions to air associated with the construction and operational phases of the Proposal, examines the potential for off-site impacts and identifies appropriate mitigation measures that would be required to reduce those potential impacts.

2. The Proposal

The following provides a description of the context, location, and scale of the Proposal, provides a description of the processes and phasing, and identifies the potential for emissions to air associated with the development phases.

2.1. Environmental Setting

The Proposal Site is located at 657-769 Mamre Road, Kemps Creek, NSW. The Proposal Site is located within the Local Government Area (LGA) of Penrith. A map showing the location of the Proposal Site within the broader Mamre Road South Precinct is provided in **Figure 1** below.

Figure 1 Proposal Site location

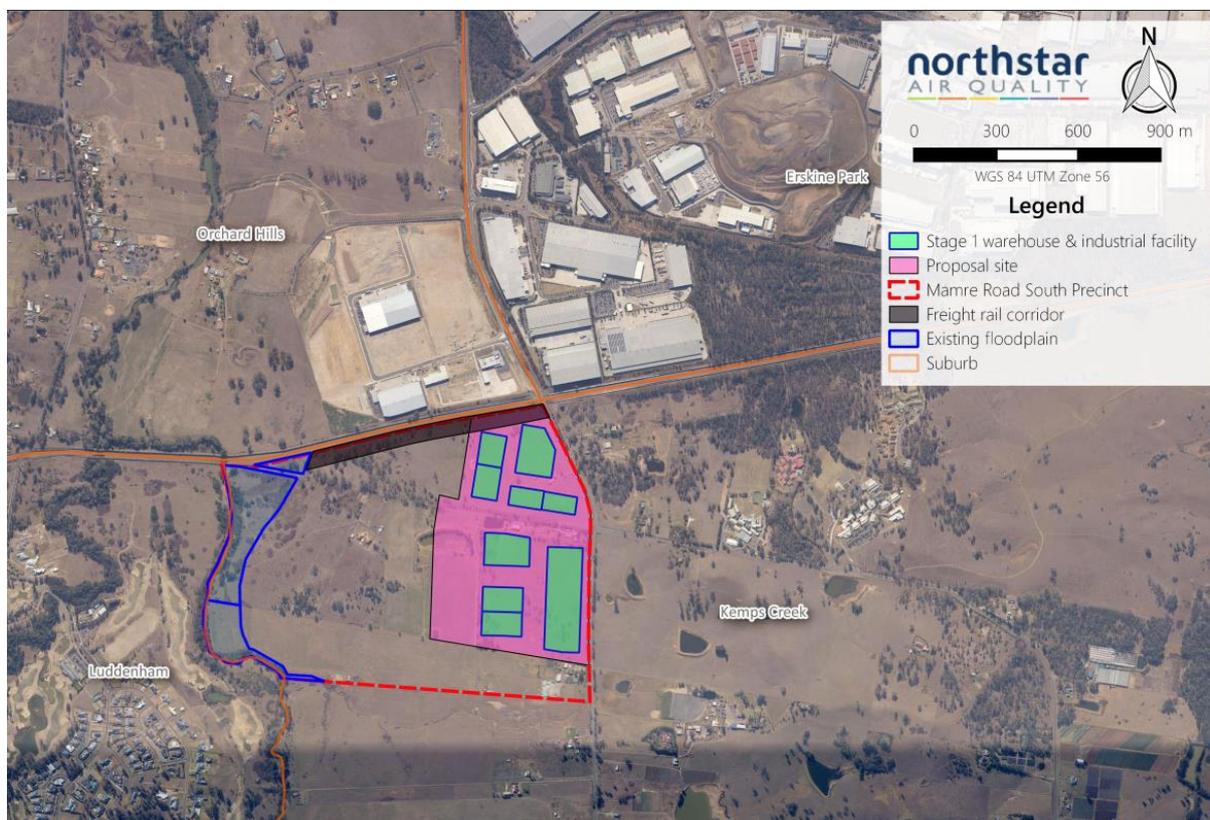


Image courtesy of Google Maps

The land on which the Proposal Site is situated is currently zoned as RU2 (Rural Landscape) and E2 (Environmental Conservation) (see **Section 4.1.1** on P21 of this report). Lands to the immediate north and northeast of the Proposal Site are zoned as IN1 (General Industrial).

The closest residential property is approximately 110 metres (m) from the Proposal Site boundary to the south, with the closest major residential area 1.8 kilometres (km) to the north of the Proposal Site (see **Section 4.1.2** on P22 of this Report).

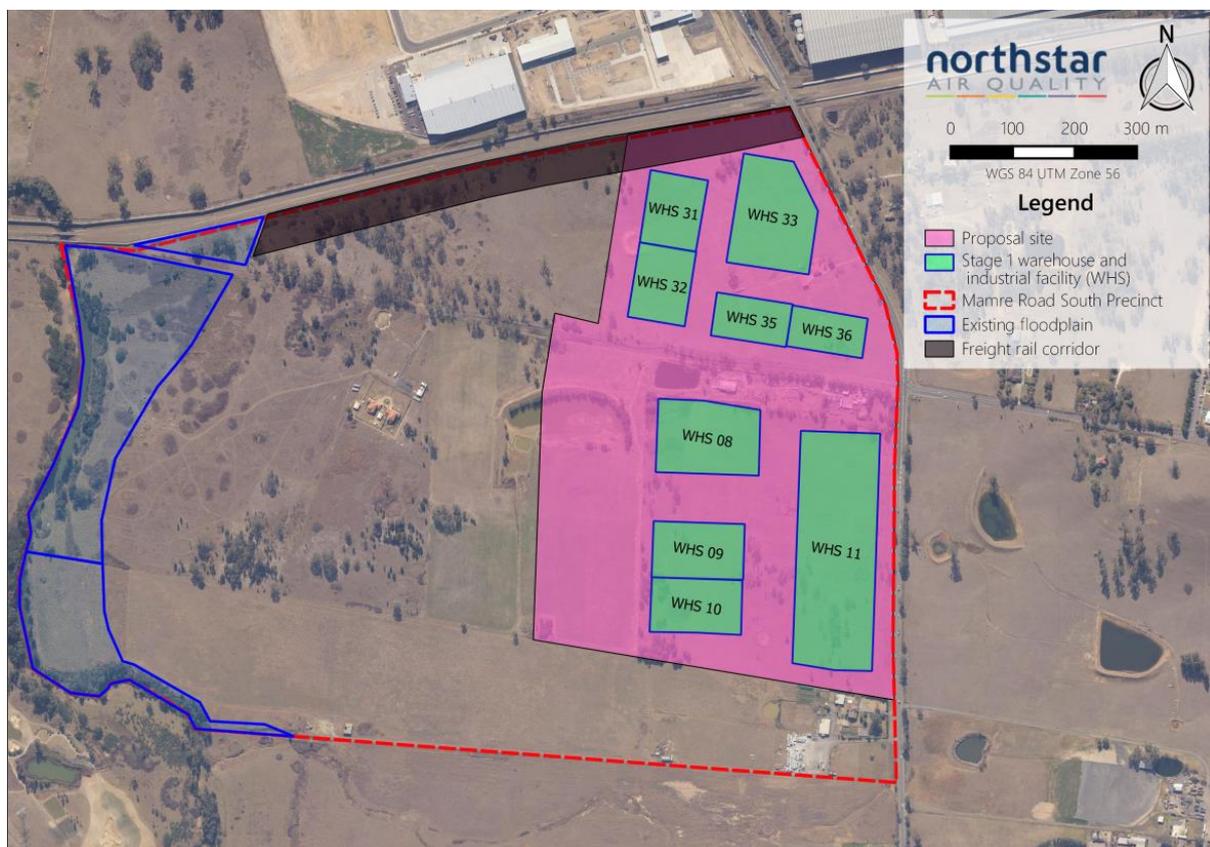
A full description of the sensitivity of the surrounding land, and the identification of discrete receptor locations used in the AQIA is provided in **Section 4.1** (on P21 of this Report).

2.2. Overview and Purpose

The Proposal seeks to gain approval to develop the subject land to accommodate a number of warehouses, industrial sheds and freight-handling facilities. Although the exact use or tenant of each of the proposed 11 warehouse and industrial facilities proposed under this SSD application is not currently known, it is anticipated that the site would be occupied and operated in a similar nature to the approved Orchard Hills development, located to the immediate north, at 585-649 Mamre Road.

A layout of the Proposal Site is provided in **Figure 2** below.

Figure 2 Proposal Site layout



2.3. Identification of Potential Emissions to Atmosphere

Given the nature of the Proposal described above, emissions to air would be likely to be generated as described below.

2.3.1. Construction Phase

Construction of the Proposal would involve demolition of existing structures, bulk earthworks (cut and fill), building and construction of new roads, pavements, services and hardstand, and construction of buildings, fit-out and commissioning.

An indicative list of plant and equipment that may be used during the construction of the Proposal includes:

- Excavators.
- Front End Loaders.
- Graders.
- Light vehicles.
- Heavy vehicles.
- Drills.
- Pneumatic hand or power tools.
- Cranes.
- Commercial vans.
- Cherry pickers.

The assessment of the potential impacts upon local air quality, resulting from construction activities, is presented in **Section 6**.

2.3.2. Operational Phase

During the operation of the Proposal, the following activities are anticipated to result in emissions to air:

- Movement of vehicles around the internal roadways of the Proposal Site on paved road surfaces;
- Diesel combustion emissions from the consumption of diesel fuel, in the truck movements importing and exporting materials. The potential emissions would include particulate matter (as PM₁₀ and PM_{2.5}) and oxides of nitrogen (NO_x), including nitrogen dioxide (NO₂). There would additionally be some more minor emissions of carbon monoxide (CO), sulphur dioxide (SO₂) and air toxics (including benzene and 1,3-butadiene) but for the purposes of this assessment, it is comfortably assumed that the principal gaseous pollutant would be NO_x.

Experience in performing assessments of the impact of combustion related emissions from the use of vehicles, indicates that the principal indicator pollutants, are particulate matter (PM₁₀ and PM_{2.5}) and NO₂ and their associated short-term criteria. NO_x/NO₂ concentrations have been used within this assessment as an indicator pollutant for all other combustion-related gaseous emissions resulting from traffic.

A summary of the emission sources and potential emissions to air during the construction and operation of the Proposal, is presented in **Table 3**.

Table 3 Identified potential sources of air emissions

Source	Particulate Emissions			Gaseous Emissions
	TSP	PM ₁₀	PM _{2.5}	NO _x
Construction Phase				
• Construction dust	✓	✓	✓	
Operational Phase				
• Wheel generated particulate – trucks	✓	✓	✓	
• Exhaust emissions – truck engine	✓	✓ ⁽¹⁾	✓	✓

Note (1) Particulate emissions from diesel combustion are predominantly less than 1 micrometre (1 µm) in diameter and are therefore assessed as PM_{2.5}. As PM_{2.5} is essentially a subset of PM₁₀, PM₁₀ has been assessed at an equivalent rate to PM_{2.5} for the relevant sources.

Given the nature of the development, it is not anticipated that odour would be emitted in any significant quantity during construction. Given the site history (predominantly grazing with no industrial development or other significant development), there is a low potential for contamination of the subsurface of the site. Any invasive groundworks would therefore not be anticipated to result in emissions of odour. Operations at the Proposal Site, are not likely to be odorous and odour has not been considered further as part of this assessment.

3. Legislation, Regulation and Guidance

State air quality guidelines adopted by the NSW EPA, are published in the *‘Approved Methods for the Modelling and Assessment of Air Pollutants in NSW’* (the Approved Methods (NSW EPA, 2016)), which has been consulted during the preparation of this Assessment Report.

3.1. Ambient Air Quality Standards

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the Proposal. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, DoE, WHO and ANZECC). Where relevant to this AQIA (coincident with the potential emissions identified in **Section 2.3** and **Table 3**), the criteria have been adopted as set out in Section 7.1 of NSW EPA (2017) which are presented in **Table 4**.

Table 4 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units ^(e)	Criterion	Notes
Nitrogen dioxide (NO ₂)	1 hour	µg·m ⁻³	246	Numerically equivalent to the AAQ NEPM ^(b) standards and goals.
	Annual	µg·m ⁻³	62	
Particulates (as PM ₁₀)	24 hours	µg·m ⁻³	50	
	1 year	µg·m ⁻³	25	
Particulates (as PM _{2.5})	24 hours	µg·m ⁻³	25	
	1 year	µg·m ⁻³	8	
Particulates (as TSP)	1 year	µg·m ⁻³	90	
Particulates (as dust deposition)	1-year ^(c)	g·m ⁻² ·month ⁻¹	2	Assessed as insoluble solids as defined by AS 3580.10.1
	1-year ^(d)	g·m ⁻² ·month ⁻¹	4	

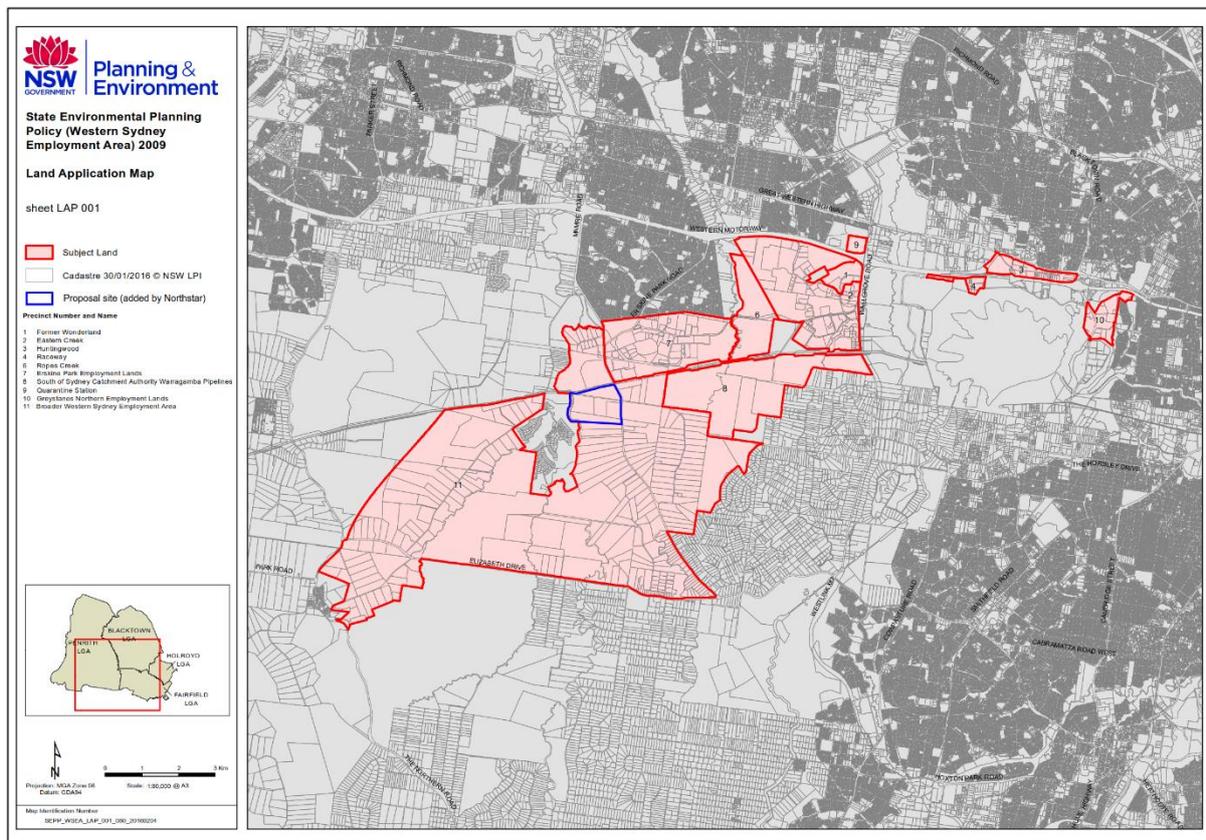
Notes: (a): micrograms per cubic metre of air (b): National Environment Protection (Ambient Air Quality) Measure (c): Maximum increase in deposited dust level (d): Maximum total deposited dust level (e) Gas volumes are expressed at 25°C (298 K) and at an absolute pressure of 1 atmosphere (101.325 kPa)

3.2. NSW Government Air Quality Planning

NSW EPA has formed a comprehensive strategy with the objective of driving improvements in air quality across the State. This comprises several drivers, including:

- Legislation: formed principally through the implementation of the Protection of the Environment Operations Act 1997, and the Protection of the Environment Operations (Clean Air) Regulations 2010.

Figure 3 Western Sydney Employment Area – Land application map



Source: New South Wales Government (<https://legislation.nsw.gov.au/#/view/EPI/2009/413/maps>) SEPP_WSEA_LAP_001_080_20160204, and adapted by Northstar Air Quality

The Proposal Site is currently zoned as RU2 (Rural Landscape) and E2 (Environmental Conservation) (refer to **Section 4.1.1** on P21). Lands to the immediate north and northeast of the Proposal Site are zoned as IN1 (General Industrial).

The WSEA SEPP outlines the objectives of each permitted zone, which are reproduced below for both IN1 (General Industrial) and E2 (Environmental Conservation):

Zone IN1 General Industrial

The objectives of zone IN1 (General Industrial) are:

- To facilitate a wide range of employment-generating development including industrial, manufacturing, warehousing, storage and research uses and ancillary office space.
- To encourage employment opportunities along motorway corridors, including the M7 and M4.
- To minimise any adverse effect of industry on other land uses.
- To facilitate road network links to the M7 and M4 Motorways.
- To encourage a high standard of development that does not prejudice the sustainability of other enterprises or the environment.

- To provide for small-scale local services such as commercial, retail and community facilities (including child care facilities) that service or support the needs of employment-generating uses in the zone.

Both warehousing and distribution centres are permitted with consent within this land use zoning.

Zone E2 Environmental Conservation

The objectives of zone E2 (Environmental Conservation) are:

- To provide for infrastructure and related uses.
- To prevent development that is not compatible with or that may detract from the provision of infrastructure.

Roads are permitted with consent within this land-use zoning.

The proposed development meets the requirements and objectives of the WSEA SEPP. This AQIA seeks to demonstrate that the proposed development, would be constructed and operated to minimise the effects of industry on other land uses, and to minimise impacts upon the surrounding environment.

4. Existing Conditions

4.1. Surrounding Land Sensitivity

4.1.1. Land Use Zoning

The land use surrounding the Proposal Site is zoned by Penrith City Council in the Penrith City Council Local Environmental Plan (LEP) (2015) and the current land use zoning is illustrated in **Figure 4** below.

