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520 Gardeners Road

Air Quality Impact Assessment

Addressee(s): Charter Hall Holdings Pty Ltd

Report Reference: 22.1054.FR1V1

Date: 16 December 2021

Quality Control

Study	Status	Prepared	Checked	Authorised
INTRODUCTION	Final	Northstar	MD	MD
THE PROPOSAL	Final	Northstar	MD	MD
LEGISLATION, REGULATION AND GUIDANCE	Final	Northstar	MD	MD
EXISTING CONDITIONS	Final	Northstar	MD	MD
METHODOLOGY	Final	Northstar	MD	MD
CONSTRUCTION AIR QUALITY IMPACT ASSESSMENT	Final	Northstar	MD	MD
OPERATIONAL AIR QUALITY IMPACT ASSESSMENT	Final	Northstar	MD	MD
MITIGATION AND MONITORING	Final	Northstar	MD	MD
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Report Status

Northstar References		Report Status	Report Reference	Version
Year	Job Number	(Draft: Final)	(R*x*)	(V*x*)
22	1054	Final	R1	V1
Based upon the above, the specific reference for this version of the report is:				22.1054.FR1V1

Final Authority

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

Martin Dolye 16th December 2021

Non-Technical Summary

Northstar Air Quality Pty Ltd was engaged by Charter Hall Holdings Pty Ltd, to perform an Air Quality Impact Assessment for the construction and operation of a two-storey warehouse and distribution centre located at 520 Gardeners Road, Alexandria.

This air quality impact assessment presents an assessment of the risks to local air quality associated with the construction and operation of the proposed warehouse facility and supports the State Significant Development Application, while presenting a range of recommended mitigation measures to minimise any identified air quality impacts where required and relevant.

The construction assessment showed there to be a high risk of health or nuisance impacts associated with earthworks, construction works, and construction traffic should no mitigation measures be applied. 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 Environment Protection Authority Approved Methods (NSW EPA 2016), using an approved and appropriate dispersion modelling technique.

All air quality criteria are predicted to be achieved, with the exception of one minor exceedance of the maximum 24-hour average $PM_{2.5}$ criterion. Good site management practices such as the observation of vehicle speeds, and minimisation of vehicle idling whilst on site, would be sufficient to ensure that this minor exceedance is not observed during operation of the warehouse facility.

It is respectfully suggested that the State Significant Development Application should not be refused on the grounds of air quality.

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Units Used in the Report

All units presented in the report follow 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 expressed as 50 $\mu g \cdot m^{-3}$ and not 50 $\mu g/m^3$.

Common Abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
AWS	automatic weather station
BoM	Bureau of Meteorology
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPI&E	Department of Planning, Industry and Environment
EPA	Environment Protection Authority
m^{-2}	per square metre
m^{-3}	per cubic metre
$mg \cdot m^{-3}$	milligram per cubic metre of air
$\mu g \cdot m^{-3}$	microgram per cubic metre of air
mE	metres East
$month^{-1}$	per month
mS	metres South
NEPM	National Environment Protection Measure
NO	nitric oxide
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
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
SSD	State Significant Development
TAPM	The Air Pollution Model
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator

1. INTRODUCTION

Charter Hall Holdings Pty Ltd (the Applicant) has engaged Northstar Air Quality Pty Ltd (Northstar) to perform an Air Quality Impact Assessment (AQIA) for the construction of a two-storey warehouse and distribution centre comprising 21 952 square metres (m^2) of warehouse and distribution gross floor area (GFA) with 5 557 m^2 ancillary office space, landscaping at ground and second floor levels, bicycle and car parking (the Proposal).

The Proposal will be situated within Lot 302 in Deposited Plan (DP) 1231238 at 520 Gardeners Road, Alexandria, NSW (the Proposal site). The Proposal site has an area of approximately 18 988 m^2 and a frontage of approximately 170 metres (m) on Bourke Road to the west and approximately 100 m on Gardeners Road to the south.

This AQIA presents an assessment of the risks to local air quality associated with the construction and operation of the Proposal. This AQIA supports the State Significant Development Application (SSDA) for the Proposal and presents a range of recommended mitigation measures to minimise any identified air quality 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*, in accordance with Section 4.36 of the EP&A Act.

1.1. Secretary's Environmental Assessment Requirements

NSW Department of Planning, Industry & Environment (DPIE), issued Industry Specific Secretary's Environmental Assessment Requirements (SEARs) for the Proposal on 30 November 2021. Table 1 below identifies the SEARs relevant to this AQIA report and the relevant sections of the report in which they have been addressed.

Table 1 Secretary's Environmental Assessment Requirements (SSD 32489140)

Issue	Requirement	Addressed
Air Quality	Identify significant air emission sources at the proposed development (during construction and operation)	Section 2.3
	Assess their potential to cause adverse off-site impacts	Section 6 and Section 7
	Detail proposed management and mitigation measures that would be implemented	Section 8
	Where air emissions during operation have the potential to cause adverse off-site impacts, provide a quantitative air quality impact assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.	Section 6

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);
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2007);
- Technical Framework and 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 2021; and
- State Environmental Planning Policy (State and Regional Development) 2011.

2. THE PROPOSAL

The following provides a description of the context, location, and scale of the Proposal, and a description of the processes and development activities on site. It also identifies the potential for emissions to air associated with the Proposal.

2.1. Environmental Setting

The Proposal site is located at 520 Gardeners Road, in the suburb of Alexandria in the Sydney Local Government Area (LGA). The Proposal site is approximately 6 kilometres (km) southwest of the Sydney Central Business District (CBD). A map showing the location of the Proposal site is provided in Figure 1.

The closest residential property is approximately 37 m from the Proposal site boundary to the southeast, on Gardeners Road, Mascot (see Section 4.1.2). 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.

2.2. Overview and Purpose

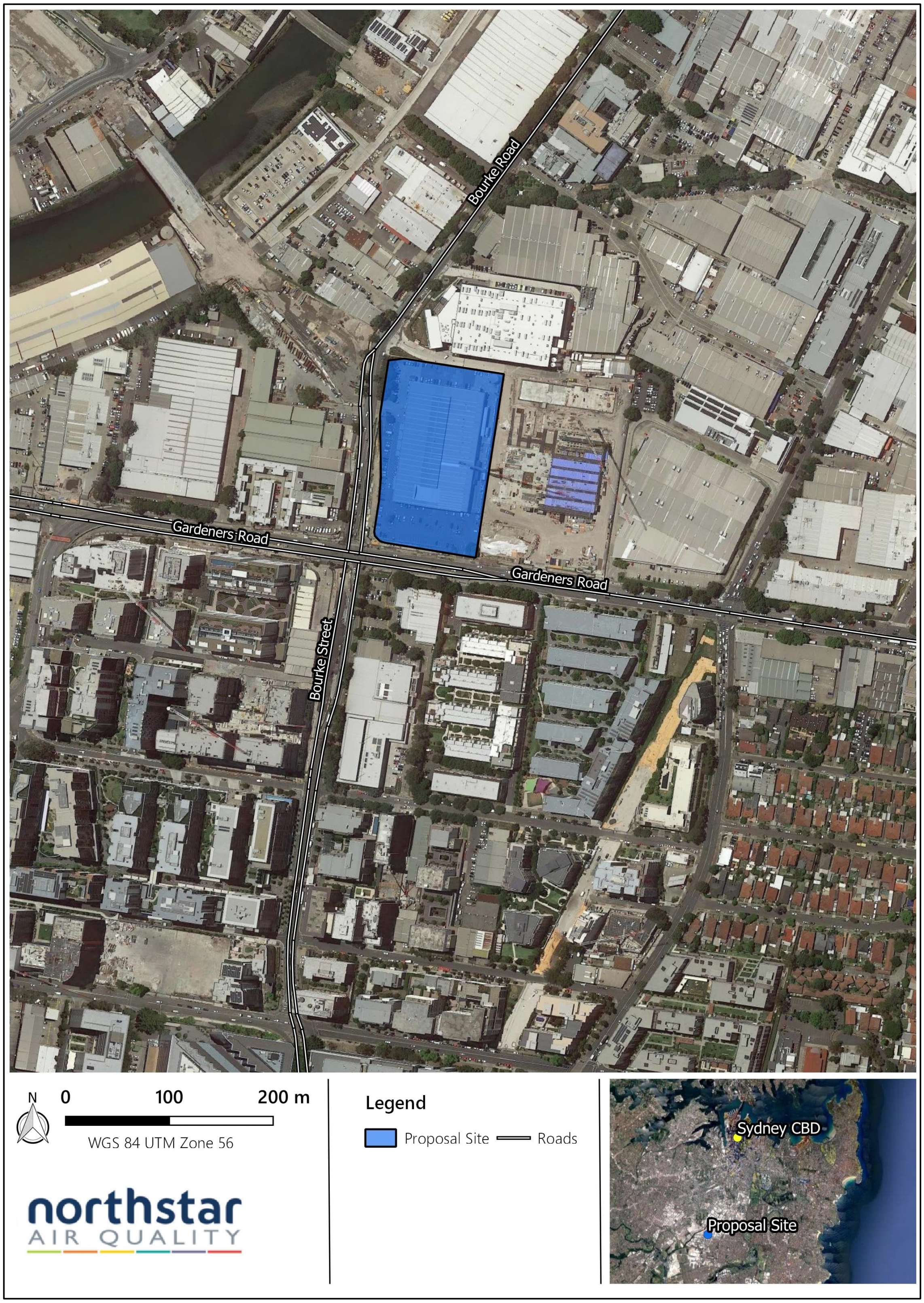
Consent is sought for the construction and operation of a two-storey warehouse and distribution centre and ancillary offices at the Proposal site. The intended use of the warehouses located at the Proposal site is not yet determined.