Figure 4 Current land use zoning

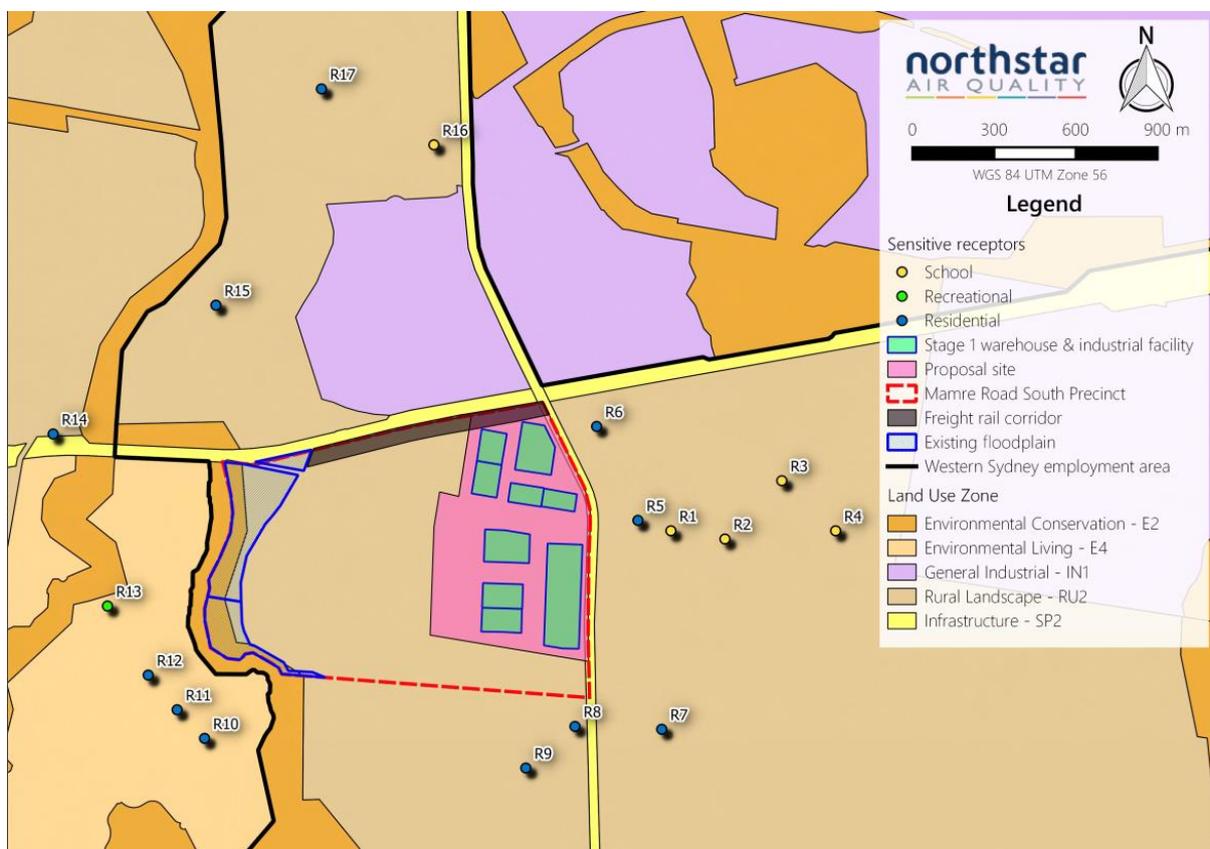


Image courtesy of NSW Department of Planning and Environment, adapted by Northstar Air Quality

The land use surrounding the Proposal Site, is currently zoned as 'Rural Landscape' (RU2), 'Environmental Conservation' (E2) and 'General Industrial' (IN1). Given that the land surrounding the Proposal Site (and the Proposal Site itself) is located within the Western Sydney Employment Area and subject to the relevant State Environmental Planning Policy (SEPP) (WSEA SEPP 2009, refer **Section 3.3**), land zoning of the surrounding area is likely to change in future years to become more predominantly 'General Industrial' (IN1) and 'Environmental Conservation' (E2).

4.1.2. Discrete Receptor Locations

Air quality assessments typically use a desk-top mapping study to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors, refers to places at which humans may be present for a period, representative of the averaging period for the pollutant being assessed. Typically, these locations are identified as residential properties, although other sensitive land uses may include schools, medical centres, places of employment, recreational areas or ecologically sensitive locations.

It is noted that the assessment criteria applied to particulates, is over a 24-hour period, and as such the predicted impacts need to be interpreted at commercial and industrial receptor locations with care. It is considered to be atypical for a person to be at those locations for a complete 24-hour period and as such, the exposure risks at those locations would be over-estimated by the modelling assessment.

It is important to note that the selection of discrete receptor locations, is not intended to represent a fully inclusive selection of all sensitive receptors across the Study Area. The location selected should be considered to be representative of its broader location and may be reasonably assumed to be representative of the immediate environs. In some instances, several viable receptor locations may be identified in a small area, for example a school neighbouring a medical centre. In this instance the receptor closest to the potential sources to be modelled, would generally be selected and would be used to assess the risk to other sensitive land uses in the area.

It is further noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations (see **Section 4.1.3** on P24 of this Report) that are used to plot out the predicted impacts, and as such the accidental non-inclusion of a location that is sensitive to changes in air quality, does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the Proposal Site reside, population-density data has been examined. Population-density data based on the 2016 census, have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km²) grid, covering mainland Australia (ABS, 2017). Using a Geographical Information System (GIS), the locations of sensitive receptor locations, have been confirmed with reference to their population densities.

For clarity, the ABS use the following categories to analyse population density (persons-km⁻²):

- | | | | |
|-------------|--------|-----------------|------|
| • Very high | >8,000 | • Low | >500 |
| • High | >5,000 | • Very low | <500 |
| • Medium | >2,000 | • No population | 0 |

Using ABS data in a GIS, the population density of the area surrounding the Proposal Site are presented in **Figure 5** overleaf.

Figure 5 Population density and sensitive receptors surrounding the Proposal Site

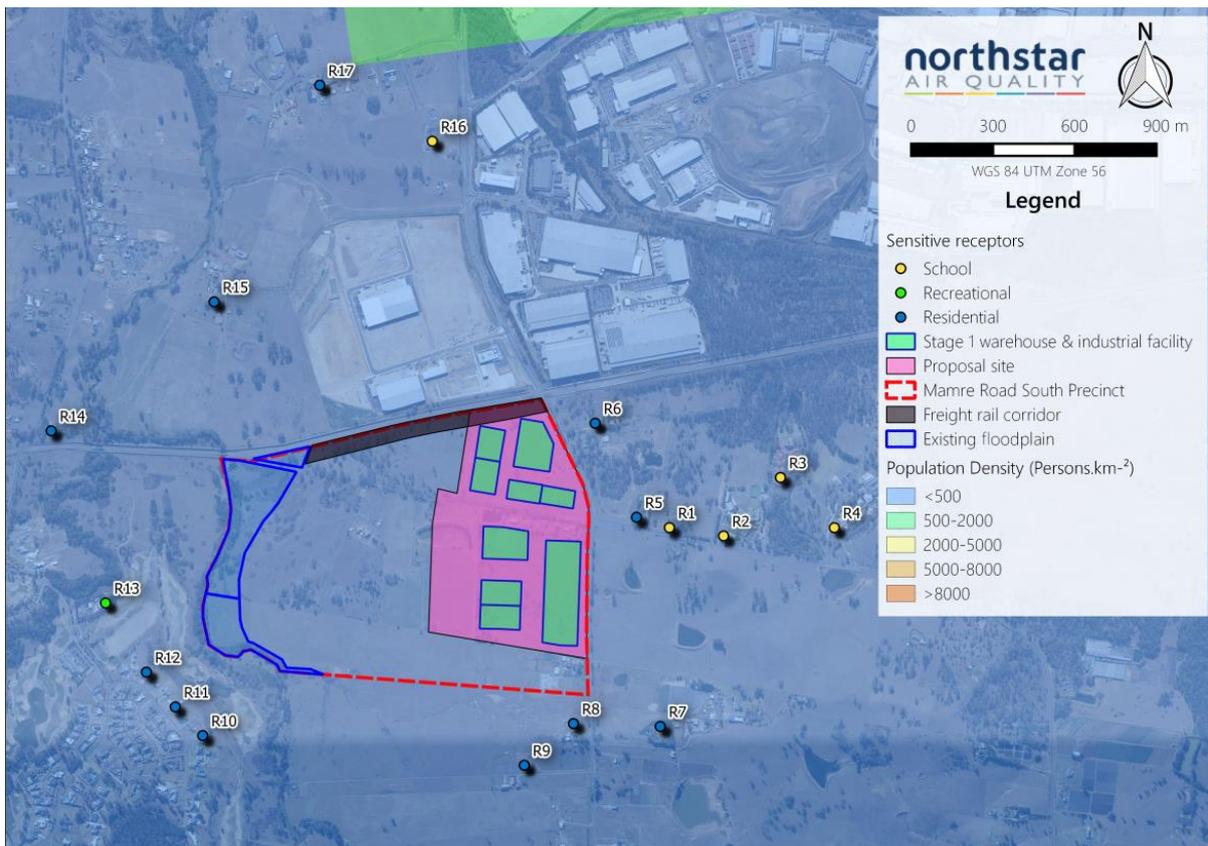


Image courtesy of Google Maps

The Proposal Site and receptors, are located in an area of ‘very low’ to ‘low’ population densities, which would be expected given the largely (currently) rural nature of the immediate area.

In accordance with the requirements of the NSW EPA, several receptor locations (representing educational, recreational and residential locations) have been identified and the receptors adopted for use within this AQIA, are presented in **Table 5**. This selection is derived from the information presented in **Figure 4** and **Figure 5**.

Table 5 is not intended to represent a definitive list of sensitive land uses, but a cross section of available locations, that are used to characterise larger areas, or selected as they represent more sensitive locations, which may represent people who are more susceptible to changes in air pollution.

Table 5 Discrete sensitive receptor locations used in the study

Rec	Location	Land use	Location (UTM)	
			mE	mS
R1	Little Smarties Early Learning Centre	School	294,944	6,254,299
R2	Mamre Anglican School	School	295,143	6,254,273
R3	Trinity Primary School	School	295,348	6,254,492
R4	Emmaus Catholic College	School	295,549	6,254,312
R5	676-702 Mamre Rd Kemps Creek	Residential	294,822	6,254,335

Table 5 - Continued

Rec	Location	Land use	Location (UTM)	
			mE	mS
R6	654-674 Mamre Rd Kemps Creek	Residential	294,663	6,254,677
R7	772-782 Mamre Rd Kemps Creek	Residential	294,926	6,253,569
R8	771-781 Mamre Rd Kemps Creek	Residential	294,607	6,253,572
R9	799-803 Mamre Rd Kemps Creek	Residential	294,430	6,253,415
R10	15 Medinah Ave Luddenham	Residential	293,247	6,253,499
R11	9 Medinah Ave Luddenham	Residential	293,145	6,253,602
R12	3 Medinah Ave Luddenham	Residential	293,036	6,253,727
R13	Golf Course (Maintenance Facility)	Recreational	292,880	6,253,978
R14	320-326 Luddenham Rd Orchard Hills	Residential	292,667	6,254,606
R15	579A Mamre Rd Orchard Hills	Residential	293,255	6,255,093
R16	Old MacDonald's Child Care	School	294,043	6,255,700
R17	53-63 Mandalong Close Orchard Hills	Residential	293,625	6,255,897

Note: The requirements of this AQIA may vary from the specific requirements of other studies, and as such the selection and naming of receptor locations, may vary between technical reports. This does not affect or reduce the validity of those assumptions.

Land to the north (Orchard Hills development) is currently being developed as a warehouse and logistics hub. Land to the north-east is occupied by the Erskine Park Industrial Precinct. Impacts from the Proposal on these areas has been considered through the interpretation of contour plots of predicted impacts, rather than as discrete receptor points, as their sensitivity to impacts is low given the restricted rate of exposure at those non-residential locations.

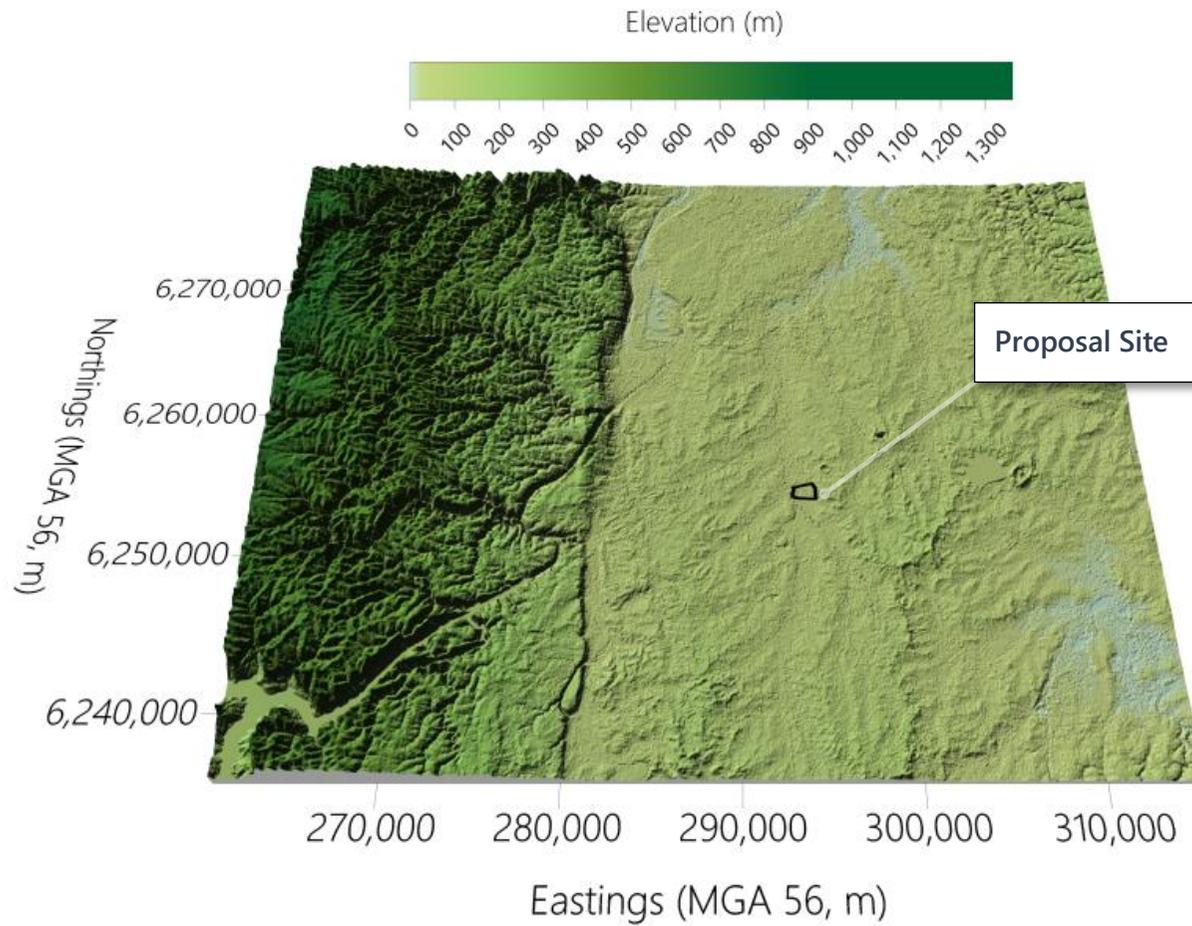
4.1.3. Uniform Receptor Locations

Additional to the sensitive receptors identified in **Section 4.1.2** on P22 earlier in this Report, a grid of uniform receptor locations, has been used in the AQIA to allow presentation of contour plots of predicted impacts.

4.2. Topography

The elevation of the Proposal Site is approximately 60 m to 70 m Australian Height Datum (AHD). The topography between the Proposal Site and nearest sensitive receptor locations, is uncomplicated. A 3-dimensional representation of the topography surrounding the Proposal Site is presented in **Figure 6** overleaf.

Figure 6 Three-dimensional representation of topography surrounding the Proposal Site



Source: Northstar Air Quality

Note: MGA – Map Grid of Australia

4.3. Meteorology

The meteorology experienced within an area, can govern the generation (in the case of wind-dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorological conditions surrounding the Proposal Site, have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at a number of surrounding Automatic Weather Stations (AWS). Meteorology is also measured by the NSW Office of Environment and Heritage (OEH) at a number of Air Quality Monitoring Station (AQMS) surrounding the Proposal Site (refer **Section 4.4** on P28 of this Report).

To provide a characterisation of the meteorology which would be expected at the Proposal Site, a meteorological modelling exercise has also been performed.

A summary of the inputs and outputs of the meteorological modelling assessment, including validation of those outputs is presented in **Appendix A**.

Seven meteorological stations are located within a 17 km radius of the Proposal Site (BoM and OEH operated). A summary of the relevant AWS is provided in **Table 6** below (listed by proximity) and also displayed in **Figure 7** overleaf.

Table 6 Details of meteorological monitoring surrounding the Proposal Site

Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
St Marys AQMS	OEH	293,170	6,258,083	3.9
Horsley Park Equestrian Centre AWS – Station # 67119	BoM	301,710	6,252,290	7.9
Badgerys Creek AWS – Station # 67108	BoM	289,920	6,246,951	8.3
Bringelly AQMS	OEH	293,028	6,244,518	9.7
Prospect AQMS	OEH	306,744	6,258,645	13.5
Penrith Lakes AWS – Station # 67113	BoM	284,866	6,266,510	15.2
Liverpool AQMS	OEH	306,439	6,243,322	16.5

Figure 7 Meteorological monitoring stations surrounding the Proposal Site

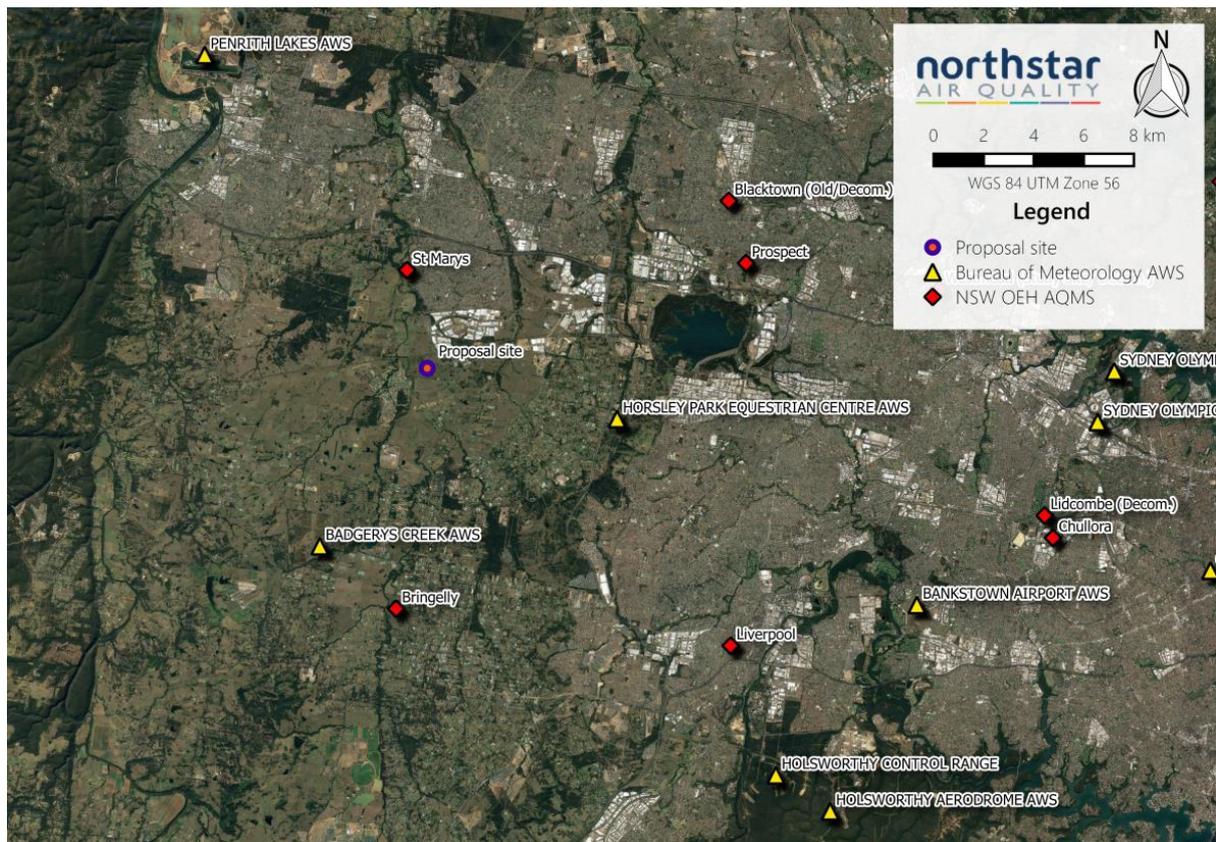


Image courtesy of Google Earth

The meteorological conditions measured at the identified meteorological stations, are presented in **Appendix A**.