The overall scope of the proposed development is outlined as follows:

- Construction, fit out and operation of a two-storey warehouse and distribution centre comprising approximately 27 509 m^2 GFA including:
  - 21 952 m^2 of warehouse and distribution GFA; and
  - 5 557 m^2 GFA ancillary office space.
- Provision of 64 bicycle parking spaces at ground floor level and 144 car parking spaces at second floor level.
- Approximately 3 342 m^2 of hard and soft landscaping at ground and second floor levels.
- Replacement of the existing vehicular access from Bourke Road with two new access driveways from Bourke Road.
- Earthworks and upgrades to existing on-site infrastructure.
- Provision of internal vehicle access route and loading docks.
- Building identification signage.
- Operation 24 hours per day seven days per week.

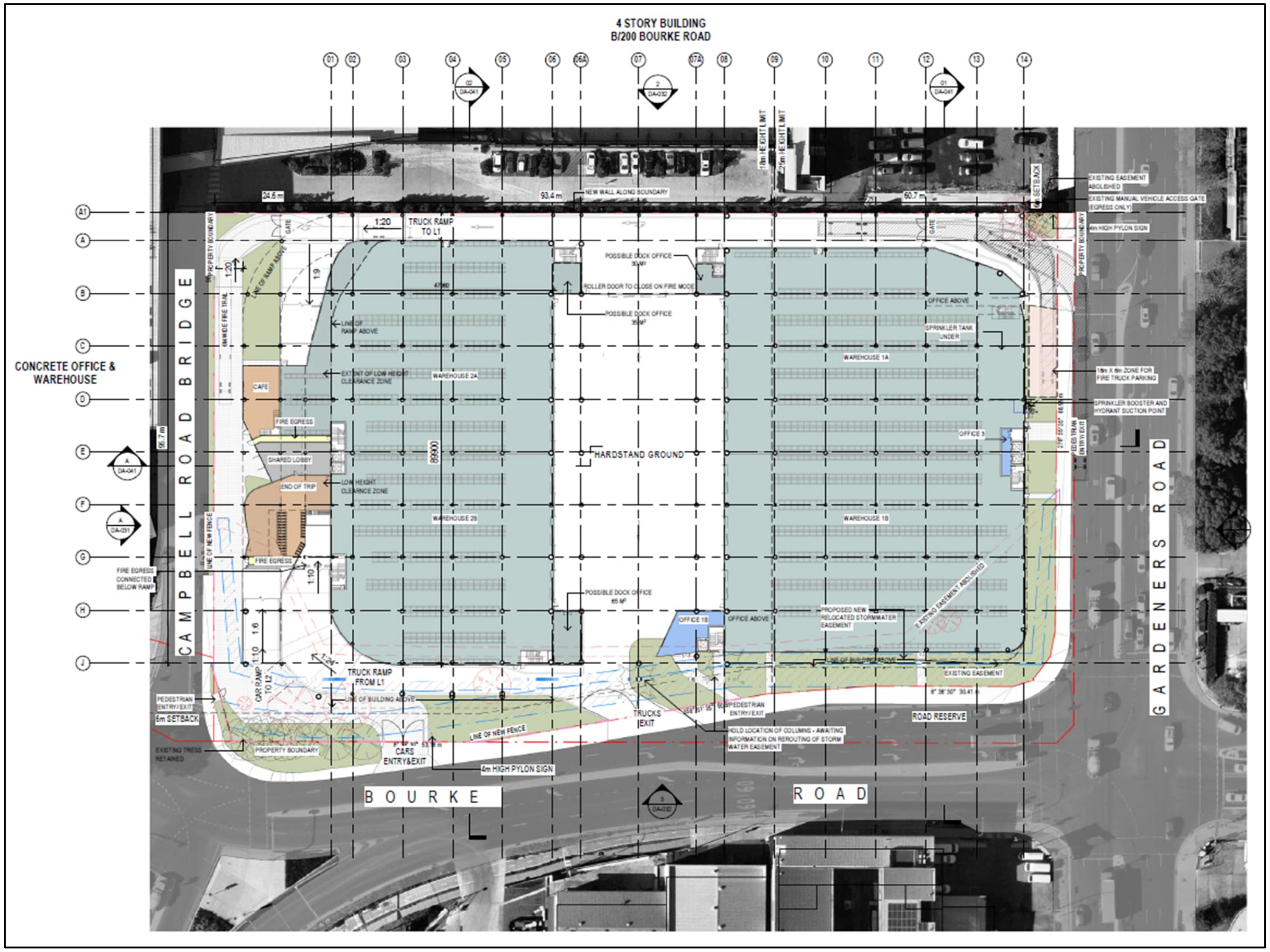
A layout of the Proposal site associated with the ground floor, level 1 and level 2, is provided in Figure 2, Figure 2, Figure 3 and Figure 4 and, respectively.

Figure 1 Proposal site location



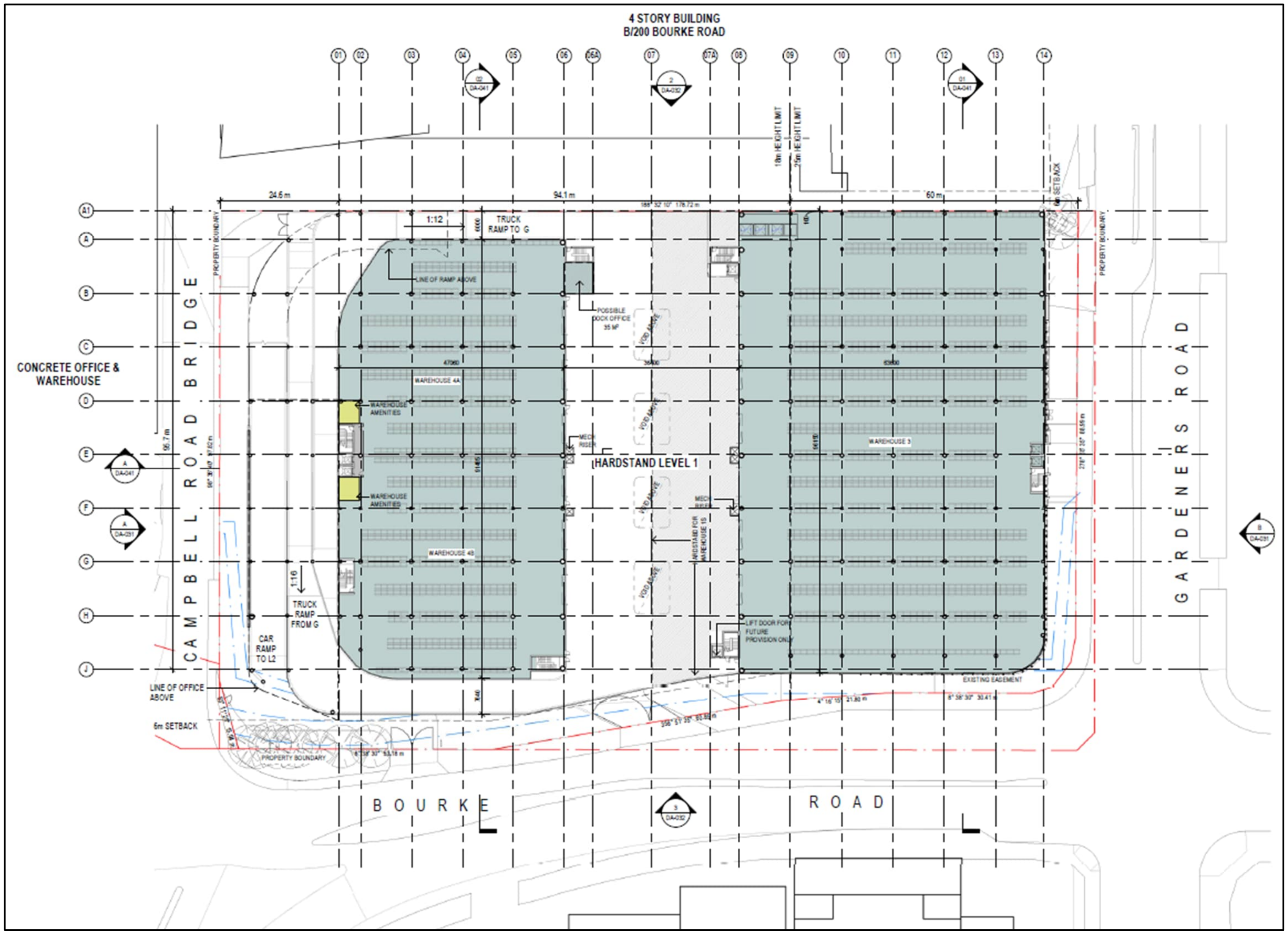
Source: Northstar Air Quality

Figure 2 Proposal site layout, ground floor



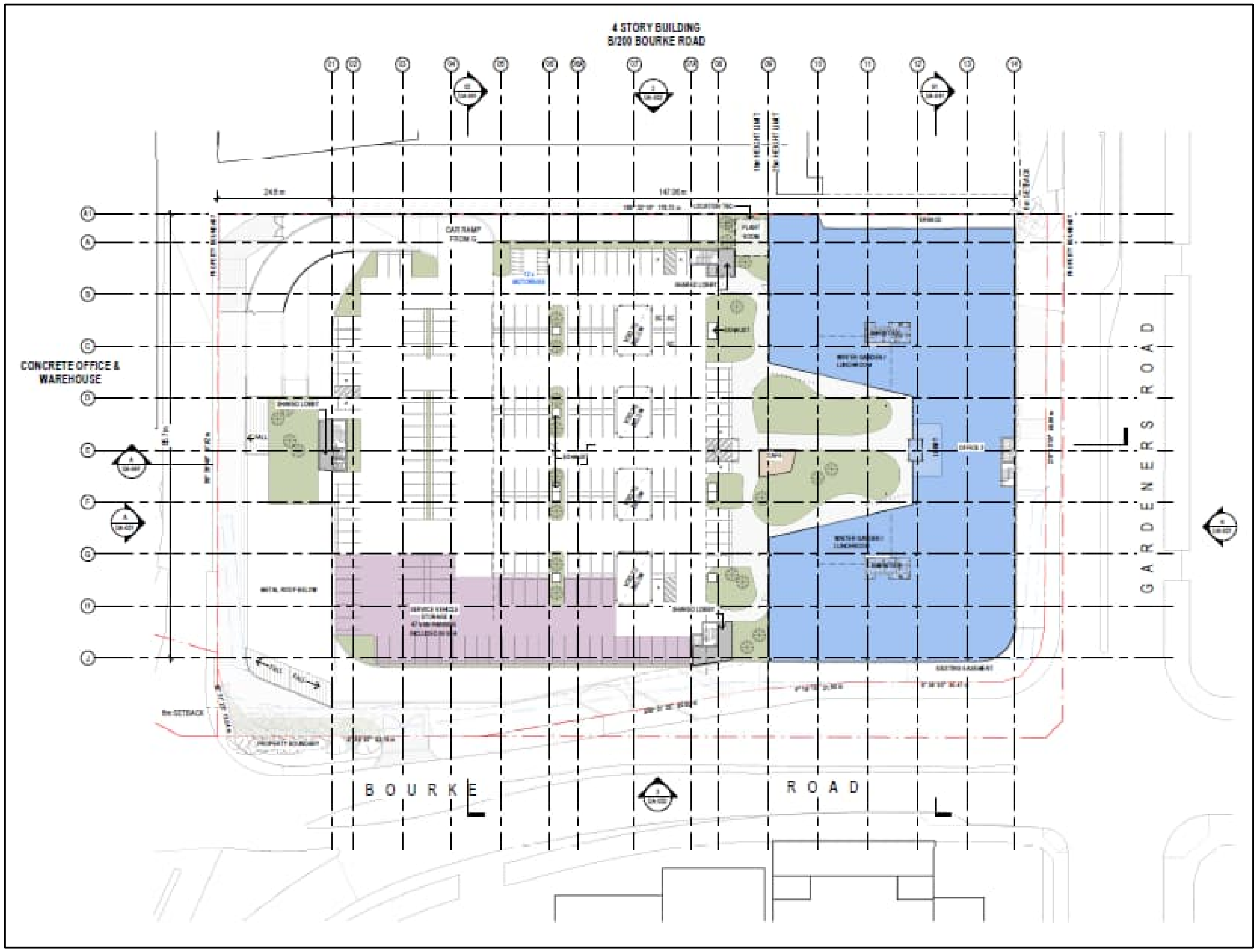
Source: SBA Architects

Figure 3 Proposal site layout, level 1



Source: SBA Architects

Figure 4 Proposal site layout, level 2



Source: SBA Architects

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 minor earthworks, construction of a warehouse, ancillary offices, car and van parking, docking areas, associated infrastructure, site access points and landscaping.

The total volume of the construction required for the Proposal is anticipated to be approximately 396 740 m^3, assuming a ground floor footprint of 16 600 m^2 and an average building height of 23.9 m.

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; and
- 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 potential emissions to air:

- Movement of vehicles around the internal roadways of the Proposal site on paved road surfaces;

- Diesel and petrol combustion emissions from the consumption of fuel, in the truck movements importing and exporting materials, and cars accessing the car park. The potential emissions would include particulate matter (as PM_{10} and $PM_{2.5}$) and oxides of nitrogen (NO_X), including nitrogen dioxide (NO_2). There would additionally be some less significant emissions of carbon monoxide (CO), sulphur dioxide (SO_2) 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 (PM_{10} and $PM_{2.5}$) and NO_2 associated with relevant short-term criteria. NO_X/NO_2 concentrations have been used within this assessment as an indicator pollutant for all other combustion-related gaseous emissions resulting from traffic.