It is considered that St Marys AQMS is most likely to represent the conditions at the Proposal Site, based upon its proximity and lack of significant topographical features between the two locations. The wind roses presented in **Appendix A** indicate, that from 2013 to 2017, winds at St Marys AQMS show similar wind distribution patterns across the years assessed, with a predominant south-westerly wind direction.

The majority of wind speeds experienced at St Marys AQMS over the 5-year period, 2013 to 2017, are generally in the range <0.5 metres per second ($m \cdot s^{-1}$) to $5.5 m \cdot s^{-1}$ with the highest wind speeds (greater than $8 m \cdot s^{-1}$) occurring from a south-westerly direction. Winds of this speed are not frequent, occurring $<0.1\%$ of the observed hours over the 5-year period, at St Marys. Calm winds ($<0.5 m \cdot s^{-1}$) occur during 32.5% of hours on average across the 5-year period.

Given the wind distributions across the years examined, data for the year 2014 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied. Reference should be made to **Appendix A** for further details.

4.4. Air Quality

The air quality experienced at any location will be a result of emissions generated by natural and anthropogenic sources on a variety of scales (local, regional and global). The relative contributions of sources at each of these scales to the air quality at a location, will vary based on a wide number of factors including the type, location, proximity and strength of the emission source(s), prevailing meteorology, land uses and other factors affecting the emission, dispersion and fate of those pollutants.

When assessing the impact of any particular source of emissions on the potential air quality at a location, the impact of all other sources of an individual pollutant, should also be assessed. This 'background' (sometimes called 'baseline') air quality will vary depending on the pollutants to be assessed and can often be characterised by using representative air quality monitoring data.

The Proposal Site is located proximate to a number of AQMS operated by NSW OEH. These locations (listed by proximity) are briefly summarised in **Table 7** and presented in **Figure 7**.

Table 7 Closest OEH AQMS to the Proposal Site

AQMS Location	Data Availability	Distance to Site (km)	Screening Parameters					
			2014 Data	Measurements				
				PM ₁₀	PM _{2.5}	TSP	NO ₂	O ₃ ^(A)
St Marys	1992 - 2018	3.9	✓	✓	✗	✗	✓	✓
Bringelly	1992 - 2018	9.7	✓	✓	✗	✗	✓	✓
Prospect	2007 - 2018	13.5	✓	✓	✗	✗	✓	✓
Liverpool	1988 - 2018	16.5	✓	✓	✓	✗	✓	✓

Note: A Ozone (O₃) data used to assist in the conversion of predicted NO_x concentrations to NO₂

The closest active AQMS is noted to be located at St Marys, and is generally considered to be the monitoring location most reflective of the conditions at the Proposal Site.

Appendix B provides a detailed assessment of the background air quality monitoring data collected at the St Marys AQMS. As PM_{2.5} was not measured at St Marys in 2014, the data has been taken from the Liverpool AQMS, being the next proximate operating AQMS location with the available data.

It is noted that none of the AQMS, measure Total Suspended Particulate (TSP) which is of relevance to the expected emissions from the Proposal Site. Based upon long-term historic monitoring data, a numerical relationship between TSP and PM₁₀ has been established for the Sydney Metropolitan region. Based upon these data a relationship between ambient concentrations of TSP : PM₁₀ of 2.0551 : 1 is used to approximate background annual average TSP concentrations. This relationship is established and is used frequently to approximate background annual average TSP concentrations in similar locations (see **Appendix B**).

The impact assessment criteria used for deposited dust (see **Table 4** on P17) are presented as (i) a cumulative deposition rate of $4 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$ and (ii) a discrete deposition rate of $2 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$. In lieu of a background deposition rate to derive a cumulative rate, the incremental impact assessment criterion ($2 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$) will be used. This is a commonly adopted approach when background deposition rates are not available.

A detailed summary of the background air quality is presented in **Appendix B**, and a summary of the air quality monitoring data and assumptions used in this assessment are presented in **Table 8**.

Table 8 Summary of background air quality used in the AQIA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP) (derived from PM ₁₀)	Annual $\mu\text{g}\cdot\text{m}^{-3}$	34.4	Estimated on a TSP:PM ₁₀ ratio of 2.0551 : 1
Particles (as PM ₁₀) (St Marys)	24-hour $\mu\text{g}\cdot\text{m}^{-3}$	Daily Varying	The 24-hour maximum for PM ₁₀ in 2014 was $45.0 \mu\text{g}\cdot\text{m}^{-3}$
	Annual $\mu\text{g}\cdot\text{m}^{-3}$	16.7	
Particles (as PM _{2.5}) (Liverpool)	24-hour $\mu\text{g}\cdot\text{m}^{-3}$	Daily Varying	The 24-hour maximum for PM _{2.5} in 2014 was $24.3 \mu\text{g}\cdot\text{m}^{-3}$
	Annual $\mu\text{g}\cdot\text{m}^{-3}$	8.6	
Dust deposition	Annual $\text{g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$	2.0	Difference in NSW OEH maximum allowable and incremental impact criterion
Ozone (O ₃) (St Marys)	1-hour $\mu\text{g}\cdot\text{m}^{-3}$	214.0	Hourly max 1-hr average in 2014
	4-hours $\mu\text{g}\cdot\text{m}^{-3}$	181.4	Hourly max 4-hr average in 2014
Nitrogen dioxide (NO ₂) (St Marys)	1-hour $\mu\text{g}\cdot\text{m}^{-3}$	63.6	Hourly max 1-hr average in 2014
	Annual $\mu\text{g}\cdot\text{m}^{-3}$	7.1	Annual average in 2014

Note: Reference should be made to **Appendix B**

The AQIA has been performed to assess the contribution of the Proposal to the air quality of the surrounding area. A full discussion of how the Proposal impacts upon the air quality is presented in **Section 6** (on P39 of this Report).

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5. Methodology

5.1. Construction Phase

Construction phase activities have the potential to generate short-term emissions of particulates. Generally, these are associated with uncontrolled (or 'fugitive') emissions and are typically experienced by neighbours as amenity impacts, such as dust deposition and visible dust plumes, rather than associated with health-related impacts. Localised engine-exhaust emissions from construction machinery and vehicles may also be experienced, but given the very minor scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts.

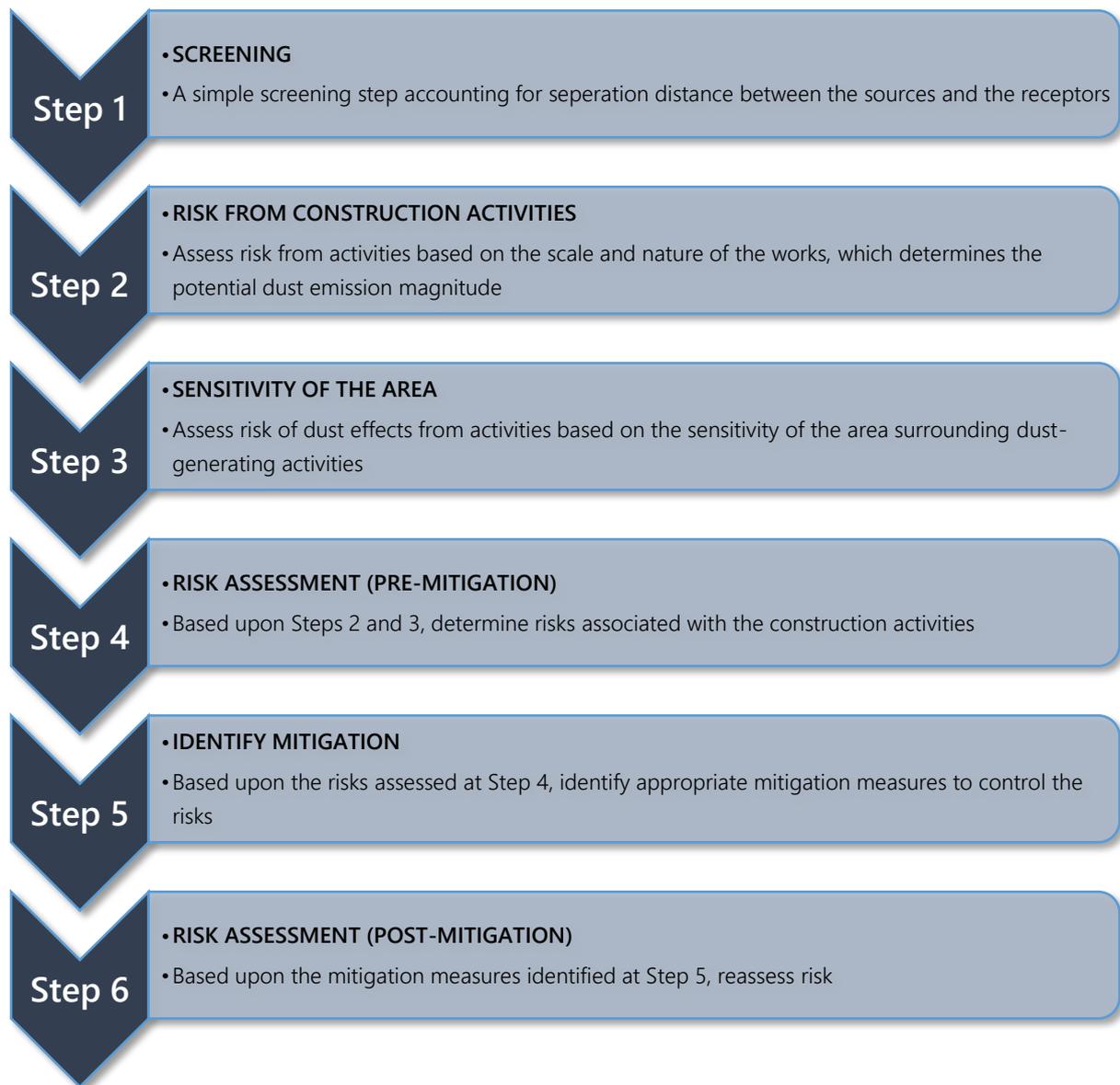
Modelling of dust from construction Proposals is generally not considered appropriate, as there is a lack of reliable emission factors from construction activities upon which to make predictive assessments, and the rates would vary significantly, depending upon local conditions. In lieu of a modelling assessment, the construction-phase impacts associated with the Proposal have been assessed using a risk-based assessment procedure. The advantage of this approach is that it determines the activities that pose the greatest risk, which allows the Construction Environmental Management Plan (CEMP) to focus controls to manage that risk appropriately and reduce the impact through proactive management.

For this risk assessment, Northstar has adapted a methodology presented in the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (IAQM)¹. Reference should be made to **Appendix C** for the methodology.

Briefly, the adapted method uses a six-step process for assessing dust impact risks from construction activities, and to identify key activities for control, as illustrated in **Figure 8** (overleaf).

¹ www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf

Figure 8 Construction phase impact risk assessment methodology



The assessment approach, as illustrated above in **Figure 8**, is detailed in **Appendix C**.

5.2. Operational Phase

5.2.1. Dispersion Modelling

A Dispersion Modelling Assessment has been performed using the NSW EPA approved CALPUFF Atmospheric Dispersion Model. The modelling has been performed in CALPUFF 2-dimensional (2-D) mode. Given the flat (uncomplex) terrain and the proximity of the receptors to the Proposal Site, a detailed assessment using a 3-D meteorological dataset is not warranted.

The 2-D meteorological dataset has been developed using The Air Pollution Model (TAPM, v 4.0.5) (see **Appendix A** for further information).

An assessment of the impacts of the operation of activities at the Proposal Site has been performed, which characterises the likely day-to-day (and hour-to-hour) operation, approximating average operational characteristics which are appropriate to assess against longer term (annual average) and shorter term (24-hr and 1-hr) criteria for emissions to air.

The modelling scenario provides an indication of the air quality impacts of the operation of activities at the Proposal Site. Added to these impacts, are background air quality concentrations (where available and discussed in **Section 4.4** and **Appendix B**) which represent the air quality which may be expected within the area surrounding the Proposal Site, without the impacts of the Proposal itself.

The following provides a description of the determination of appropriate emissions of air pollutants resulting from the operation of the Proposal.

5.2.2. Emissions Estimation

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors, which appropriately represent the processes under assessment. This assessment has adopted emission factors from the US EPA AP42 emission factor compendium (US EPA, various) specifically Chapter 13 (Miscellaneous Sources) (USEPA, 2011) for the assessment of particulate matter emissions resulting from the use of paved roads by delivery vehicles. To account for gaseous emissions (of NO_x/NO_2) and particulate matter, resulting from idling vehicles at the delivery bays at each warehouse and industrial facility, emissions have been calculated using emission factors adopted from the US EPA document "*Idling Vehicle Emissions for Passenger Cars Light-Duty Trucks, and Heavy-Duty Trucks*" (USEPA, 2008).

Data has been provided by the proponent to approximate the activities being performed at the Proposal Site on a day-to-day basis. These data, and the relevant emission factors associated with each activity are presented in **Table 9** and in **Table 10** (on pp 34-35). Activity data associated with the activities is presented in **Table 11** and in **Table 12** (on pp 36-37).

Trip generation rates for each warehouse and industrial facility have been calculated using data adopted within the Traffic Impact Assessment for the Proposal (Ason Group, 2018) and a recent proposal (Ason Group, 2016) which indicates that an average of 2.38 vehicle trips per 100 m² of gross floor area (GFA) per day would be likely to be generated by a development of this nature (average of the following three developments):

- Wonderland Business Park - 2.308 veh·day⁻¹ (Ason Group, 2016),
- Erskine Park Industrial Estate 1.892 veh·day⁻¹ (Ason Group, 2016); and,
- Riverwood Business Park 2.64 veh·day⁻¹ (Ason Group, 2018).

It is assumed that 95% of these vehicles would be associated with the warehouses (Ason Group, 2018).

A total of 116 loading bays across 9 warehouses and industrial facilities have been calculated to be associated with the Proposal (average of 12 to 13 loadings bays per warehouse). The likelihood that all 116 bays would be occupied by vehicles at any one time is extremely unlikely. Furthermore, the likelihood that all of those 116 vehicles would be idling is more unlikely still. However, this assessment needs to assess a potential likely worst-case scenario, especially to allow determination of the possible short term (1-hour) impacts at nearby receptor locations.

An assumption has been made that all 116 bays would be occupied simultaneously, and that the vehicles would be idling for a period of 10 minutes within each hour.

Operators of trucks actively seek to reduce operational costs and a reduction in vehicle idling time also presents associated reductions in fuel use and engine wear. Engine idling time can be reduced through:

- implementation of operational efficiencies (booking systems, parking rather than queueing vehicles, expanded hours of operation to avoid peak periods);
- the use of idle-off devices; and,
- the use of Auxiliary Power Units (APUs).

The above measures are sought to be adopted through the Green Truck Partnership, an RMS and road transport industry alliance. Steering group members of the Green Truck Partnership include Australia Post, Coles and TOLL ²

Given that a reduction in engine idling is being targeted by the road transport industry, the assumptions outlined above can be considered to be conservative in nature.

Table 9 Emission factors, particulate matter – vehicle transport

Source	Activity rate	Units	Emission factor source	Emission factor			Units
				TSP	PM ₁₀	PM _{2.5}	
Trucks entering / leaving Proposal Site	Various (see Table 11)	VKT·hr ⁻¹	AP42 - 13.2.1 Paved Roads Assumed silt loading of road is 0.015 g·m ⁻² (ubiquitous baseline, >10,000 AADT flow, limited access (USEPA, 2011)). Average vehicle weight assumed to be 29 t (70% Pick Up and Delivery [PUD] vehicles at average of 20 t, 30% B-Double at average of 50 t).	2.42	0.46	0.11	VKT·hr ⁻¹

² <http://www.rms.nsw.gov.au/about/environment/air/green-truck-partnership/index.html>

Table 10 Emission factors – gaseous and particulate matter emissions, diesel engines

Source	Activity rate	Units	Vehicle type	Op. hours	Emission factor source	NO _x emission factor (g·hr ⁻¹)	PM ₁₀ emission factor (g·hr ⁻¹)	PM _{2.5} emission factor (g·hr ⁻¹)
Trucks idling in bays at warehouses and industrial facilities	Various (see Table 12) ^(A)	veh·hr ⁻¹	PUD	24	(USEPA, 2008).	3.705	-	-
			B-Double	24		33.763	1.196	1.1
			Average	24		24.746	0.837	0.77

Notes: A Vehicles assumed to be idling for a 10-minute period each hour

Table 11 Emission estimation, particulate matter - vehicle transport

Facility number	Area of facility (m ²)	Number of daily trips	Distance of road from Proposal Site entrance to facility (m) (1-way)	VKT·day ⁻¹ (A)	TSP emission rate (kg·year ⁻¹) (A)	PM ₁₀ emission rate (kg·year ⁻¹) (A)	PM _{2.5} emission rate (kg·year ⁻¹) (A)
8	18,480	400	1,199	479.9	17.7	3.4	0.8
9	13,020	282	1,149	324.0	11.9	2.3	0.6
10	12,785	277	902	249.8	9.2	1.8	0.4
11A	24,098	522	1,110	579.4	21.3	4.1	1.0
11B	24,243	525	706	370.7	13.7	2.6	0.6
31	11,120	241	1495	360.1	13.3	2.5	0.6
32	11,120	241	1,242	299.1	11.0	2.1	0.5
33	21,900	474	1,362	646.1	23.8	4.6	1.1
35	8,790	190	1,139	216.9	8.0	1.5	0.4
36	8,790	190	1,387	264.1	9.7	1.9	0.5

Notes: A: VKT and emissions presented as two-way totals

Table 12 Emission estimation – gaseous and particulate matter emissions, diesel engines

Facility number	Number of vehicle bays	NO _x emission rate (kg-year ⁻¹) ^(A)	PM ₁₀ emission rate (kg-year ⁻¹) ^(A)	PM _{2.5} emission rate (kg-year ⁻¹) ^(A)
8	11	381.5	12.9	11.9
9	10	346.8	11.7	10.8
10	12	416.2	14.1	13.0
11A	14	485.6	16.4	15.1
11B	15	520.3	17.6	16.2
31	10	346.8	11.7	10.8
32	10	346.8	11.7	10.8
33	16	554.9	18.8	17.3
35	9	554.9	18.8	17.3
36	9	312.2	10.6	9.7

Notes: A: Vehicles assumed to be idling for a 10-minute period each hour

The emissions estimation as outlined above represents the proposed development. The results presented in **Section 7** are associated with a slightly altered previous layout (associated with minor changes to warehouse layouts in the northern and south-eastern portion of the Proposal Site). The minor changes have been reviewed and result in a lower total emission rate from the Proposal in its current form when compared to this previous layout (e.g. TSP emission rates associated with road transport are calculated to be approximately 7% lower). The results presented in **Section 7** can therefore be viewed as being marginally conservative.