The hardstand nature of the Proposal site, and the nature of the activities being performed (i.e. warehousing and distribution, with no 'dusty' activities) would result in the Proposal site roads having a low silt loading, and correspondingly the potential for wheel generated particulate matter at the Proposal site is anticipated to be minimal and has not been subject to quantitative assessment. It is noted however that particulate emissions from brake and tyre wear, in addition to that generated through fuel combustion, have been assessed in this AQIA.

A summary of the emission sources and potential emissions to air during the construction and operation of the Proposal, which have been subject to assessment, is presented in Table 2.

Table 2 Identified potential sources of air emissions

Source	Particulate Emissions			Gaseous Emissions
	TSP	PM_{10}	$PM_{2.5}$	NO_X
Construction Phase				
Construction activities	✓	✓	✓	
Operational Phase				
Exhaust emissions – truck and car engine	✓	✓	✓	✓

Given the nature of the development at this Proposal site, it is not anticipated that odour would be emitted in any significant quantity during construction or operation. Any potential contamination identified through detailed site investigation would be managed to ensure that no odour would impact upon surrounding receptor locations during construction. During operation, no odorous activities are anticipated, and correspondingly, odour has not been considered further as part of this AQIA.

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 AQIA.

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 National Health and Medical Research Council (NHMRC), National Environment Protection Council (NEPC), Department of Environment (DoE), World Health Organisation (WHO), and Australian and New Zealand Environment and Conservation Council (ANZECC)). Where relevant to this AQIA (coincident with the potential emissions identified in Section 2.3 and Table 2), the criteria have been adopted as set out in Section 7.1 of NSW EPA (2016) which are presented in Table 3 below.

Table 3 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units	Criterion	Notes
Nitrogen dioxide (NO_2)	1 hour	$\mu g \cdot m^{-3}$	246	Numerically equivalent to the AAQ NEPM[(b)] standards and goals.
	Annual	$\mu g \cdot m^{-3}$	62	
Particulates (as PM_{10})	24 hours	$\mu g \cdot m^{-3}$	50	
	1 year	$\mu g \cdot m^{-3}$	25	
Particulates (as $PM_{2.5}$)	24 hours	$\mu g \cdot m^{-3}$	25	
	1 year	$\mu g \cdot m^{-3}$	8	
Particulates (as TSP)	1 year	$\mu g \cdot m^{-3}$	90	
Particulates (as dust deposition)	1-year[(c)]	$g \cdot m^{-2} \cdot month^{-1}$	2	Assessed as insoluble solids as defined by AS 3580.10.1
	1-year[(d)]	$g \cdot m^{-2} \cdot month^{-1}$	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

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. The overall objective of this legislative instruments is to achieve the requirements of the National Environment Protection (Ambient Air Quality) Measure;
- Clean Air for NSW: The 10-year plan for the improvement in air quality;
- Inter-agency Taskforce on Air Quality in NSW: a vehicle to co-ordinate cross-government incentives and action on air quality;
- Managing particles and improving air quality in NSW; and
- Diesel and marine emission management strategy.

In regard to the relevance of the NSW Government's drive to improve air quality across the State and this AQIA, it is imperative that this Proposal demonstrates leadership in the development of the NSW economy (in terms of activity and employment) and concomitantly not cause a detriment in achieving its objectives.

4. EXISTING CONDITIONS

4.1. Surrounding Land Sensitivity

4.1.1. Land Use Zoning

The land use surrounding the Proposal site is zoned IN1 (General Industrial) under the provision of the Sydney Local Environmental Plan 2012 (LEP 2012). The closest residential property to the Proposal site is approximately 37 m to the southeast on Gardeners Road. Land zoning of B4 (Mixed use) is located to the south and south east of the Proposal site.

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 (see Table 3) is as a 24-hour averaging 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 adoption of those locations in 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) 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 (km^2) 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
- High > 5 000
- Medium > 2 000
- Low > 500
- Very low < 500
- No population 0

Using ABS data in a GIS, the population density of the area surrounding the Proposal site are presented in Figure 4.

The Proposal site and receptors are located in an area of very low to high population density. Generally, the broader context of the Proposal site is typified by employment-generating land uses and also residential areas.

In accordance with the requirements of the NSW EPA, several receptors have been identified and the receptors adopted for use within this AQIA are presented in Table 4.

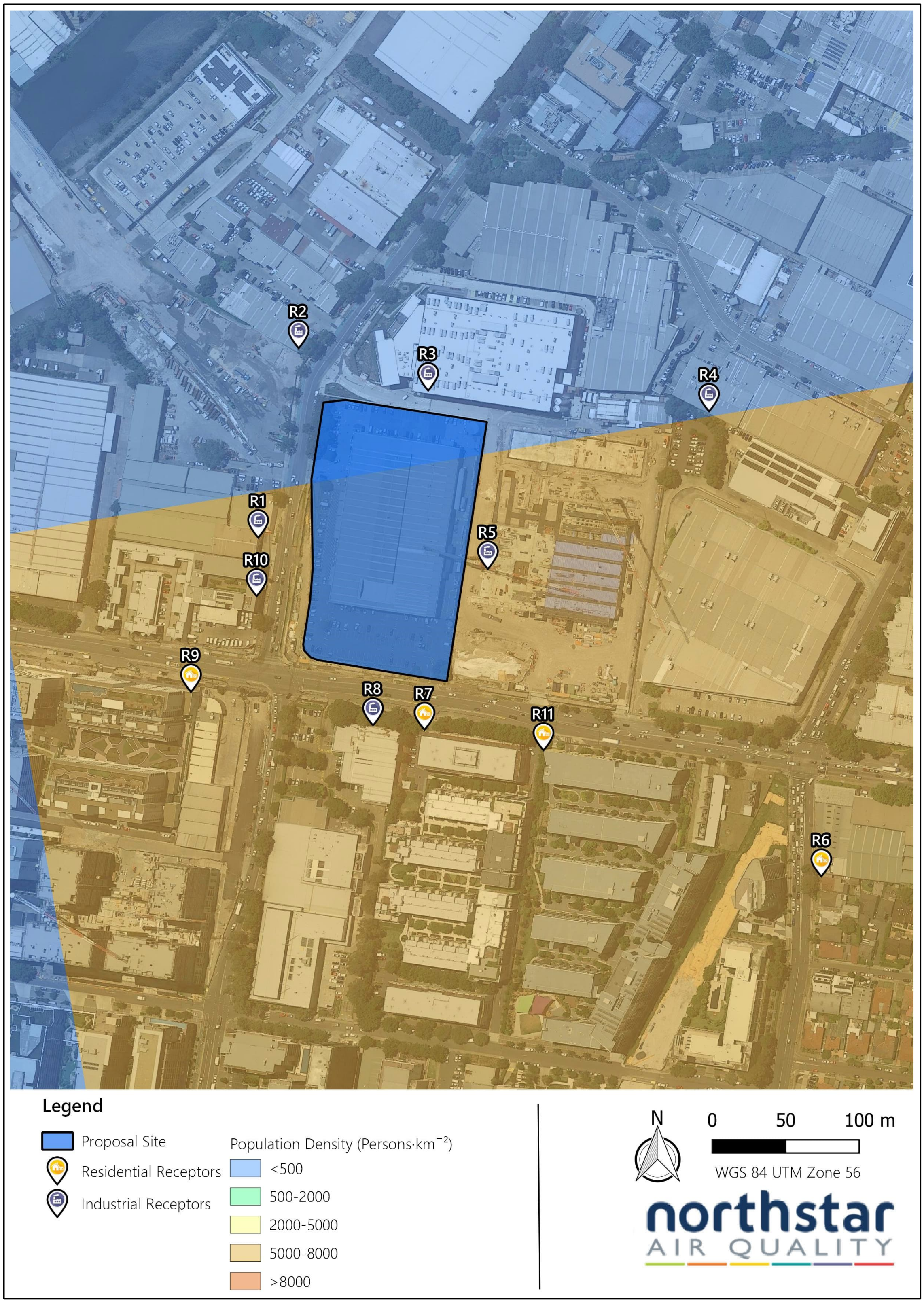
Table 4 is not intended to represent a definitive list of sensitive land uses, but a cross section of available locations, that are used to characterise larger areas, or selected as they represent more sensitive locations, which may represent people who are more susceptible to changes in air pollution.

Table 4 Receptor locations used in the study

Rec	Location	Land use	Coordinates (UTM)	
			mE	mS
R1	83 Bourke Road, Alexandria	Industrial	332 475	6 245 302
R2	79 Bourke Road, Alexandria	Industrial	332 502	6 245 431
R3	200 Bourke Road, Alexandria	Industrial	332 590	6 245 402
R4	190-196 Bourke Road, Alexandria	Industrial	332 782	6 245 388
R5	506 Gardeners Road, Alexandria	Industrial	332 631	6 245 281
R6	112 O'Riordan Street, Mascot	Residential	332 858	6 245 071
R7	635 Gardeners Road, Mascot	Residential	332 588	6 245 171
R8	639 Gardeners Road, Mascot	Industrial	332 553	6 245 174
R9	659 Gardeners Road, Mascot	Residential	332 429	6 245 197
R10	85 Bourke Road, Alexandria	Industrial	332 474	6 245 262
R11	629 Gardeners Road, Mascot	Residential	332 669	6 245 157

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.

Figure 5 Population density and sensitive receptors surrounding the Proposal site



Source: Image courtesy of Google Maps and data sourced from the ABS, adapted by Northstar Air Quality

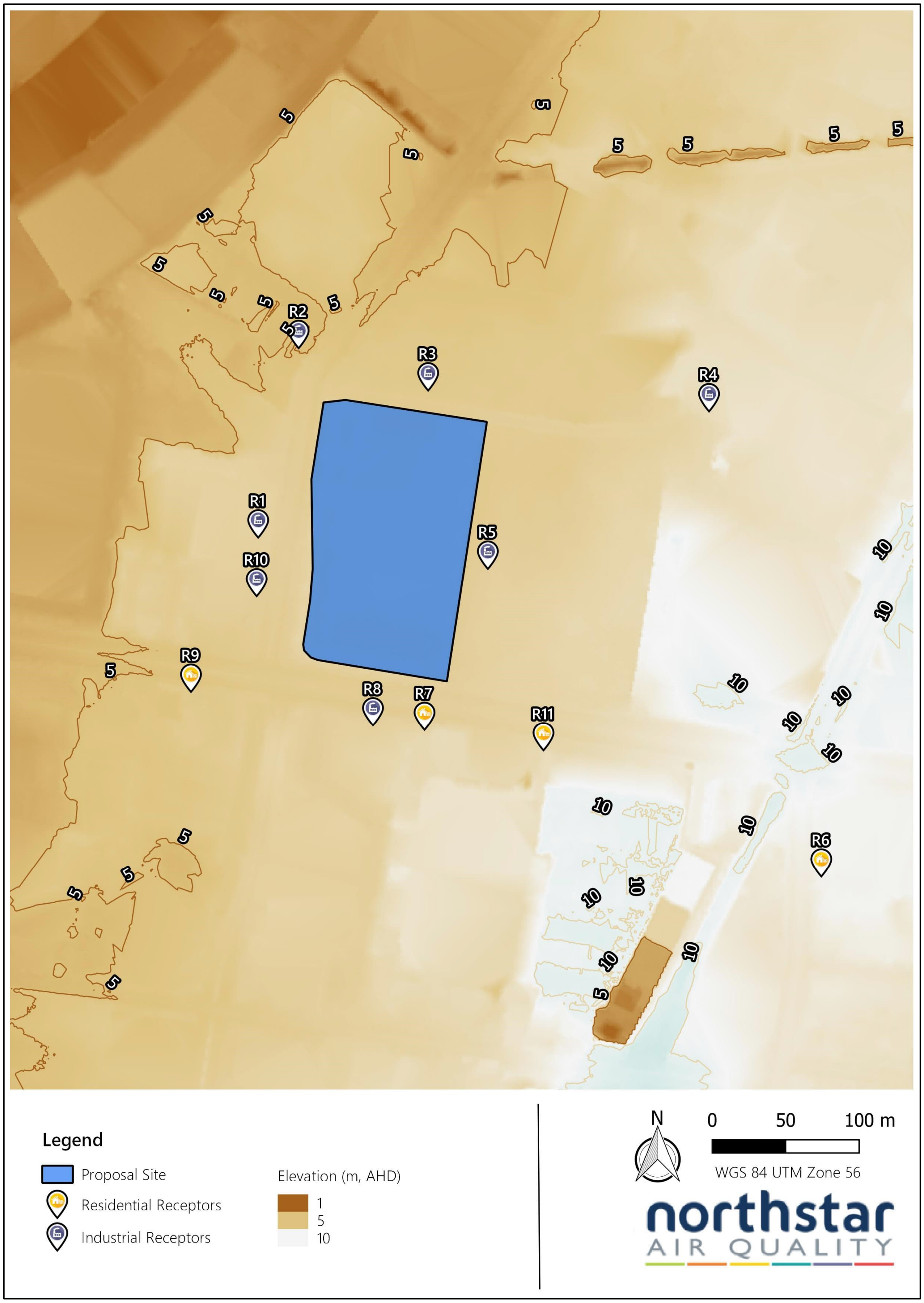
4.1.3. Uniform Receptor Locations

Additional to the sensitive receptors identified in Section 4.1.2, 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 8 m Australian Height Datum (AHD). The topography between the Proposal site and nearest sensitive receptor locations is uncomplicated. A representation of the topography surrounding the Proposal site is presented in Figure 6.

Figure 6 Topography surrounding the Proposal site



Source: Image courtesy of Google Maps

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).

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.

A number of meteorological stations operated by BoM are located within a 7.5 km radius of the Proposal site. A summary of the relevant AWS is provided in Table 5 below (listed by proximity).

Table 5 Details of meteorological monitoring surrounding the Proposal site

Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Sydney Airport – Station # 066037	BoM	331 173	6 242 272	3.2
Sydney Observatory Hill – Station # 066062	BoM	333 955	6 251 840	6.7
Canterbury Racecourse– Station # 066194	BoM	325 572	6 246 697	7.1

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

It is considered that Sydney Airport AMO 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 2018 to 2020, winds at Sydney Airport AMO show similar wind distribution patterns across the years assessed, with a predominant north-westerly wind direction with north-easterly and south-westerly components evident.

The majority of wind speeds experienced at the Sydney Airport AMO between 2018 and 2020 are generally in the range 1.5 meters per second ($m \cdot s^{-1}$) to 8 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from south-easterly, south-westerly and north-easterly directions. Winds of this speed occur during 20.5 % of the observed hours during the years. Calm winds (< 0.5 $m \cdot s^{-1}$) are less common and occur during 1.6 % of hours across the years.

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. These 'background' (sometimes called 'baseline') air quality conditions 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 DPIE. These locations (listed by proximity) are briefly summarised in Table 6 .

Table 6 Closest DPIE AQMS to the Proposal site

AQMS Location	Distance to Site (km)	Screening Parameters				
		2018 Data	Measurements			
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Randwick	3.6	✓	✓	✓	×	✓
Earlwood	9.4	✓	✓	✓	×	✓

The closest active AQMS is noted to be located at Randwick and is generally considered to be the monitoring location most reflective of the conditions at the Proposal site.