In the interests of full transparency, the emissions inventory for the previous layout as modelled are presented in **Appendix D**.

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6. Construction Air Quality Impact Assessment

The methodology used to assess construction phase risk is discussed in **Section 5.1** and **Appendix C**.

Briefly, after 'Step 1 Screening' (which excludes those receptors that are sufficiently distanced from construction phase activities to not warrant further assessment) *risk* is determined by the product of *receptor sensitivity* and the identified *magnitude of impacts* associated with the construction phase activities (construction, track-out, demolition and earthworks [as applicable]). The definitions used to screen receptors, determine receptor sensitivity and the magnitude of impacts are all presented in **Appendix C**.

6.1. Screening Based on Separation Distance

The screening criteria applied to the identified sensitive receptors, are whether they are located in excess of:

- 50 m from the route used by construction vehicles on public roads.
- 350 m from the boundary of the site.
- 500 m from the site entrance.
- Track-out is assumed to affect roads up to 100 m from the site entrance.

Further to the above distance-based screening criteria, the construction activities are screened by the required construction activities.

Table 13 overleaf presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table 13 Construction phase impact screening criteria distances

Rec	Location	Land Use	Screening Distance (m)		
			Boundary (350m)	Site Entrance (500m)	Construction route (50m)
R1	Little Smarties Early Learning Centre	School	297	299	292
R2	Mamre Anglican School	School	497	500	493
R3	Trinity Primary School	School	712	722	707
R4	Emmaus Catholic College	School	902	904	896
R5	676-702 Mamre Rd Kemps Creek	Residential	175	177	169
R6	654-674 Mamre Rd Kemps Creek	Residential	138	355	135
R7	772-782 Mamre Rd Kemps Creek	Residential	366	804	804
R8	771-781 Mamre Rd Kemps Creek	Residential	244	751	751
R9	799-803 Mamre Rd Kemps Creek	Residential	425	932	933
R10	15 Medinah Ave Luddenham	Residential	912	1,623	1,624
R11	9 Medinah Ave Luddenham	Residential	969	1,665	1,666
R12	3 Medinah Ave Luddenham	Residential	1,046	1,717	1,718
R13	Golf Course (Maintenance Facility)	Recreational	1,189	1,799	1,771
R14	320-326 Luddenham Rd Orchard Hills	Residential	1,436	1,999	1,688
R15	579A Mamre Rd Orchard Hills	Residential	1,021	1,590	970
R16	Old MacDonald's Child Care	School	998	1,504	122
R17	53-63 Mandalong Close Orchard Hills	Residential	1,316	1,877	529

With reference to **Table 13**, sensitive receptors are noted to be within the screening distance boundaries and therefore require further assessment as summarised in **Table 14**.

Table 14 Application of Step 1 Screening

Construction Impact	Screening Criteria	Step 1 Screening	Comments
Demolition	350 m from boundary 500 m from site entrance	Not screened	Receptors identified within the screening distance
Earthworks	350 m from boundary 500 m from site entrance		
Construction	350 m from boundary 500 m from site entrance		
Trackout	100 m from site entrance	Screened	Trackout screened as receptors > 100m from site entrance.
Construction Traffic	50 m from roadside	Screened	Construction traffic screened as receptors > 50m from road side.

6.2. Impact Magnitude

The footprint of Stage 1 (the area affected) is estimated as being approximately 600 m x 730 m = 438,000 m² (43.8 hectares [ha]) in area.

The Proposal would involve demolition of a small number of current residences within the area, earthworks for the Proposal Site area and the construction of 10 warehouse and industrial facilities with an approximate (total) building volume of 1,555,000 m³.

The assumed supply route around the Proposal Site during construction works may be up 3,000 m in two-way length. It is anticipated that more than 50 heavy vehicle movements per day would be required each day to service the Proposal Site. For the purposes of the assessment, the route for construction traffic to/from the Proposal Site is assumed to be along arterial roads, heading northbound along Mamre Road towards the M4 Western Motorway.

Based upon the above assumptions and the assessment criteria presented in **Appendix C**, the dust emission magnitudes are as presented in **Table 15** (below). It is noted that the dust-emission magnitudes, assume that construction would be performed across the entire area subject to this SSD at one time. This is highly unlikely to occur.

Table 15 Construction phase impact categorisation of dust emission magnitude

Activity	Dust Emission Magnitude
Demolition	Medium
Earthworks and enabling works	Large
Construction	Large
Track-out	N/A
Construction traffic routes	N/A

6.3. Sensitivity of an Area

6.3.1. Land Use Value

The assessment criteria as described in **Section 6** (on P40), including the conditions pertaining to *land use value* of the area surrounding the Proposal Site, is provided in detail in **Appendix C** of this report.

It is concluded to be *medium* for health impacts and for dust soiling, given that the distance between the receptors and the Proposal Site, the nature of receptors surrounding the site and the background PM₁₀ annual average concentration of 16.7 µg.m⁻³ as measured at St Marys in 2014 and as reported in **Section 4.4** (on P28).

6.3.2. Sensitivity of an Area

The assessment criteria as described in **Section 6** (on P40), including the conditions pertaining to *sensitivity of the area* surrounding the Proposal Site, is provided in detail in **Appendix C** of this report.

The sensitivity of the surrounding area to health effects and dust soiling may be identified as being *low*. The assumed existing background annual average PM₁₀ concentrations (as measured at St Marys in 2014) are reported in **Section 4.4** (on P28) and presented in **Table 7** (on P28). The annual average PM₁₀ concentration as measured at St Marys in 2014 was 16.7 µg.m⁻³, which classifies the sensitivity of the area as *low* for dust health impacts.

6.4. Risk (Pre-Mitigation)

Given the sensitivity of the identified receptors is classified as ‘low’ for dust soiling, and ‘low’ for health effects, and the dust emission magnitudes for the various construction phase activities as shown in **Table 15** (on P41), the resulting risk of air quality impacts (without mitigation) is as presented in **Table 16** (below).

Table 16 Risk of air quality impacts from construction activities

Impact	Sensitivity of Area	Dust Emission Magnitude					Preliminary Risk				
		Demolition	Earthworks	Construction	Track-out	Const. Traffic	Demolition	Earthworks	Construction	Track-out	Const. Traffic
Dust Soiling	low	medium	large	large	-	-	low	low	low	-	-
Human Health	low	medium	large	large	-	-	low	low	low	-	-

The risks summarised in **Table 16** (above) show that there is a *low* risk of adverse dust soiling and human health impacts at all properties, if no mitigation measures were to be applied to control emissions associated with construction-phase activities.

6.5. Identified Mitigation

The following represents a selection of recommended mitigation measures recommended by the IAQM methodology for a *low* risk site for construction and construction traffic. A detailed review of the recommendations would be performed once details of the construction phase are available.

Table 17 lists the relevant mitigation measures identified, and have been presented as follows:

- **N** = not required (although they may be implemented voluntarily).
- **D** = desirable (to be considered as part of the CEMP, but may be discounted if justification is provided).
- **H** = highly recommended (to be implemented as part of the CEMP, and should only be discounted if site-specific conditions render the requirement invalid or otherwise undesirable).

Table 17 Site-specific management measures

Identified Mitigation		Unmitigated Risk
		Low
1 Communications		
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	N
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H
1.2	Display the head or regional office contact information.	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	D
2 Site Management		
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	H
2.2	Make the complaints log available to the local authority when asked.	H
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	H

Identified Mitigation		Unmitigated Risk
		Low
2.4	Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.	N
3 Monitoring		
3.1	Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary.	D
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to the local authority when asked.	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H
4 Preparing and Maintaining the Site		
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	H
4.2	Avoid site runoff of water or mud after treatment and cleaning.	H
4.3	Keep site fencing, barriers and scaffolding clean using wet methods.	D
4.4	Cover, seed or fence stockpiles to prevent wind erosion	D
5 Operating Vehicle/Machinery and Sustainable Travel		
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles	H
5.3	Impose and signpost a maximum-speed-limit of 25 km·h ⁻¹ on surfaced and 15 km·h ⁻¹ on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	D
5.4	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	N
5.5	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	N
6 Operations		
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	H

Identified Mitigation		Unmitigated Risk
		Low
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	H
6.3	Use enclosed chutes and conveyors and covered skips	H
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	H
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	D
7 Waste Management		
7.1	Avoid bonfires and burning of waste materials.	H
8 Measures Specific to Demolition		
8.1	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	D
8.2	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	H
8.3	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	H
8.4	Bag and remove any biological debris or damp down such material before demolition.	H
8.5	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	N
8.6	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	N
8.7	Only remove the cover in small areas during work and not all at once	N
9 Measures Specific to Construction		
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	D
8.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	D
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N
8.4	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust	N

Identified Mitigation		Unmitigated Risk
		Low
10	Measures Specific to Track-Out	
10.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D
10.2	Avoid dry sweeping of large areas.	D
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D
10.6	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.	N
10.7	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	D
10.8	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	N
10.9	Access gates to be located at least 10 m from receptors where possible.	N
11	Specific Measures to Construction Traffic (adapted)	
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D

Notes D = desirable (to be considered), H = highly recommended (to be implemented), N = not required (although can be voluntarily implemented)

6.6. Risk (Post-Mitigation)

For almost all construction activity, the adapted methodology notes that the aim should be to prevent significant effects on receptors through the use of effective mitigation and experience shows that this is normally possible.

Given the size of the Proposal Site, the distance to sensitive receptors and of the activities to be performed, residual impacts associated with fugitive dust emissions from the Proposal, would be anticipated to be 'low'.

7. Operational Air Quality Impact Assessment

The methodology used to assess operational phase impacts is discussed in **Section 5**. This section presents the results of the dispersion modelling assessment and uses the following terminology:

- **Incremental impact** – relates to the concentrations predicted as a result of the operation of the proposal in isolation.
- **Cumulative impact** – relates to the concentrations predicted as a result of the operation of the proposal PLUS the background air quality concentrations discussed in **Section 4.4** (on P28).

The results are presented in this manner to allow examination of the likely impact of the proposal in isolation and the contribution to air quality impacts in a broader sense.

In the presentation of results, the tables included shaded cells which represent the following:

Model prediction	Pollutant concentration / deposition rate less than the relevant criterion	Pollutant concentration / deposition rate equal to, or greater than the relevant criterion
------------------	--	--

The results presented in the following sections are associated with a slightly different Proposal layout to that presented above and are associated with minor changes to warehouse layouts in the northern portion of the Proposal Site. The minor changes have been reviewed and result in a lower total emission rate from the Proposal in its current form (e.g. TSP emission rates associated with road transport are calculated to be approximately 7% lower). The results below can therefore be viewed as being marginally conservative.

7.1. Particulate Matter

Results are presented in this section for the predictions of particulate matter (TSP, PM₁₀, PM_{2.5} and dust deposition). The averaging periods associated with the criteria for these pollutants is 24-hour and annual averages, as specified in **Table 4** (on P17). The emissions adopted for this scenario reflect the operational profile of the Proposal over those averaging periods (refer **Section 5.2.2** on P33), notwithstanding the note above regarding the minor changes to the Proposal layout.

7.1.1. Annual Average TSP, PM₁₀ and PM_{2.5}

The predicted annual average particulate matter concentrations (as TSP, PM₁₀ and PM_{2.5}) resulting from the Proposal operations, are presented in **Table 18** overleaf.

The results indicate that predicted incremental concentrations of TSP, PM₁₀ and PM_{2.5} at residential receptor locations are low (<1.5% of the annual average TSP criterion, <1.5% of the annual average PM₁₀ criterion and <1.5% of the PM_{2.5} criterion).

The addition of existing background concentrations (refer **Section 4.4** on P28) results in predicted concentrations of annual average TSP being less than 4% and annual average PM₁₀ being less than 57% of the relevant criteria, at the nearest residential receptors.

The existing adopted annual average PM_{2.5} background concentration, is shown to be in exceedance of the relevant criterion, even without the operation of the Proposal added. Examination of the predicted PM_{2.5} impacts which would result from the operation of the Proposal, indicates that these concentrations are predicted to be ≤0.1 µg·m⁻³ at all surrounding receptors.

The performance of the Proposal does not in itself result in any exceedances of the annual average particulate matter impact assessment criteria.

Table 18 Predicted annual average TSP, PM₁₀ and PM_{2.5} concentrations

Receptor	Annual Average Concentration (µg·m ⁻³)								
	TSP			PM ₁₀			PM _{2.5}		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	0.4	34.3	34.6	0.1	16.7	16.8	<0.1	8.6	8.7
R2	0.2	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R3	0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R4	<0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R5	0.7	34.3	34.9	0.2	16.7	16.9	<0.1	8.6	8.7
R6	1.0	34.3	35.2	0.4	16.7	17.0	0.1	8.6	8.8
R7	0.2	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R8	0.9	34.3	35.2	0.3	16.7	17.0	<0.1	8.6	8.7
R9	0.7	34.3	34.9	0.2	16.7	16.9	<0.1	8.6	8.7
R10	<0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R11	<0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R12	<0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R13	<0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R14	<0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R15	0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
R16	0.2	34.3	34.5	0.1	16.7	16.8	<0.1	8.6	8.7
R17	0.1	34.3	34.4	<0.1	16.7	16.8	<0.1	8.6	8.7
Criterion	-	90		-	25		-	8	

No contour plots of annual average TSP, PM₁₀ or PM_{2.5} are presented, given the minor contribution from the Proposal at the nearest relevant sensitive receptors.

7.1.2. Annual Average Dust Deposition Rates

Table 19 below presents the annual average dust deposition predicted as a result of the operations at the Proposal Site. An assumed background dust deposition of 2 g·m⁻²·month⁻¹ is presented in **Table 19**, although comparison of the incremental concentration with the incremental criterion of 2 g·m⁻²·month⁻¹ is also valid (as discussed within **Section 4.4**). In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the Proposal Site where the predicted impacts are less than 5% of the incremental criterion at receptor locations.

No contour plot of annual average dust deposition is presented, given the minor contribution from the Proposal at the nearest sensitive receptors.

The performance of the Proposal does not result in any exceedances of the annual average dust deposition impact assessment criteria.

Table 19 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition (g·m ⁻² ·month ⁻¹)		
	Incremental Impact	Background	Cumulative Impact
R1	<0.1	2.0	2.1
R2	<0.1	2.0	2.1
R3	<0.1	2.0	2.1
R4	<0.1	2.0	2.1
R5	<0.1	2.0	2.1
R6	<0.1	2.0	2.1
R7	<0.1	2.0	2.1
R8	<0.1	2.0	2.1
R9	<0.1	2.0	2.1
R10	<0.1	2.0	2.1
R11	<0.1	2.0	2.1
R12	<0.1	2.0	2.1
R13	<0.1	2.0	2.1
R14	<0.1	2.0	2.1
R15	<0.1	2.0	2.1

Receptor	Annual Average Dust Deposition ($\text{g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R16	<0.1	2.0	2.1
R17	<0.1	2.0	2.1
Criterion	2.0	-	4.0

7.1.3. Maximum 24-Hour PM_{10} and $\text{PM}_{2.5}$

Table 20 below presents the maximum 24-hour average PM_{10} and $\text{PM}_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the Proposal operations. No background concentrations are included within this table.

Table 20 Predicted maximum incremental 24-hour PM_{10} and $\text{PM}_{2.5}$ concentrations

Receptor	Maximum 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM_{10}	$\text{PM}_{2.5}$
R1	1.1	0.4
R2	0.7	0.3
R3	0.6	0.2
R4	0.5	0.2
R5	1.7	0.6
R6	1.7	0.7
R7	0.7	0.3
R8	1.9	0.6
R9	1.5	0.5
R10	0.3	0.1
R11	0.3	0.1
R12	0.3	0.1
R13	0.4	0.1
R14	0.3	0.1
R15	0.4	0.2
R16	0.5	0.2
R17	0.5	0.2

The predicted incremental concentration of PM₁₀ and PM_{2.5}, are demonstrated to be small (refer **Table 20** above). At the receptor where the maximum incremental 24-hour PM₁₀ impact is expected to occur (R8), the operation of the Proposal contributes 3.8% to the 24-hour PM₁₀ criterion and 2.8% of the 24-hour PM_{2.5} criterion, at Receptor R6.

The predicted maximum 24-hour average PM₁₀ and PM_{2.5} concentrations resulting from the operation of the Proposal, with background included are presented in **Table 21** and **Table 22** (overleaf) respectively. These results as presented, demonstrate that even with the addition of background concentrations, the cumulative impacts are not in exceedance of the relevant criterion.

The performance of the Proposal, does not result in any exceedances of the maximum 24-hour average particulate matter impact assessment criteria.

Results are presented in **Table 21** and **Table 22** (below and overleaf) for those receptors at which the greatest impacts have been predicted (refer to **Table 20** on P50).

The left side of the tables show the predicted concentration on days with the highest regional background, and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations respectively.

The analysis indicates that no exceedances of the 24-hour average impact assessment criteria for PM₁₀ or PM_{2.5} are likely to occur, as a result of the operation of the Proposal. Examination of the results for all receptors indicates, that no exceedances of the PM₁₀ or PM_{2.5} criteria are predicted at any receptor location.