Given the wind distributions across the years examined, data for the year 2018 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.

Appendix B provides a detailed assessment of the background air quality monitoring data collected at the Randwick AQMS.

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 PM_{10} has been established for the Sydney Metropolitan region. Based upon these data, a relationship between ambient concentrations of TSP : PM_{10} 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 3) are presented as (i) a cumulative deposition rate of 4 g·m^{-2}·month^{-1} and (ii) a discrete deposition rate of 2 g·m^{-2}·month^{-1}. In lieu of a background deposition rate to derive a cumulative rate, the incremental impact assessment criterion (2 g·m^{-2}·month^{-1}) will be used. This is a commonly adopted approach when background deposition rates are not available.

A summary of the air quality monitoring data and assumptions used in this assessment are presented in Table 7.

Table 7 Summary of background air quality used in the AQIA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP) (derived from PM_{10})	Annual µg·m^{-3}	43.6	Estimated on a TSP:PM_{10} ratio of 2.0551 : 1
Particles (as PM_{10}) (Randwick)	24-hour µg·m^{-3}	Daily Varying	The 24-hour maximum for PM_{10} in 2018 was 95.5 µg.m^{-3}
	Annual µg·m^{-3}	21.2	
Particles (as $PM_{2.5}$) (Randwick)	24-hour µg·m^{-3}	Daily Varying	The 24-hour maximum for $PM_{2.5}$ in 2018 was 31.8 µg.m^{-3}
	Annual µg·m^{-3}	7.6	
Dust deposition	Annual g·m^{-2}·month^{-1}	2.0	Difference in NSW EPA maximum allowable and incremental impact criterion
Nitrogen dioxide (NO_2) (Randwick)	1-hour µg·m^{-3}	75.2	Hourly maximum 1-hr average in 2018
	Annual µg·m^{-3}	12.4	Annual average in 2018

Note: Reference should be made to Appendix B

A number of AQMS in NSW metropolitan and regional population centres recorded particulate matter concentrations above the national standard on some days during 2018. This was mainly driven by intense drought conditions, with an increase in hazard reduction burns around Sydney and the Illawarra from April to August and the increasing frequency of widespread dust storms throughout the year (NSW DPIE, 2020).

The 24-hour NEPM PM_{10} standard was exceeded on five distinct calendar days at Randwick AQMS due to exceptional events as presented in Table 8. Widespread dust storms and extensive hazard reduction burns (HRB) throughout the NSW Greater Metropolitan Region were the major influences on elevated PM_{10} levels throughout New South Wales.

During 2018, five exceedances of the 24 hour PM_{10} criterion, and one exceedance of the 24 hour $PM_{2.5}$ criterion were experienced at the Randwick AQMS. As presented in Table 8, all of these exceedances were due to dust storms or fires[1].

[1] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/national-environment-protection-measure-ambient-air-quality-nsw-compliance-report-2018-200278.pdf

Table 8 Days exceeding PM_{10} and $PM_{2.5}$ 24-hour AAQ NEPM standard at Randwick AQMS - 2018

Date	Max. 24-hr PM_{10} concentration ($\mu g \cdot m^{-3}$)	Max. 24-hr $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)	Event
15 February	53.2	11.1	Dust Storm due to strong south-westerly winds
19 March	62.4	17	Widespread dust storm
29 May	47.4	31.8	Hazard reduction burns occurring in Colo Heights and the Blue Mountains
18 July	59.9	10.3	Dust from South Australia and Victoria impacted much of New South Wales
21 November	67.1	16	Significant dust storm, ahead of strong, dry cold front, transported dust from western New South Wales and the Mallee region of Victoria
22 November	95.5	15	Significant dust storm, ahead of strong, dry cold front, transported dust from western New South Wales and the Mallee region of Victoria

Source: New South Wales Annual Compliance Report 2018

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 local air quality is presented in Section 6.

4.5. Potential for Cumulative Impacts

The area surrounding the Proposal site includes a number of recently approved developments which have been considered within this AQIA.

Data centre developments have been approved/constructed at the following locations:

- 200 Bourke Road, Alexandria (constructed - identified as receptor R3 in Figure 5 and Table 4)
- 506 Gardeners Road, Alexandria (approved - identified as receptor R5 in Figure 5 and Table 4)
- 639 Gardeners Road, Alexandria (constructed - identified as receptor R8 in Figure 5 and Table 4)

Review of the documentation supporting the development applications for those data centre developments does not provide any information relating to potential air quality impacts during their construction or operation. Experience in performing assessments for developments of this nature indicates that emissions during construction would be similar to those assessed for the Proposal, which can be appropriately managed through considerate dust management measures to result in minimal impacts on the surrounding environment. Cumulative impacts with the Proposal associated with construction activities for any development would therefore be anticipated to be minor.

In relation to operation of data centres, emissions are generally negligible, although during periods of power interruption, emergency diesel fuelled generators may be present to maintain electricity supply to those buildings and infrastructure. Short-term elevations in combustion related pollutant concentrations (refer Section 2.3) may be experienced in the local area, although the impacts associated with the Proposal would be likely to be significantly lower than that generated by those developments, in that situation.

Cumulative impacts have been considered through the adoption of an appropriate background air quality dataset, as described in Section 4.4.

Residential / mixed use developments are located at the following locations:

- 635 Gardeners Road, Alexandria (identified as receptor R7 in Figure 5 and Table 4)
- 629 Gardeners Road, Alexandria (identified as receptor R11 in Figure 5 and Table 4)
- 659 Gardeners Road, Alexandria (identified as receptor R9 in Figure 5 and Table 4)

No significant sources of emissions which may cumulatively impact with the Proposal would be anticipated during the ongoing operation of residential or mixed use developments.

Receptor locations have been included at each of the addresses identified above, to ensure that the Proposal does not impact upon the air quality at those locations, when compared to the relevant air quality criteria as outlined in Section 3.

Cumulative impacts have been considered through the adoption of an appropriate background air quality dataset, as described in Section 4.4.

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.

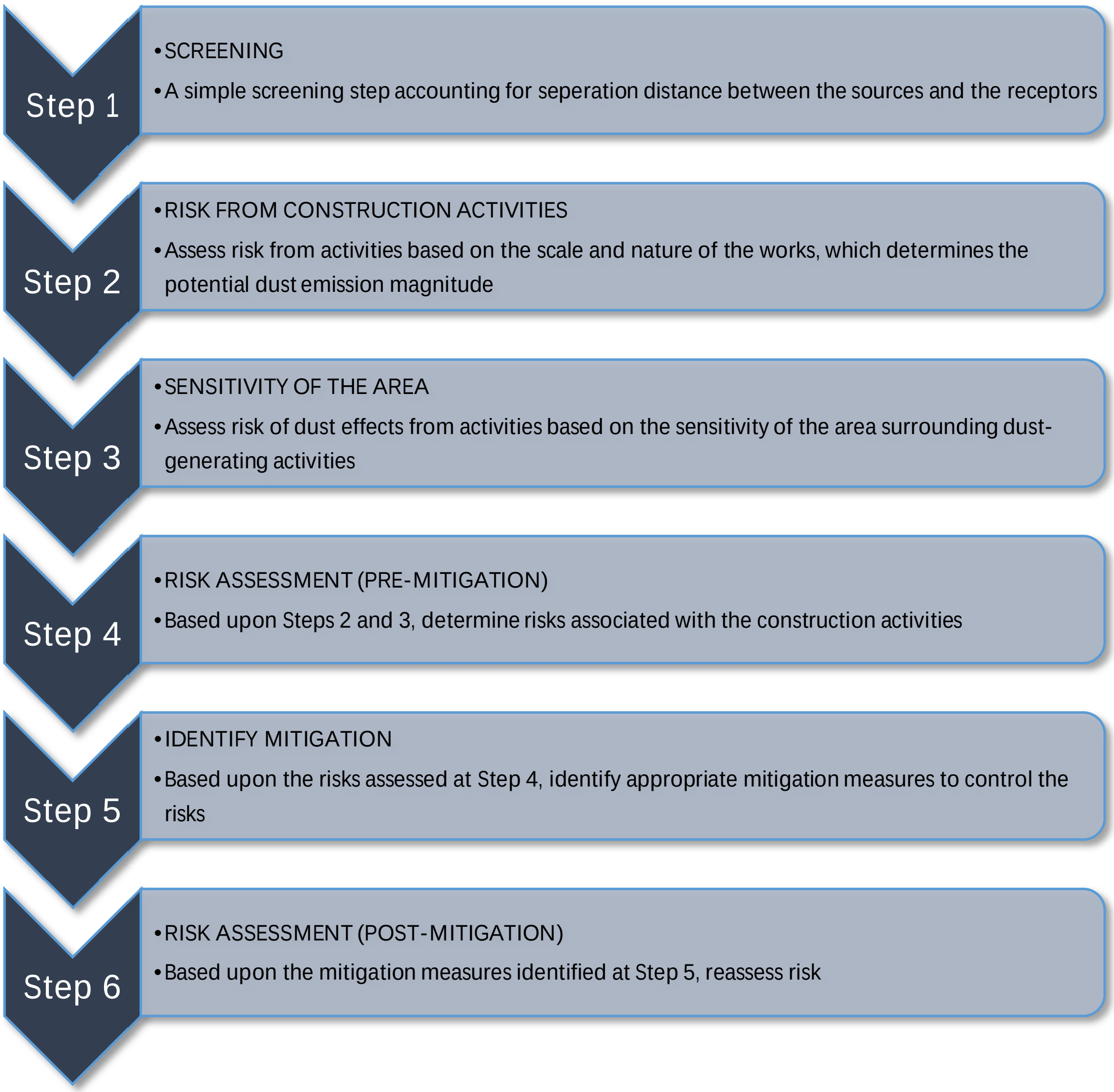
Modelling of dust from construction Proposals is generally not considered appropriate, as there is a lack of reliable emission factors from construction activities upon which to make predictive assessments, and the rates would vary significantly, depending upon local conditions. In lieu of a modelling 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)[2]. 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 7.

[2] www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf

Figure 7 Construction phase impact risk assessment methodology



The assessment approach, as illustrated above in Figure 7, 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. The predictions are termed 'incremental impacts'. Added to the incremental 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 addition of background assumptions to the incremental impacts derives the predicted 'cumulative impacts'.

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. For road-traffic emissions, the assessment considered the applicability of emission factors presented in the National Pollutant Inventory (NPI) *Emission estimation technique manual for aggregated emissions from motor vehicles* (2000) (NPI, 2000). The emission factors were discounted due to the age of the emission factors, and the rapid improvements in engine performance over the last two decades. For example, a data set published in the year 2000 would utilise emission standards for passenger cars performing to Australian Design Rule (ADR) 37/01 (at best) which specifies (by way of example) a NO_X emission of 1.93 $g \cdot km^{-1}$ for petrol fuelled cars. For comparison, ADR7904 (type approval 2016) specify NO_X emission standard of 0.06 $g \cdot km^{-1}$ for petrol fuelled cars respectively, which represents 3 % of the ADR37/01 standard[3].

To better represent more modern emission performance, reference has been made to the fleet-average NSW EPA GMR Emission Inventory On-Road emission assessment, adapted for this study by assumptions relating to site-specific fleet composition, road gradient and traffic conditions. The model is a development of ADR emission performance standards, fleet distribution published by the Motor Vehicle Census for Australia, and numerous sources of published road-traffic emission databases, including COPERT4.

Emissions of non-exhaust PM, including brake wear, tyre wear and road wear are included as factors in the assessment of PM_{10} and $PM_{2.5}$ emissions.

[3] https://www.infrastructure.gov.au/vehicles/environment/emission/files/Emission_Standards_for_Petrol_Cars.pdf

The emission factors are provided as weighted by the road type, which helps provide definition of base vehicle speed and general traffic flow characteristics. For the purposes of this assessment, the roads at the Proposal site have been assessed as being typified as an "local/residential" road (to represent conditions within the Proposal site):

> *Secondary roads with prime purpose of access to property. Characterised by low congestion and low levels of heavy vehicles. Generally one lane each way, undivided with speed limits of 50 km/h maximum. Regular intersections, mostly unsignalised, low intersection delays.*

Traffic data for the Proposal has been provided by Ason Group, with a summary presented in Table 9. Note that the AM peak traffic data has been adopted for the assessment against short-term (1-hour) air quality criteria, with the daily total used to assess against longer term (24-hour and annual) criteria.

Table 9 Traffic data - Proposal

Vehicle	AM Peak	PM Peak	Daily total
Light	121	101	1 106
Heavy	34	29	142
Total	155	30	1 248

A summary of the data adopted as part of the assessment is presented in Table 9. The height of emissions, specifically associated with the ramp up to, and down from, level 1 and level 2 at the Proposal site has been taken into account in the modelling assessment.

In relation to emissions associated with idling trucks at the Proposal site, these have been assumed to be limited to four locations (two on the ground level, and two on level 1) at any one time over an entire 1-hour period, which is considered to be conservative. Given the layout of the Proposal site, it is anticipated that no more than four vehicles would be idling at any one time. Emission factors associated with idling trucks have been sourced from (USEPA, 2008).

Table 10 Data used in calculation of vehicle flows and emissions

ID	Parameter	Source	Data
1	Traffic flows for the Proposal	Ason Group (see Table 9)	Traffic data split by car and rigid vehicles
2	Peak hour traffic flows	Ason Group (see Table 9)	Peak AM adopted as conservative
3	Vehicle types	Ason Group (see Table 9)	Traffic data split by cars and rigid vehicles
4	Fuel types	ABS Motor Vehicle Census, 2020	Diesel and petrol fuel split for car, light commercial, light rigid, heavy rigid, articulated vehicles (most recent data available, not available by State or Territory)
5	Emissions	NSW EPA GMR Emissions Inventory 2008	NO_X, PM_{10} exhaust emissions PM_{10}, $PM_{2.5}$ brake and tyre wear emissions calculated for local/residential roads, $PM_{2.5}$ from exhaust emission calculated to be 71.4% of PM_{10}

5.2.3. NO to NO_2 Conversion

The conversion of NO to NO_2 has been assumed to be in accordance with Method 2 of the NSW EPA Approved Methods (section 8.1.2 of (NSW EPA, 2016)). This is termed the Ozone Limiting Method (OLM). This method assumes that all the available ozone in the atmosphere will react with NO in the plume until either all the ozone (O_3) or all the nitrous oxide (NO) is depleted. This approach assumes that the atmospheric reaction is instant, although in reality the reaction takes place over a number of hours.

A level 2 assessment has been performed which uses the contemporaneous hourly model predictions of NO_X and measured hourly NO_2 and O_3 concentrations at the Randwick AQMS in 2018.

$$[NO_2]_{total} = \{0.1 \times [NO_x]_{pred}\} + MIN\left\{(0.9 \times [NO_x]_{pred}\ or\ \left(\frac{46}{48}\right) \times [O_3]_{bkgrd}\right\} + [NO_2]_{bkgrd}$$

where:

$[NO_2]_{total}$ = the predicted concentration of NO_2 in $\mu g \cdot m^{-3}$

$[NO_x]_{pred}$ = the dispersion model prediction of the ground level concentration of NO_X in $\mu g \cdot m^{-3}$

$[O_3]_{bkgrd}$ = the background ambient O_3 concentration in $\mu g \cdot m^{-3}$

$\left(\frac{46}{48}\right)$ = the ratio of molar mass of NO_2 and O_3

$[NO_2]_{bkgrd}$ = the background ambient NO_2 concentration in $\mu g \cdot m^{-3}$

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.