Table 21 Summary of contemporaneous impact and background – PM₁₀ Receptor R8

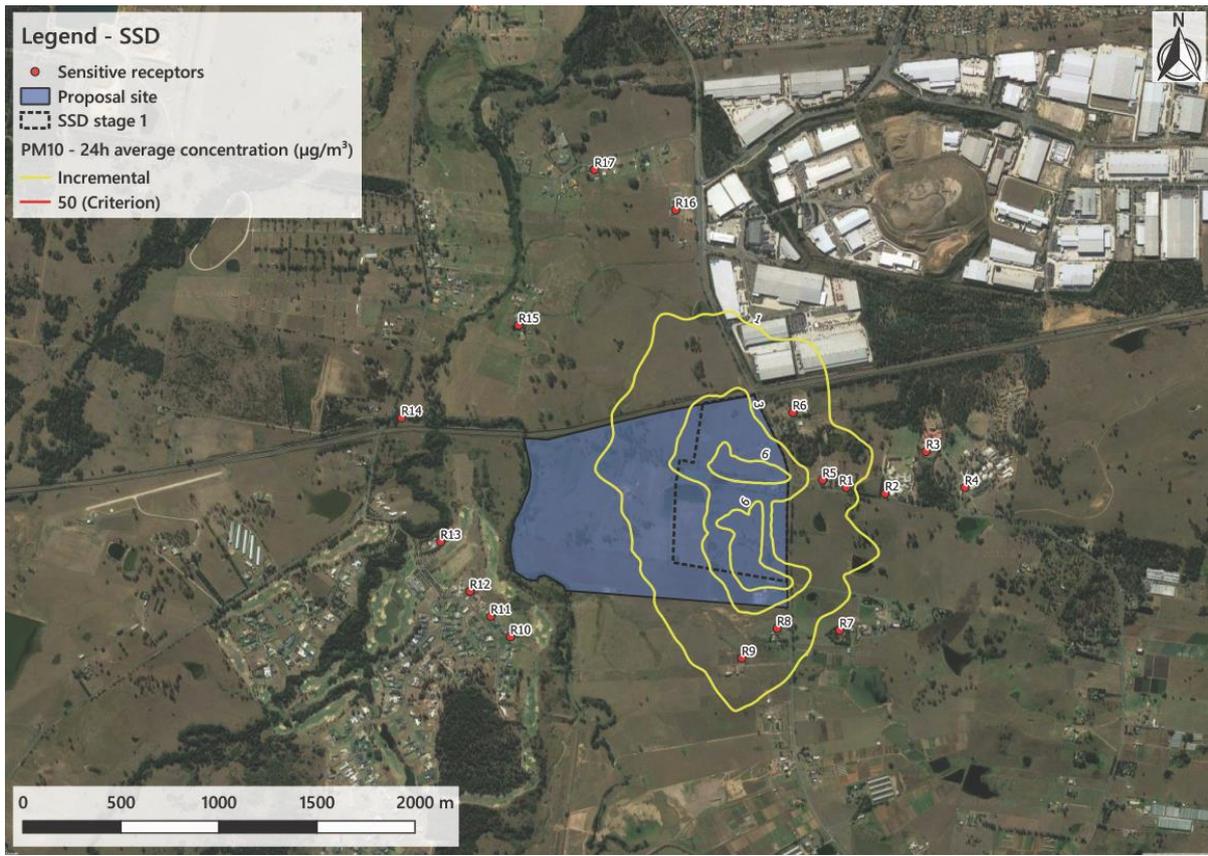
Date	24-hour average PM ₁₀ concentration (µg·m ⁻³)			Date	24-hour average PM ₁₀ concentration (µg·m ⁻³)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
6/08/2014	0.2	45.0	45.2	10/05/2014	1.9	33.9	35.8
23/05/2014	1.3	43.0	44.3	9/07/2014	1.9	18.7	20.6
10/02/2014	<0.1	43.9	44.0	20/06/2014	1.7	13.7	15.4
17/12/2014	0.1	38.0	38.1	28/03/2014	1.6	14.7	16.2
31/12/2014	<0.1	37.1	37.2	2/06/2014	1.5	9.1	10.6
11/02/2014	<0.1	36.5	36.6	26/04/2014	1.4	15.8	17.2
10/05/2014	1.9	33.9	35.8	15/03/2014	1.4	14.8	16.2
15/11/2014	<0.1	32.8	32.9	19/05/2014	1.3	23.1	24.4
4/10/2014	0.2	32.6	32.8	23/05/2014	1.3	43.0	44.3
2/01/2014	0.6	32.1	32.7	23/06/2014	1.2	9.8	11.0
These data represent the highest Cumulative Impact 24-hour PM ₁₀ predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour PM ₁₀ predictions (outlined in blue) as a result of the operation of the Proposal.			

Table 22 Summary of contemporaneous impact and background – PM_{2.5} Receptor R6

Date	24-hour average PM _{2.5} concentration (µg·m ⁻³)			Date	24-hour average PM _{2.5} concentration (µg·m ⁻³)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
3/07/2014	0.2	24.3	24.5	4/06/2014	0.7	6.5	7.2
12/10/2014	<0.1	21.3	21.4	6/05/2014	0.6	6.6	7.2
6/08/2014	0.5	20.7	21.2	16/10/2014	0.5	6.8	7.3
8/07/2014	0.2	20.3	20.5	19/09/2014	0.5	7.4	7.9
18/05/2014	0.2	20.1	20.3	2/10/2014	0.5	4.3	4.8
9/08/2014	0.1	19.5	19.6	7/07/2014	0.5	9.5	10.0
4/07/2014	0.1	19.3	19.4	8/06/2014	0.5	10.8	11.3
26/05/2014	<0.1	18.9	19	6/08/2014	0.5	20.7	21.2
10/05/2014	<0.1	18.8	18.9	1/07/2014	0.5	6.9	7.4
5/08/2014	0.2	18.3	18.5	6/04/2014	0.5	5.1	5.5
These data represent the highest Cumulative Impact 24-hour PM _{2.5} predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour PM _{2.5} predictions (outlined in blue) as a result of the operation of the Proposal.			

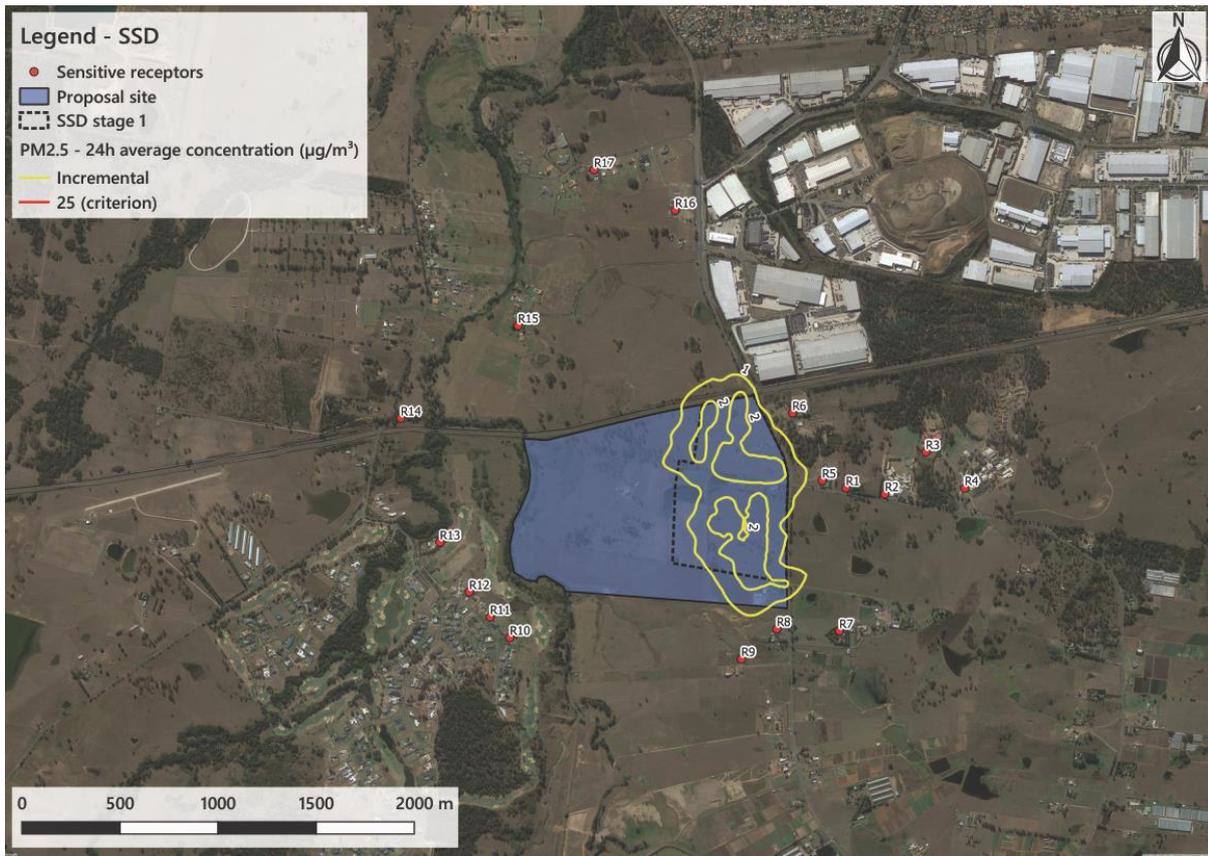
Contour plots of the predicted incremental 24-hour PM₁₀ and PM_{2.5} concentrations associated with the Proposal, are presented in **Figure 9** and **Figure 10** (on pp 53-54).

Figure 9 Incremental 24-hour PM₁₀ concentrations



Note Criterion = $50 \mu\text{g}\cdot\text{m}^{-3}$ (cumulative)

Figure 10 Incremental 24-hour PM_{2.5} concentrations



Note Criterion = 25 µg·m⁻³ (cumulative)

Review of the predicted contour plots, indicates that concentrations of particulate matter within the industrial area to the north-east of the Proposal Site (Erskine Park Industrial Precinct) and to the immediate north (Orchard Hills development), are predicted to be similar to those experienced at receptor R6. Concentrations above the criteria, with the addition of existing background concentrations, are not predicted to be experienced at these industrial locations.

7.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO₂). The averaging periods associated with the criteria for these pollutants is 1-hour and an annual average, as specified in **Table 4** (on P17 of this Report). The emissions adopted for this scenario, reflect the operational profile of the Proposal over those averaging periods (refer **Section 5.2.2**), notwithstanding the note above regarding the minor changes to the Proposal layout.

Emissions of NO_x have been calculated, with subsequent ground-level concentrations predicted using dispersion modelling techniques. Given that NO_x is a mixture of NO₂ and nitric oxide (NO), conversion of NO_x predictions to NO₂ concentrations is required. Within this assessment, the Ozone Limiting Method (OLM) has been adopted and is in accordance with method 2 (level 1) as outlined in the Approved Methods (NSW EPA, 2017). For calculation of annual average NO₂ concentrations, the annual average ozone concentration measured at the St Marys AQMS, has been used. In the assessment of maximum 1-hour concentrations of NO₂, the daily maximum ozone concentration across the year has been used within the OLM calculation.

The predicted maximum 1-hour and annual average NO₂ concentrations resulting from the Proposal's operations, are presented in **Table 23** below.

Table 23 Predicted 1 hour and annual average nitrogen dioxide concentrations

Rec.	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)					
	1 hour			Annual Average		
	Increment	Background	Cumulative	Increment	Background	Cumulative
R1	25.6	63.6	89.1	0.2	7.1	7.3
R2	17.1	63.6	80.7	<0.1	7.1	<7.2
R3	8.8	63.6	72.3	<0.1	7.1	<7.2
R4	7.7	63.6	71.2	<0.1	7.1	<7.2
R5	44.4	63.6	108.0	0.4	7.1	7.5
R6	30.0	63.6	93.5	0.9	7.1	8.0
R7	16.2	63.6	79.8	0.1	7.1	7.2
R8	29.9	63.6	93.4	0.4	7.1	7.5
R9	22.7	63.6	86.2	0.6	7.1	7.7
R10	6.8	63.6	70.3	0.4	7.1	7.5
R11	6.3	63.6	69.8	0.4	7.1	7.5
R12	5.8	63.6	69.3	0.3	7.1	7.4
R13	6.4	63.6	70.0	0.3	7.1	7.4
R14	6.2	63.6	69.7	0.2	7.1	7.3
R15	8.7	63.6	72.3	0.3	7.1	7.4
R16	12.3	63.6	75.8	0.5	7.1	7.6
R17	10.9	63.6	74.5	0.3	7.1	7.4

The results indicate, that predicted incremental concentrations of combustion-related pollutants (characterised by NO_2), are below the criteria at all surrounding receptor locations. At the worst affected receptor (R5) and for the pollutant with the highest predicted concentrations (1-hour maximum NO_2), predicted increments are shown to be less than 19% of the relevant criterion as a result of the Proposal, even using a less refined screening approach to determine the NO_x to NO_2 conversion. The calculated cumulative impacts (Proposal plus background), are shown to result in impacts less than the criteria.

The performance of the Proposal does not result in any exceedances of the criteria for combustion related pollutants.

No contour plots of combustion related pollutants are presented, given the minor contribution from the Proposal at the nearest relevant sensitive receptors.

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8. Mitigation and Monitoring

8.1. Construction Phase Mitigation

The potential impacts associated with construction phase activities, has been performed using a risk-based assessment procedure. This approach is preferred, principally because emissions from construction activities are hard to estimate, as they occur over short-term periods and the rate of actual emissions, is highly dependent upon the prevailing meteorology and conditions coincidental to the performance of the specific operations. Also these can be influenced significantly, by the manner in which those activities are performed and managed.

To offer a methodology to identify potential construction phase risks and where controls are required, the IAQM risk-based assessment procedure has been adopted. This methodology has been adapted for use in Australia by Northstar and used previously in NSW and Australia.

The published procedure, assesses risk associated with various construction-phase activities, including demolition, earthworks, construction and track-out. The identified risks are summarised in **Section 6.4** (on P42 of this Report), and the mitigation measures identified to manage that risk are presented in **Section 6.5** (on P43). To manage the risks, the identified mitigation measures presented in **Table 16** (on P42), are anticipated to be implemented in the Construction Environmental Management Plan (CEMP)³.

8.2. Operational Phase Mitigation

Based on the findings of the air quality impact assessment, it is considered that the level of activity being performed at the Proposal Site, would result in minor incremental impacts at all surrounding receptor locations.

In the case of predicted incremental annual, average particulate matter concentrations (as TSP, PM₁₀ and PM_{2.5}), the predicted ground-level concentrations are predicted to be low:

- TSP: 1.0 µg·m⁻³;
- PM₁₀: 0.4 µg·m⁻³; and
- PM_{2.5}: 0.1 µg·m⁻³.

The incremental dust deposition rate is predicted to be 0.1 g·m⁻²·month⁻¹.

³ https://www.planning.nsw.gov.au/~/_media/Files/DPE/Guidelines/guideline-for-the-preparation-of-environmental-management-plans-2004.ashx?la=en

In the case of predicted incremental 24-hour average particulate matter concentrations (as PM₁₀ and PM_{2.5}), the predicted ground-level concentrations are predicted to be low:

- PM₁₀: 1.9 µg·m⁻³; and
- PM_{2.5}: 0.7 µg·m⁻³.

Accounting for the background air quality assumptions, the assessment does not predict any exceedances of the respective criteria.

In regard to nitrogen dioxide, the predicted maximum increment 1-hour and annual average predictions, are 44.4 µg·m⁻³ and 0.9 µg·m⁻³ respectively. Accounting for the relevant background assumptions, the assessment does not predict an exceedance of the relevant impact assessment criteria.

No specific mitigation measures are considered to be required to minimise impacts on surrounding receptor locations. Good site management practices, including the observation of speed limits on site, and the minimisation of vehicle use (through avoidance of engine idling) would be sufficient to ensure that no off-site impacts are experienced.

8.3. Monitoring

Given the discussion presented above, taking into consideration the minor incremental contribution of the Proposal to air quality impacts in the surrounding area, no air quality monitoring is required or proposed, for either the construction phase or the operational phase.

9. Conclusion

Northstar Air Quality was engaged by Frasers Property Australia and Altis Property Partners, to perform an Air Quality Impact Assessment (AQIA) for the proposed construction and operation of a warehouse and industrial facility at 657-769 Mamre Road, Kemps Creek, NSW which would form the Mamre Road South Precinct.

The AQIA has been performed to support an SSD application for Stage 1 of the development, which is located within the area covered by the requirements of the NSW State Environmental Planning Policy (Western Sydney Employment Area) 2009.

Construction phase activities will involve demolition works and earth works, construction works and associated vehicle traffic. The associated risks of impacts from demolition, construction, track-out and construction traffic have been assessed using the published guidance in *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (IAQM), and adapted by Northstar Air Quality for use in Australia. This methodology has been used in a similar context on numerous other similar AQIA studies. That assessment showed there to be a low risk of health or nuisance impacts during construction works. However, a range of standard mitigation measures are available to ensure that short-term impacts associated with construction activities are minimised. Furthermore, the assessment has assumed that construction activities across the entire Proposal Site would be performed at one time, where in reality the construction operations would be staged.

The prediction of potential impacts associated with operational activities has been performed in general accordance with the requirements of the NSW Approved Methods (NSW EPA 2016), using an approved and appropriate dispersion modelling technique. The estimation of emissions has been performed using referenced emission factors, and this is documented in **Section 5.2.2** (on P33 of this Report).

The potential incremental impacts (i.e. without consideration of assumed background air quality conditions) at all the identified receptor locations, are presented in **Section 7** (on P47) which documents those predictions as:

- **Incremental impact** – relates to the concentrations predicted as a result of the operation of the Proposal in isolation.
- **Cumulative impact** – relates to the concentrations predicted as a result of the operation of the Proposal PLUS the background air quality concentrations discussed in **Section 4.4** (on P28).

Conclusion: It is demonstrated that the operation of the Proposal does not cause any exceedances of the Air Quality Criteria.

It is respectfully suggested that the SSD application should not be refused on the grounds of air quality issues.

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Appendix A

Meteorology

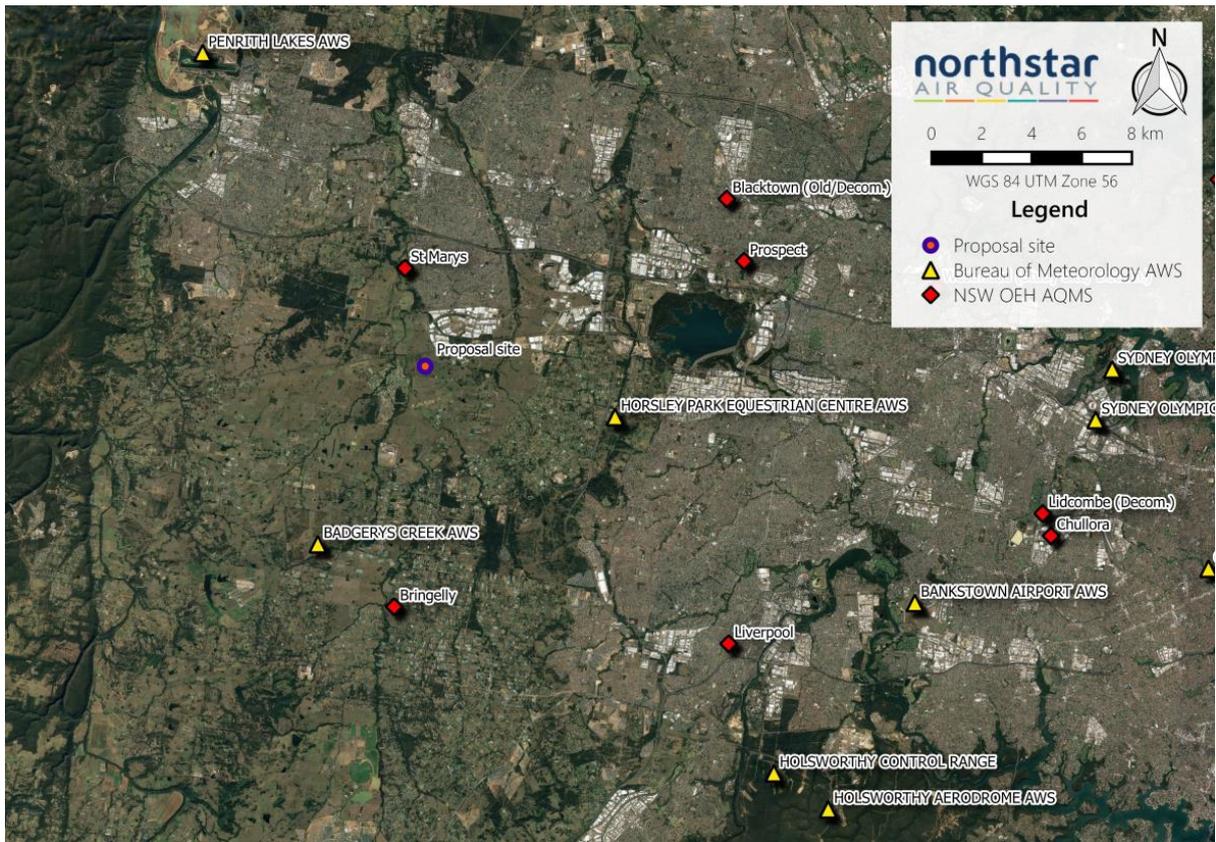
As discussed in **Section 4.3** a meteorological modelling exercise has been performed to characterise the meteorology of the Proposal Site in the absence of site specific measurements. The meteorological monitoring has been based on measurements taken at a number of surrounding automatic weather stations (AWS) operated by the Bureau of Meteorology (BoM). Meteorology is also measured by the NSW Office of Environment and Heritage (OEH) at a number of Air Quality Monitoring Station (AQMS) surrounding the Proposal Site (refer **Section 4.4**).

A summary of the relevant monitoring sites is provided in **Table A1** and also displayed in **Figure A1**.

Table A1 Details of the meteorological monitoring surrounding the Proposal Site

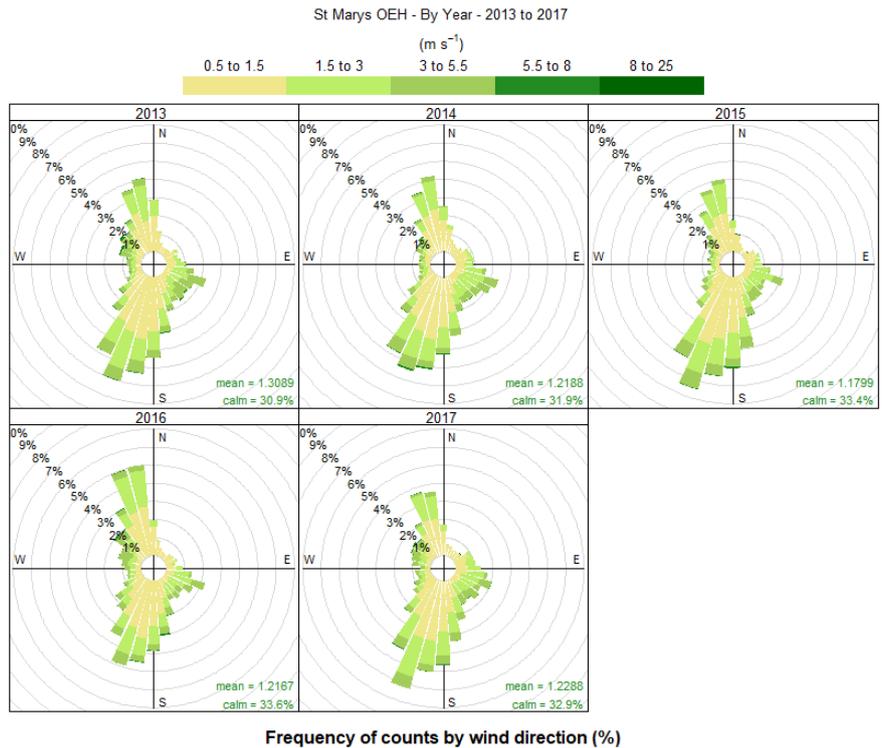
Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
St Marys AQMS	OEH	293,170	6,258,083	3.9
Horsley Park Equestrian Centre AWS – Station # 67119	BoM	301,710	6,252,290	7.9
Badgerys Creek AWS – Station # 67108	BoM	289,920	6,246,951	8.3
Bringelly AQMS	OEH	293,028	6,244,518	9.7
Prospect AQMS	OEH	306,744	6,258,645	13.5
Penrith Lakes AWS – Station # 67113	BoM	284,866	6,266,510	15.2
Liverpool AQMS	OEH	306,439	6,243,322	16.5

Figure A1 Meteorological and air quality monitoring surrounding the Proposal Site



Meteorological conditions at St Marys AQMS was chosen for further investigation due to its location relative to the Proposal Site. This site has been examined to determine a ‘typical’ or representative dataset for use in dispersion modelling. Annual wind roses for the most recent 5 years of data (2013 to 2017) are presented in Figure A2.

Figure A2 Annual wind roses 2013 to 2017, St Marys AQMS



The wind roses indicate that from 2013 to 2017, winds at St Marys AQMS show similar patterns across the years, with a predominant south-westerly wind direction.

The majority of wind speeds experienced at St Marys AQMS over the 5-year period, 2013 to 2017 are generally in the range $0.5\text{ m}\cdot\text{s}^{-1}$ to $5.5\text{ m}\cdot\text{s}^{-1}</math> with the highest wind speeds (greater than $8\text{ m}\cdot\text{s}^{-1}</math>) occurring from a south westerly direction. Winds of this speed are not frequent, occurring <math><0.1\%</math> of the observed hours over the 5-year period, at St Marys. Calm winds ($<0.5\text{ m}\cdot\text{s}^{-1}</math>) occur during 32.5% of hours on average across the 5-year period.$$$

Given the wind distributions across the years examined, data for the year 2014 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied.

Presented in **Figure A3** are the annual wind rose for the 2013 to 2017 period and the year 2014 and in **Figure A4** the annual wind speed distribution for St Marys AQMS. These figures indicate that the distribution of wind speed and direction in 2014 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2014 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure A3 Annual wind roses 2013 to 2017, and 2014 – St Marys AQMS

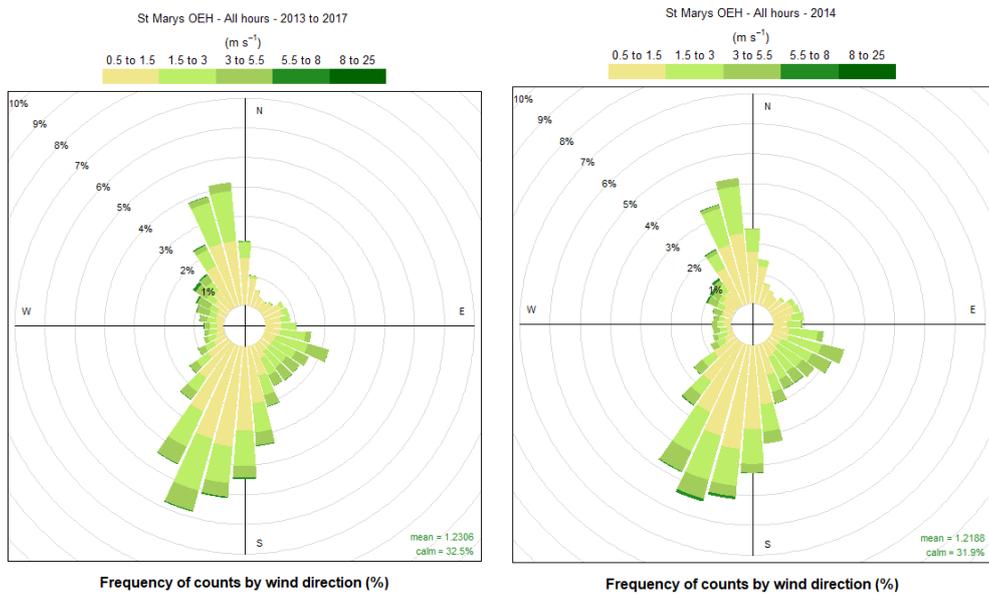
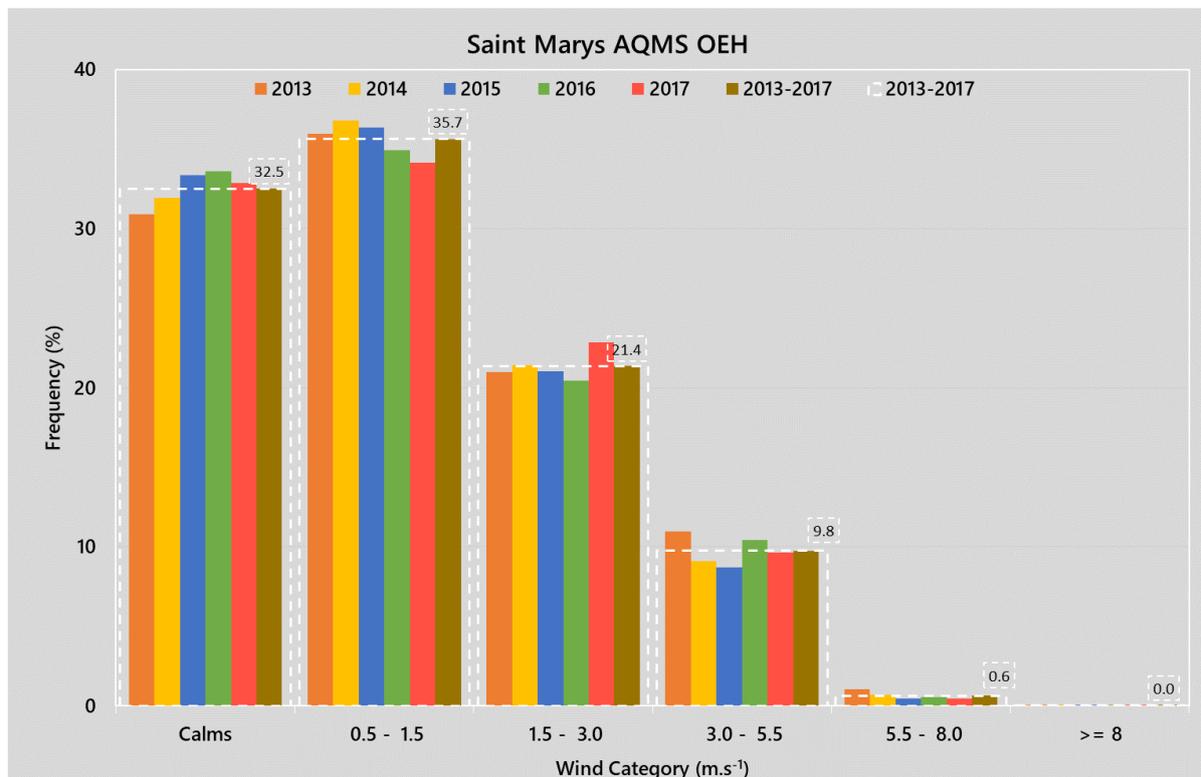


Figure A4 Annual wind speed distribution – St Marys AQMS



Meteorological Processing

The BoM and OEH data adequately covers the issues of data quality assurance, however it is limited by its location compared to the Proposal Site. To address these uncertainties, a multi-phased assessment of the meteorology data has been performed.

In absence of any measured onsite meteorological data, site representative meteorological data for this proposal was generated using the TAPM meteorological model in a format suitable for using in the CALPUFF dispersion model (refer **Section 5.1**).

Meteorological modelling using The Air Pollution Model (TAPM, v 4.0.5) has been performed to predict the meteorological parameters required for CALPUFF. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

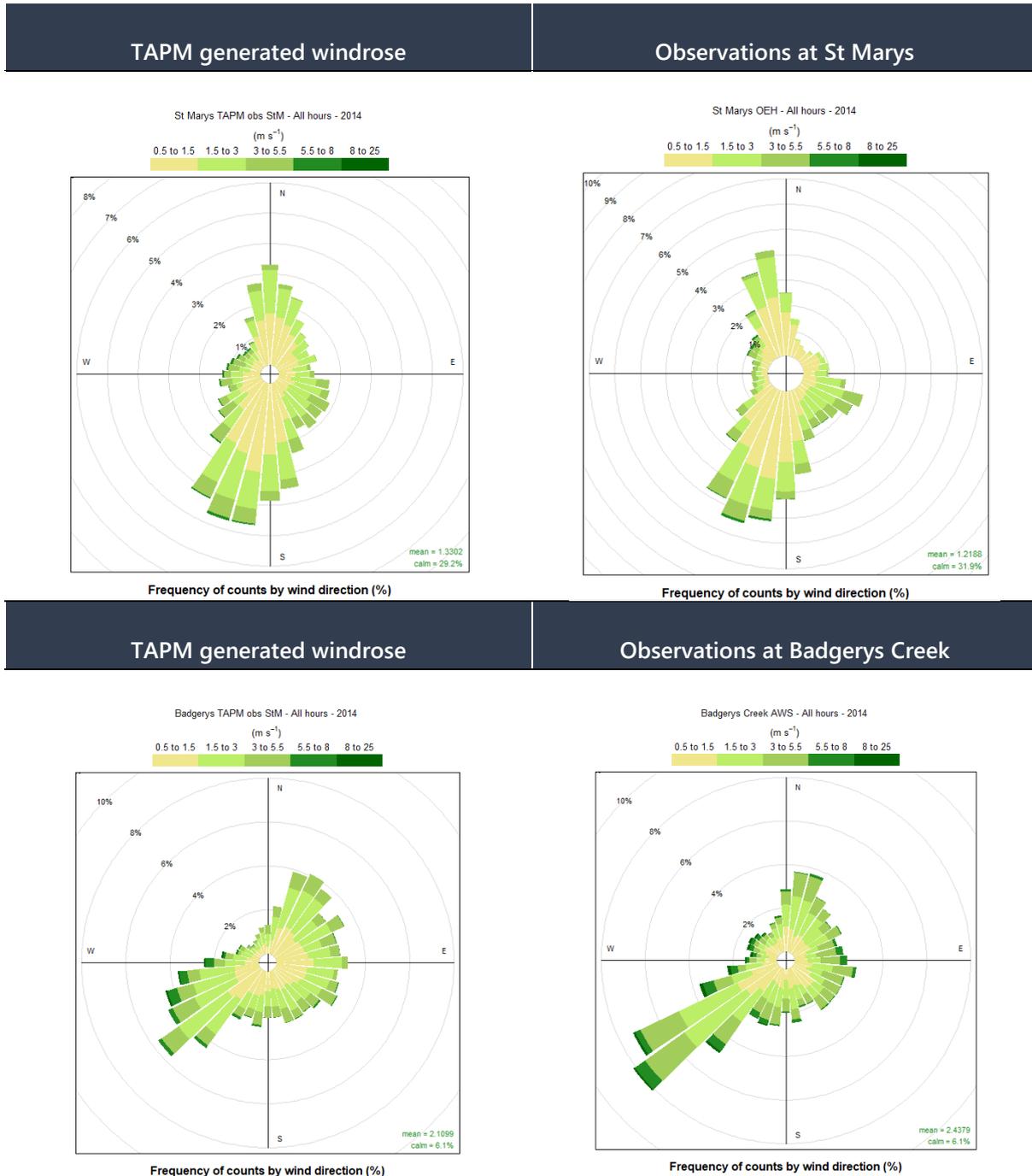
The parameters used in TAPM modelling are presented in **Table A2**.

Table A2 Meteorological parameters used for this study

TAPM v 4.0.5	
Modelling period	1 January 2014 to 31 December 2014
Centre of analysis	293,235 mE, 6,258,700 mN (UTM Coordinates)
Number of grid points	35 × 35 × 35
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	St Marys AQMS OEH

A comparison of the TAPM generated meteorological data, and that observed at the St Marys AQMS, is presented in **Figure A5**. A comparison of the TAPM generated meteorological data, and that observed at Badgerys Creek AWS was also compared to further validate the model and is presented in **Figure A5**. These data generally compare well at both sites, which provides confidence that the meteorological conditions modelled as part of this assessment are appropriate.

Figure A5 Modelled and observed meteorological data – St Marys AQMS & Badgerys Creek AWS, 2014

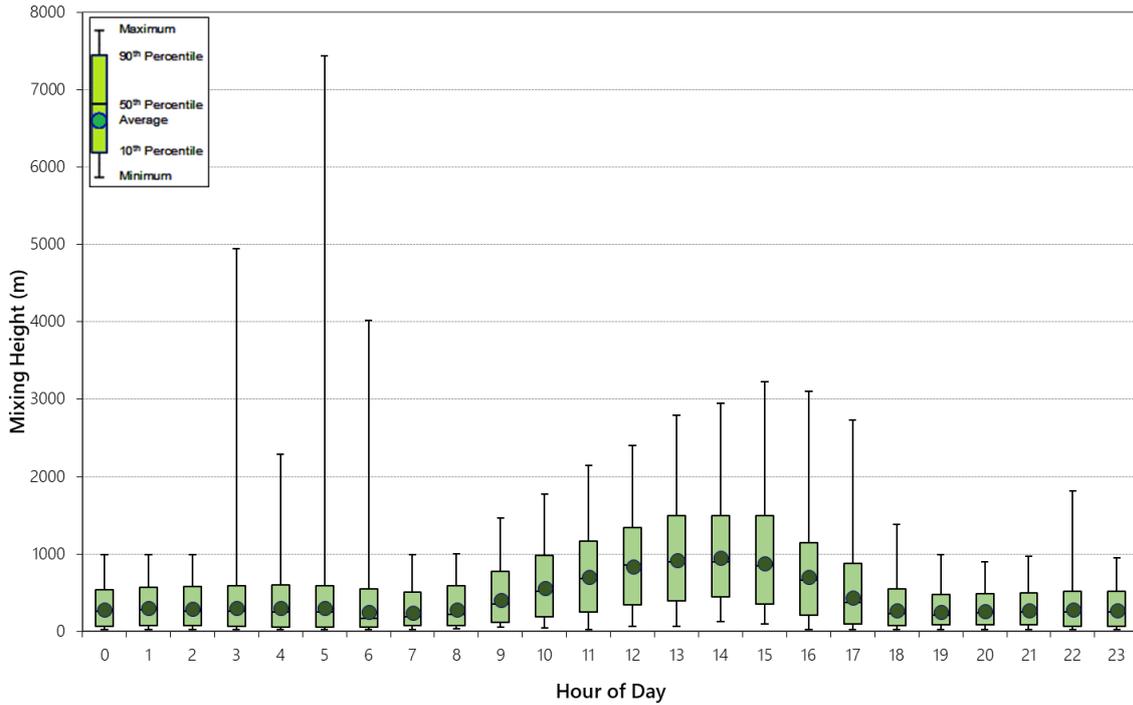


As generally required by the NSW EPA the following provides a summary of the modelled meteorological dataset. Given the nature of the pollutant emission sources at the Proposal Site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirculation potential of the Proposal Site has not been provided. Details of the predictions of wind speed and direction, mixing height and temperature at the Proposal Site are provided below.

Diurnal variations in maximum and average mixing heights predicted by TAPM at the Proposal Site during 2014 period are illustrated in **Figure A6**.

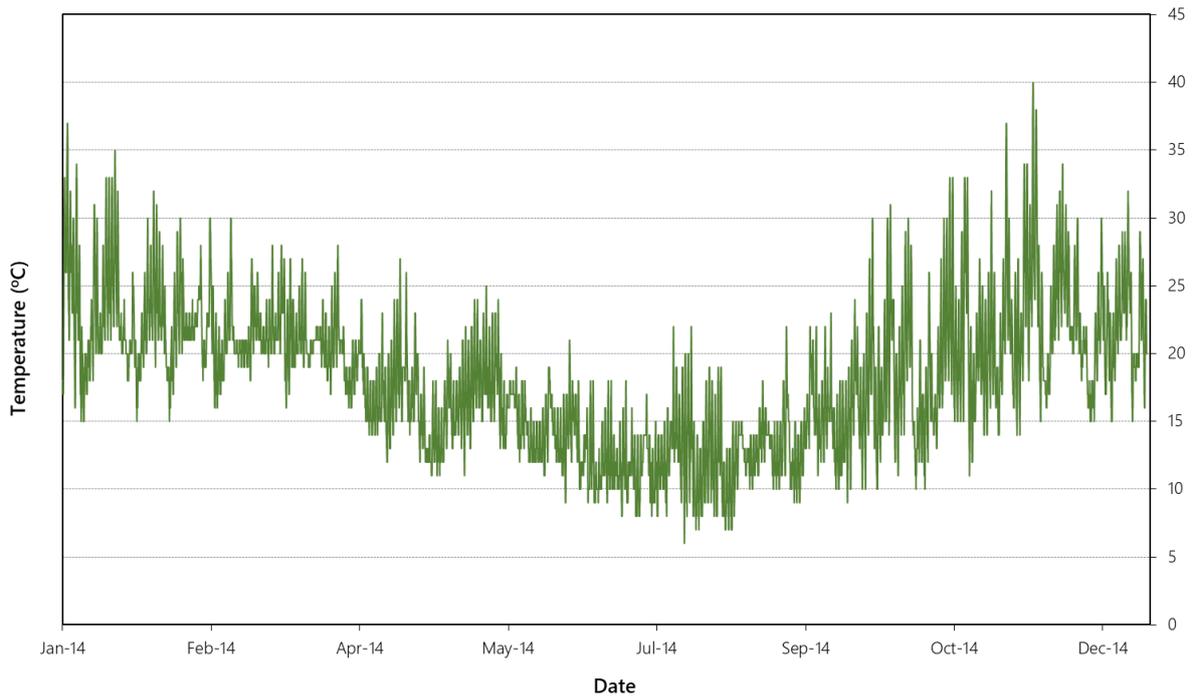
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure A6 Predicted mixing height – Proposal Site 2014



The modelled temperature variations predicted at the Proposal Site during 2014 are presented in **Figure A7**.

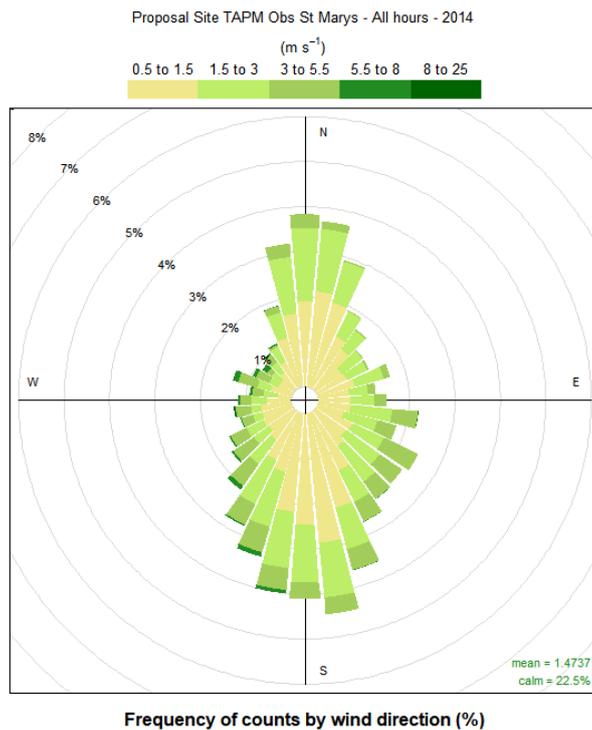
Figure A7 Predicted temperature – Proposal Site 2014



The maximum temperature of 40°C was predicted on 23 November 2014 and the minimum temperature of 6°C was predicted on 29 July, 2014.

The modelled wind speed and direction at the Proposal Site during 2014 are presented in **Figure A8**.

Figure A8 Predicted wind speed and direction – Proposal Site 2014



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Appendix B

Background Air Quality Data

Air quality is not monitored at the Proposal Site and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this assessment. Determination of data to be used as a location representative of the Proposal Site and during a representative year can be complicated by factors which include:

- the sources of air pollutant emissions around the Proposal Site and representative AQMS; and
- the variability of particulate matter concentrations (often impacted by natural climate variability).

Air quality monitoring is performed by the NSW Office of Environment and Heritage (OEH) at four air quality monitoring station (AQMS) within a 17 km radius of the Proposal Site. Details of the monitoring performed at these AQMS is presented in **Table B1** and **Figure 7**.

Table B1 Details of Closest AQMS Surrounding the Site

AQMS Location	Data Availability	Distance to Site (km)	Screening Parameters					
			2014 Data	Measurements				
				PM ₁₀	PM _{2.5}	TSP	NO ₂	O ₃
St Marys	1992 - 2018	3.9	✓	✓	✗	✗	✓	✓
Bringelly	1992 - 2018	9.7	✓	✓	✗	✗	✓	✓
Prospect	2007 - 2018	13.5	✓	✓	✗	✗	✓	✓
Liverpool	1988 - 2018	16.5	✓	✓	✓	✗	✓	✓

Note: A Ozone (O₃) data used to assist in the conversion of predicted NO_x concentrations to NO₂

Based on the sources of AQMS data available and their proximity to the Proposal Site, St Marys was selected as the candidate source of AQMS data for use in this assessment.

St Marys, in 2014 was not measuring PM_{2.5} hence the next most appropriate AQMS containing PM_{2.5} for the year 2014 was taken, which is Liverpool AQMS.

Summary statistics are for PM₁₀ and PM_{2.5} data are presented in **Table B2**.

Table B2 PM₁₀ and PM_{2.5} statistics 2014

AQMS	St Marys	Liverpool
Year	2014	2014
Pollutant	PM ₁₀	PM _{2.5}
Averaging Period	24-hour	24-hour
Data Points (number)	362	355
Mean (µg·m ⁻³)	16.7	8.6
Standard Deviation (µg·m ⁻³)	6.9	3.9
<i>Skew</i> ¹	1.0	1.0
<i>Kurtosis</i> ²	1.4	0.9
Minimum (µg·m ⁻³)	4.6	2.7
Percentiles (µg·m ⁻³)		
1	6.1	3.0
5	8.1	3.8
10	8.9	4.5
25	11.4	5.7
50	15.4	7.6
75	21.0	10.8
90	25.3	14.4
95	28.6	16.1
97	31.8	17.4
98	33.6	18.9
99	38.1	20.2
Maximum	45.0	24.3
Data Capture (%)	99.2	97.3

Notes: 1: Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

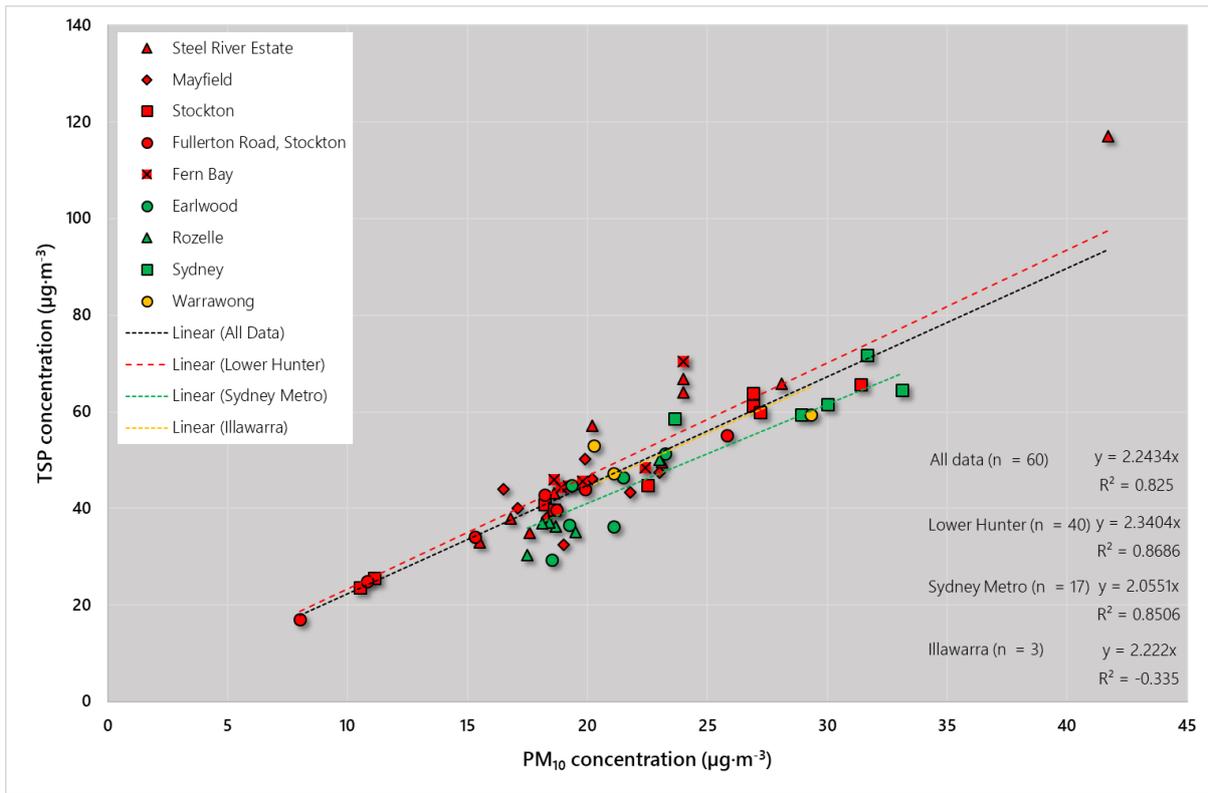
2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Concentrations of TSP are not measured by the NSW OEH at any AQMS surrounding the Proposal Site. An analysis of co-located measurements of TSP and PM₁₀ in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in **Figure B1**.

The analysis concludes that, on the basis of the measurements collected across NSW between 1999 to 2011, the derivation of a broad TSP:PM₁₀ ratio of 2.0551 : 1 (i.e. PM₁₀ represents ~48% of TSP) is appropriate to be applied to measurements in the Sydney Metro.

In the absence of any more specific information, this ratio has been adopted within this AQIA. These estimates have not been adjusted for background exceedances.

Figure B1 Co-located TSP and PM₁₀ Measurements, Lower Hunter, Sydney Metro and Illawarra



Similarly, no dust deposition data is available for the area surrounding the Proposal Site. The incremental impact criterion of $2 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$ as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of $2 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$ (the total allowable deposition being $4 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$).

A summary of background air quality data for the site for the year 2014 (consistent with the selected meteorological period) is presented in **Table B3**.

Graphs presenting the daily varying PM₁₀ and PM_{2.5} data recorded at St Marys and Liverpool in 2014 are presented in **Figure B2** and **Figure B3**, respectively.

Table B3 Summary of Background Air Quality Data (Prospect, Liverpool 2014)

Pollutant	TSP ($\mu\text{g}\cdot\text{m}^{-3}$)	PM ₁₀ ($\mu\text{g}\cdot\text{m}^{-3}$)	PM _{2.5} ($\mu\text{g}\cdot\text{m}^{-3}$)	O ₃ ($\mu\text{g}\cdot\text{m}^{-3}$)	O ₃ ($\mu\text{g}\cdot\text{m}^{-3}$)	NO ₂ ($\mu\text{g}\cdot\text{m}^{-3}$)
Averaging Period	Annual	24-Hour	24-Hour	1-Hour	Rolling 4-Hour	1-Hour
Data Points (number)	362	362	355	8256	8554	8028
Mean	34.4	16.7	8.6	39.3	38.6	7.1
Standard Deviation	-	6.9	3.9	29.8	28.1	8.9
Skew ¹	-	1.0	1.0	0.8	0.8	1.7
Kurtosis ²	-	1.4	0.9	1.1	0.8	3.7
Minimum	34.4	4.6	2.7	0.0	1.6	-6.2
Percentiles ($\mu\text{g}\cdot\text{m}^{-3}$)						
1	-	6.1	3.0	2.1	2.1	-4.1
5	-	8.1	3.8	2.1	2.9	-2.1
10	-	8.9	4.5	4.3	4.3	0.0
25	-	11.4	5.7	12.8	13.9	0.0
50	-	15.4	7.6	36.4	36.4	4.1
75	-	21.0	10.8	59.9	57.2	10.3
90	-	25.3	14.4	74.9	73.3	18.5
95	-	28.6	16.1	89.9	87.7	24.6
97	-	31.8	17.4	100.6	97.9	28.7
98	-	33.6	18.9	109.1	105.9	32.8
99	-	38.1	20.2	126.3	119.6	36.9
Maximum	34.4	45.0	24.3	214.0	181.4	63.6
Data Capture (%)	99.2	99.2	97.3	94.2	97.6	91.6

Figure B2 PM₁₀ Measurements, Prospect 2014

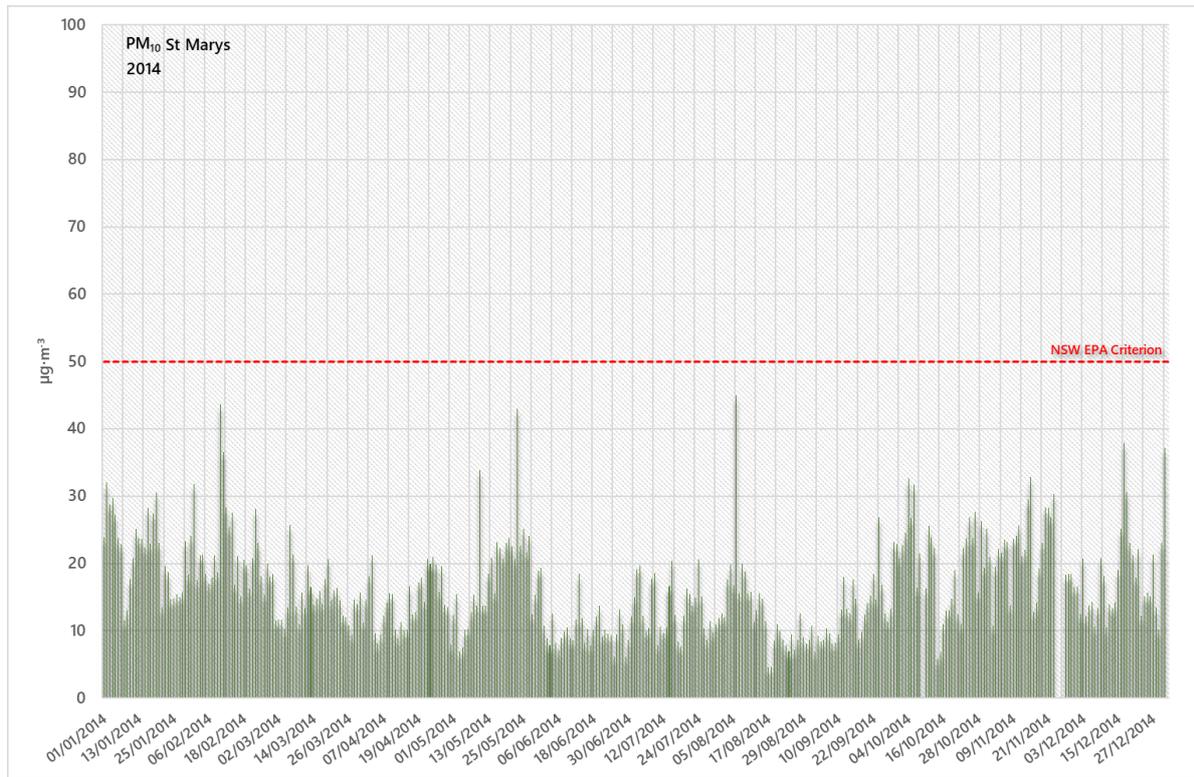
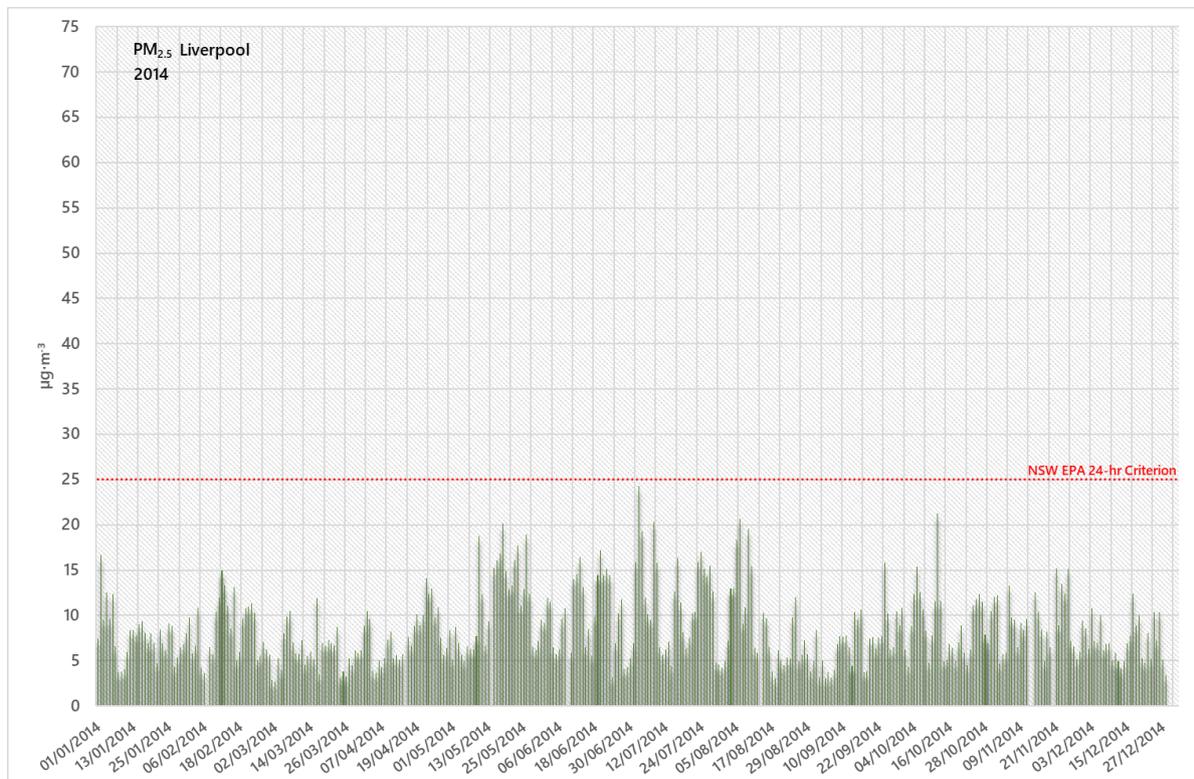


Figure B3 PM_{2.5} Measurements, Liverpool 2014



Appendix C

Construction Phase Risk Assessment Methodology

Provided below is a summary of the risk assessment methodology used in this assessment. It is based upon IAQM (2016) *Guidance on the assessment of dust from demolition and construction* (version 1.1), and adapted by Northstar Air Quality.

Adaptions to the Published Methodology Made by Northstar Air Quality

The adaptions made by Northstar Air Quality from the IAQM published methodology are:

- **PM₁₀ criterion:** an amended criterion representing the annual average PM₁₀ criterion relevant to Australia rather than the UK;
- **Nomenclature:** a change in nomenclature from “receptor sensitivity” to “land use value” to avoid misinterpretation of values attributed to “receptor sensitivity” and “sensitivity of the area” which may be assessed as having different values;
- **Construction traffic:** the separation of construction vehicle movements as a discrete risk assessment profile from those associated with the ‘on-site’ activities of demolition, earthworks and construction. The IAQM methodology considers five risk profiles of: “demolition”, “earthworks”, “construction” and “trackout”. The adaption by Northstar Air Quality introduces a fifth risk assessment profile of “construction traffic” to the existing four risk profiles; and,
- **Tables:** minor adjustments in the visualisation of some tables.

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located:

- more than 350 m from the boundary of the site;
- more than 50 m from the route used by construction vehicles on public roads; and,
- more than 500 m from the site entrance.

This step is noted as having deliberately been chosen to be conservative, and would require assessments for most developments.

Step 2 – Risk from Construction Activities

Step 2 of the assessment provides “dust emissions magnitudes” for each of the dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles) and construction traffic.

The magnitudes are: Large; Medium; or Small, with suggested definitions for each category as follows:

Dust Emission Magnitude Activities

Activity	Large	Medium	Small
Demolition			
- total building volume*	• >50,000 m ³	• 20,000 m ³ to 50,000 m ³	• <20,000 m ³
- demolition height	• > 20m AGL	• 10 m and 20 m AGL	• <10 m AGL
- onsite crushing	• yes	• no	• no
- onsite screening	• yes	• no	• no
- demolition of materials with high dust potential	• yes	• yes	• no
- demolition timing	• any time of the year	• any time of the year	• wet months only
Earthworks			
- total area	• >10,000 m ²	• 2,500 m ² to 10,000 m ²	• <2,500 m ²
- soil types	• potentially dusty soil type (e.g., clay, which would be prone to suspension when dry due to small particle size)	• moderately dusty soil type (e.g., silt),	• soil type with large grain size (e.g., sand)
- heavy earth moving vehicles	• >10 heavy earth moving vehicles active at any time	• 5 to 10 heavy earth moving vehicles active at any one time	• <5 heavy earth moving vehicles active at any one time
- formation of bunds	• >8m AGL	• 4m to 8m AGL	• <4m AGL
- material moved	• >100,000 t	• 20,000 t to 100,000 t	• <20,000 t
- earthworks timing	• any time of the year	• any time of the year	• wet months only
Construction			
- total building volume	• 100,000 m ³	• 25,000 m ³ to 100,000 m ³	• <25,000 m ³
- piling	• yes	• yes	• no
- concrete batching	• yes	• yes	• no
- sandblasting	• yes	• no	• no
- materials	• concrete	• concrete	• metal cladding or timber
Trackout (within 100 m of construction site entrance)			
- outward heavy vehicles movements per day	• >50	• 10 to 50	• <10
- surface materials	• high potential	• moderate potential	• low potential
- unpaved road length	• >100m	• 50m to 100m	• <50m

Activity	Large	Medium	Small
Construction Traffic (from construction site entrance to construction vehicle origin)			
Demolition traffic - total building volume	<ul style="list-style-type: none"> >50,000 m³ 	<ul style="list-style-type: none"> 20,000 m³ to 50,000 m³ 	<ul style="list-style-type: none"> <10,000 m³
Earthworks traffic - total area	<ul style="list-style-type: none"> >10,000 m² 	<ul style="list-style-type: none"> 2,500 m² to 10,000 m² 	<ul style="list-style-type: none"> <2,500 m²
Earthworks traffic - soil types	<ul style="list-style-type: none"> potentially dusty soil type (e.g., clay, which would be prone to suspension when dry due to small particle size) 	<ul style="list-style-type: none"> moderately dusty soil type (e.g., silt), 	<ul style="list-style-type: none"> soil type with large grain size (e.g., sand)
Earthworks traffic - material moved	<ul style="list-style-type: none"> >100,000 t 	<ul style="list-style-type: none"> 20,000 t to 100,000 t 	<ul style="list-style-type: none"> <20,000 t
Construction traffic - total building volume	<ul style="list-style-type: none"> 100,000 m³ 	<ul style="list-style-type: none"> 25,000 m³ to 100,000 m³ 	<ul style="list-style-type: none"> <25,000 m³
Total traffic - heavy vehicles movements per day when compared to existing heavy vehicle traffic	<ul style="list-style-type: none"> >50% of heavy vehicle movement contribution by Proposal 	<ul style="list-style-type: none"> 10% to 50% of heavy vehicle movement contribution by Proposal 	<ul style="list-style-type: none"> <10% of heavy vehicle movement contribution by Proposal

Step 3 – Sensitivity of the Area

Step 3 of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:

- The specific sensitivities that identified land use values have to dust deposition and human health impacts;
- The proximity and number of those receptors locations;
- In the case of PM₁₀, the local background concentration; and
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

Land Use Value

Individual receptor locations may be attributed different land use values based on the land use of the land, and may be classified as having high, medium or low values relative to dust deposition and human health impacts (ecological receptors are not addressed using this approach).

Essentially, land use value is a metric of the level of amenity expectations for that land use.

The IAQM method provides guidance on the land use value with regard to dust soiling and health effects and is shown in the table below. It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

IAQM Guidance for Categorising Land Use Value

Value	High Land Use Value	Medium Land Use Value	Low Land Use Value
Health effects	<ul style="list-style-type: none"> • Locations where the public are exposed over a time period relevant to the air quality objective for PM₁₀ (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). <p><i>Examples: Residential properties, hospitals, schools and residential care homes.</i></p>	<ul style="list-style-type: none"> • Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM₁₀ (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). <p><i>Examples: Office and shop workers, but would generally not include workers occupationally exposed to PM₁₀.</i></p>	<ul style="list-style-type: none"> • Locations where human exposure is transient. <p><i>Examples: Public footpaths, playing fields, parks and shopping street.</i></p>

Value	High Land Use Value	Medium Land Use Value	Low Land Use Value
Dust soiling	<ul style="list-style-type: none"> Users can reasonably expect a high level of amenity; or The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land. <p><i>Examples: Dwellings, museums, medium and long term car parks and car showrooms.</i></p>	<ul style="list-style-type: none"> Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or The appearance, aesthetics or value of their property could be diminished by soiling; or The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. <p><i>Examples: Parks and places of work.</i></p>	<ul style="list-style-type: none"> The enjoyment of amenity would not reasonably be expected; or Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. <p><i>Examples: Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.</i></p>

Sensitivity of the Area

The assessed land use value (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, and the local background PM₁₀ concentration (in the case of potential health impacts) and other site-specific factors.

Additional factors to consider when determining the sensitivity of the area include:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area; and if relevant, the season during which the works would take place;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document

Sensitivity of the Area - Health Impacts

For high land use values, the method takes the existing background concentrations of PM₁₀ (as an annual average) experienced in the area of interest into account, and professional judgement may be used to determine alternative sensitivity categories, taking into account the following:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local / seasonal meteorological data;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Land Use Value	Annual Mean PM ₁₀ Concentration (µg·m ⁻³)	Number of Receptors ^(a)	Distance from the Source (m) ^(b)				
			<20	<50	<100	<200	<350
High	>30	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	26 – 30	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	22 – 26	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	≤22	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Note: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m), noting that only the highest level of area sensitivity from the table needs to be considered. In the case of high sensitivity areas with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of <20m and <50m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Sensitivity of the Area - Dust Soiling

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in the table below

IAQM Guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects

Land Use Values	Number of receptors ^(a)	Distance from the source (m) ^(b)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: (a) Estimate the total number of receptors within the stated distance. Only the highest level of area sensitivity from the table needs to be considered.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of <20m and <50m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Step 4 - Risk Assessment (Pre-Mitigation)

The matrices shown for each activity determine the risk category with no mitigation applied.

Risk of dust impacts from earthworks

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (Earthworks)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from construction activities

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (Construction)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from demolition activities

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (Demolition)		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Risk of dust impacts from trackout (within 100m of construction site entrance)

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (Trackout)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from construction traffic (from construction site entrance to origin)

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (Construction Traffic)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 5 – Identify Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the site is a low, medium or high risk site.

The identified mitigation measures are presented as follows:

- **N** = not required (although they may be implemented voluntarily)
- **D** = desirable (to be considered as part of the CEMP, but may be discounted if justification is provided);
- **H** = highly recommended (to be implemented as part of the CEMP, and should only be discounted if site-specific conditions render the requirement invalid or otherwise undesirable).

The table below presents the complete mitigation table, not that assessed as required for any specific project or activity:

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
1 Communications				
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	N	H	H
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H	H	H
1.2	Display the head or regional office contact information.	H	H	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	D	H	H
2 Site Management				
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	H	H	H
2.2	Make the complaints log available to the local authority when asked.	H	H	H
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	H	H	H
2.4	Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.	N	N	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
3 Monitoring				
3.1	Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary.	D	D	H
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to the local authority when asked.	H	H	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H	H	H
3.4	Agree dust deposition, dust flux, or real-time continuous monitoring locations with the relevant regulatory bodies. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences.	N	H	H
4 Preparing and Maintaining the Site				
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	H	H	H
4.2	Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site.	H	H	H
4.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	D	H	H
4.4	Avoid site runoff of water or mud.	H	H	H
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	D	H	H
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below	D	H	H
4.7	Cover, seed or fence stockpiles to prevent wind erosion	D	H	H
5 Operating Vehicle/Machinery and Sustainable Travel				
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H	H	H
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles	H	H	H
5.3	Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
5.4	Impose and signpost a maximum-speed-limit of 25 km·h ⁻¹ on surfaced and 15 km·h ⁻¹ on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	D	D	H
5.4	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	N	H	H
5.5	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	N	D	H
6 Operations				
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	H	H	H
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	H	H	H
6.3	Use enclosed chutes and conveyors and covered skips	H	H	H
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	H	H	H
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	D	H	H
7 Waste Management				
7.1	Avoid bonfires and burning of waste materials.	H	H	H
8 Measures Specific to Demolition				
8.1	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	D	D	H
8.2	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	H	H	H
8.3	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	H	H	H
8.4	Bag and remove any biological debris or damp down such material before demolition.	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
8.5	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	N	D	H
8.6	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	N	D	H
8.7	Only remove the cover in small areas during work and not all at once	N	D	H
9 Measures Specific to Construction				
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	D	D	H
8.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	D	H	H
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overflowing during delivery.	N	D	H
8.4	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust	N	D	D
10 Measures Specific to Track-Out				
10.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D	H	H
10.2	Avoid dry sweeping of large areas.	D	H	H
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D	H	H
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H	H	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D	H	H
10.6	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.	N	H	H
10.7	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	D	H	H
10.8	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	N	H	H
10.9	Access gates to be located at least 10 m from receptors where possible.	N	H	H
11 Specific Measures to Construction Traffic (adapted)				
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N	D	H
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D	H	H
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H	H	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D	H	H

Step 6 – Risk Assessment (post-mitigation)

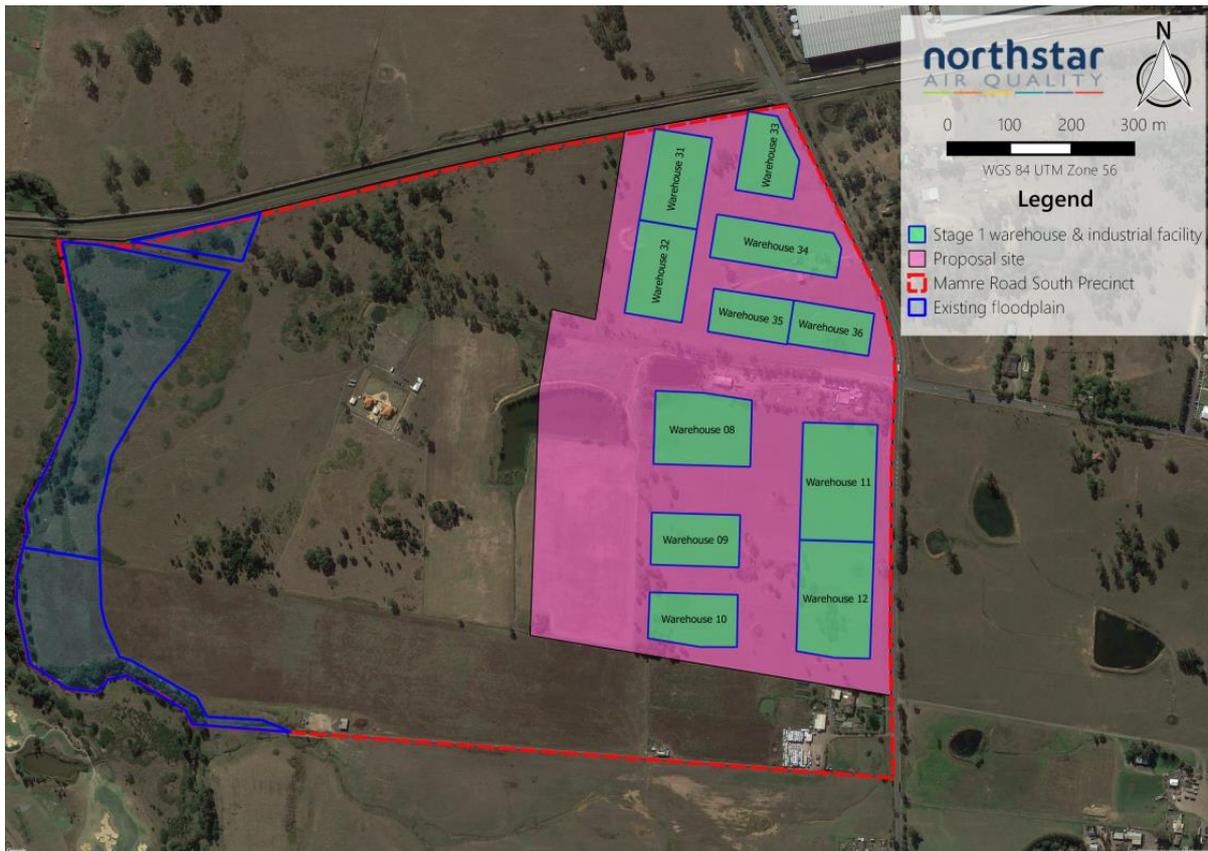
Following Step 5, the residual impact is then determined.

The objective of the mitigation is to manage the construction phase risks to an acceptable level, and therefore it is assumed that application of the identified mitigation would result in a *low* or *negligible* residual risk (post mitigation).

Appendix D

Emissions Inventory – Modelled Layout

Proposal Site layout – as modelled



Note minor changes to Warehouse 33 and 34 – now proposed to be one warehouse (33). Also note the current setback on the northern boundary associated with the freight corridor (refer **Figure 2**)

Emission factors, particulate matter – vehicle transport – as modelled

Source	Activity rate	Units	Emission factor source	Emission factor			Units
				TSP	PM ₁₀	PM _{2.5}	
Trucks entering / leaving Proposal Site	Various (see Table 11)	VKT·hr ⁻¹	AP42 - 13.2.1 Paved Roads Assumed silt loading of road is 0.015 g·m ⁻² (ubiquitous baseline, >10,000 AADT flow, limited access (USEPA, 2011)). Average vehicle weight assumed to be 29 t (70% Pick Up and Delivery [PUD] vehicles at average of 20 t, 30% B-Double at average of 50 t).	2.42	0.46	0.11	VKT·hr ⁻¹

Emission factors – gaseous and particulate matter emissions, diesel engines – as modelled

Source	Activity rate	Units	Vehicle type	Op. hours	Emission factor source	NO _x emission factor (g·hr ⁻¹)	PM ₁₀ emission factor (g·hr ⁻¹)	PM _{2.5} emission factor (g·hr ⁻¹)
Trucks idling in bays at warehouses and industrial facilities	Various (see Table 12) ^(A)	veh·hr ⁻¹	PUD	24	(USEPA, 2008).	3.705	-	-
			B-Double	24		33.763	1.196	1.1
			Average	24		24.746	0.837	0.77

Notes: A Vehicles assumed to be idling for a 10-minute period each hour

Emission estimation, particulate matter - vehicle transport – as modelled

Facility number	Area of facility (m ²)	Number of daily trips	Distance of road from Proposal Site entrance to facility (m) (1-way)	VKT·day ⁻¹ (A)	TSP emission rate (kg·year ⁻¹) (A)	PM ₁₀ emission rate (kg·year ⁻¹) (A)	PM _{2.5} emission rate (kg·year ⁻¹) (A)
8	17,980	389	1,199	466.9	17.2	3.3	0.8
9	12,080	262	1,149	300.6	11.1	2.1	0.5
10	11,635	252	902	227.3	8.4	1.6	0.4
11	22,670	491	1,110	545.0	20.1	3.9	0.9
12	22,420	486	706	342.8	12.6	2.4	0.6
31	13,860	300	1,495	448.8	16.5	3.2	0.8
32	13,860	300	1,242	372.9	13.7	2.6	0.6
33	10,855	235	1,362	320.2	11.8	2.3	0.5
34	13,655	296	1,410	417.0	15.4	2.9	0.7
35	9,135	198	1,139	225.4	8.3	1.6	0.4
36	9,135	198	1387	274.4	10.1	1.9	0.5

Notes: A: VKT and emissions presented as two-way totals

Emission estimation – gaseous and particulate matter emissions, diesel engines – as modelled

Facility number	Number of vehicle bays	NO _x emission rate (kg·year ⁻¹) ^(A)	PM ₁₀ emission rate (kg·year ⁻¹) ^(A)	PM _{2.5} emission rate (kg·year ⁻¹) ^(A)
8	10	346.8	11.7	10.8
9	11	381.5	12.9	11.9
10	10	346.8	11.7	10.8
11	16	554.9	18.8	17.3
12	15	520.3	17.6	16.2
31	12	416.2	14.1	13.0
32	13	450.9	15.3	14.0
33	11	381.5	12.9	11.9
34	14	485.6	16.4	15.1
35	12	416.2	14.1	13.0
36	12	416.2	14.1	13.0

Notes: A: Vehicles assumed to be idling for a 10-minute period each hour