Table 11 overleaf presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria. Receptors found to be within the screening distances have been highlighted.

Table 11 Construction phase impact screening criteria distances

Rec	Location	Land Use	Screening Distance (m)		
			Boundary (350m)	Site Entrance (500m)	Construction route (50m)
R1	83 Bourke Road, Alexandria	Industrial	37	63	20
R2	79 Bourke Road, Alexandria	Industrial	39	80	78
R3	200 Bourke Road, Alexandria	Industrial	12	92	92
R4	190-196 Bourke Road, Alexandria	Industrial	151	271	223
R5	506 Gardeners Road, Alexandria	Industrial	15	138	93
R6	112 O'Riordan Street, Mascot	Residential	288	445	81
R7	635 Gardeners Road, Mascot	Residential	37	196	22
R8	639 Gardeners Road, Mascot	Industrial	40	182	25
R9	659 Gardeners Road, Mascot	Residential	84	176	55
R10	85 Bourke Road, Alexandria	Industrial	37	98	15
R11	629 Gardeners Road, Mascot	Residential	81	250	23

With reference to Table 11, sensitive receptors are noted to be within the screening distance boundaries and therefore require further assessment as summarised in Table 12.

Table 12 Application of step 1 screening

Construction Impact	Screening Criteria	Step 1 Screening	Comments
Earthworks	350 m from boundary 500 m from site entrance	Not screened	Receptors identified within the screening distance
Construction	350 m from boundary 500 m from site entrance		
Track-out	100 m from site entrance		
Construction Traffic	50 m from roadside		

6.2. Impact Magnitude

The footprint of the Proposal site (the area affected) is estimated as being approximately 18 950 m^2 (1.9 hectares [ha]) in area.

The Proposal would involve minor earthworks for the Proposal site area, and the construction of a warehouse with an approximate (total) building volume of 396 740 m^3, assuming a ground floor footprint of 16 600 m^2 and an average building height of 23.9 m.

The assumed supply route around the Proposal site during construction works may be up 70 m in two-way length. Due to the significant volume of construction, 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 Gardeners Road towards the M1 Motorway.

Based upon the above assumptions and the assessment criteria presented in Appendix C, the dust emission magnitudes are as presented in Table 13.

Table 13 Construction phase impact categorisation of dust emission magnitude

Activity	Dust Emission Magnitude
Earthworks and enabling works	Large
Construction	Large
Track-out	Large
Construction traffic routes	Large

6.3. Sensitivity of an Area

6.3.1. Land Use Value

The assessment criteria as described in Section 5.1, 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.

The maximum land use value across the identified receptors has been taken forward to be conservative. It is concluded to be *high* for health impacts and for dust soiling, given the distance between the receptors and the Proposal site and the nature of receptors surrounding the site and the PM_{10} annual average concentration of 21.2 $\mu g{\cdot}m^{-3}$ as reported in Section 4.4.

6.3.2. Sensitivity of an Area

The assessment criteria as described in Section 5.1, 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 is determined to be *high* and to dust soiling may be identified as being *medium*. The assumed existing background annual average PM_{10} concentrations (measured at Randwick in 2018) are reported in Section 4.4 and presented in Table 6.

6.4. Risk (Pre-Mitigation)

Given the sensitivity of the identified receptors is classified as *medium* for dust soiling, and *high* for health effects, and the dust emission magnitudes for the various construction phase activities as shown in Table 13. The resulting risk of air quality impacts (without mitigation) is as presented in Table 14.

Table 14 Risk of air quality impacts from construction activities

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

The risks summarised in Table 14 show that there is a *high* risk of adverse dust soiling and *high* risk of human health impacts at sensitive receptors, if no mitigation measures were to be applied to control emissions associated with all construction phase activities.

6.5. Identified Mitigation

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

Table 15 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 Construction Environment Management Plan (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 15 Site-specific management measures

Identified Mitigation		Unmitigated Risk
1	Communications	High
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	H

Identified Mitigation		Unmitigated Risk
1.2	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
1.3	Display the head or regional office contact information.	H
1.4	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	H
2	Site Management	High
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
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.	H
3	Monitoring	High
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.	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
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
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.	H
4	Preparing and Maintaining the Site	High
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	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
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.	H

Identified Mitigation		Unmitigated Risk
4.4	Avoid site runoff of water or mud.	H
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	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	H
4.7	Cover, seed or fence stockpiles to prevent wind erosion	H
5	Operating Vehicle/Machinery and Sustainable Travel	High
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	Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable	H
5.4	Impose and signpost a maximum-speed-limit of 25 $km{\cdot}h^{-1}$ on surfaced and 15 $km{\cdot}h^{-1}$ 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	H
5.4	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	H
5.5	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	H
6	Operations	High
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
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.	H
7	Waste Management	High
7.1	Avoid bonfires and burning of waste materials.	H
8	Measures Specific to Construction	High
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	H

Identified Mitigation		Unmitigated Risk
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	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.	H
8.4	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust	D
9	Measures Specific to Track-Out	High
9.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	H
9.2	Avoid dry sweeping of large areas.	H
9.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	H
9.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H
9.5	Record all inspections of haul routes and any subsequent action in a site log book.	H
9.6	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.	H
9.7	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	H
9.8	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.	H
9.9	Access gates to be located at least 10 m from receptors where possible.	H
10	Specific Measures to Construction Traffic (adapted)	High
10.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H
10.2	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.	H
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	H
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.	H

Notes D = desirable (to be considered), H = highly recommended (to be 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 the activities to be performed, residual impacts associated with fugitive dust emissions from the Proposal would be anticipated to be '*negligible,* should the implementation of the mitigation measures outlined above be performed appropriately.

7. OPERATIONAL AIR QUALITY IMPACT ASSESSMENT

The methodology used to assess operational phase impacts is discussed in Section 5.2. 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.

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

7.1. Particulate Matter

Results are presented in this section for the predictions of particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition). The averaging periods associated with the criteria for these pollutants is 24-hour and annual averages, as specified in Table 3. The emissions adopted for this scenario reflect the operational profile of the Proposal over those averaging periods (refer Section 5.2.2).

7.1.1. Annual Average TSP, PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the Proposal operations, are presented in Table 16 overleaf.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at residential receptor locations are low (less than (<) 0.2 % of the annual average TSP criterion, ≤ 0.9 % of the annual average PM_{10} criterion and ≤ 2.3 % of the $PM_{2.5}$ criterion).

The addition of existing background concentrations (refer Section 4.4) results in predicted concentrations of annual average TSP being < 48.7 % , annual average PM_{10} being ≤ 85.7 % of the relevant criteria and annual average $PM_{2.5}$ being ≤ 97.3 % of the relevant criteria, at the nearest receptors.

Table 16 Predicted annual average TSP, PM_{10} 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
Criterion	90			25			8		
Max. % of criterion	0.2%	48.4%	48.7%	0.9%	84.8%	85.7%	2.3%	95.0%	97.3%
R1	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R2	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R3	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R4	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R5	0.2	43.6	43.8	0.2	21.2	21.4	0.2	7.6	7.8
R6	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R7	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R8	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R9	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R10	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7
R11	<0.1	43.6	43.7	<0.1	21.2	21.3	<0.1	7.6	7.7

No contour plots of annual average TSP, PM_{10} or $PM_{2.5}$ are presented, given the minor contribution from the Proposal at the nearest relevant sensitive receptors.

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

7.1.2. Annual Average Dust Deposition Rates

Table 17 overleaf presents the annual average dust deposition predicted as a result of the operations at the Proposal site. An assumed background dust deposition of 2 $g \cdot m^{-2} \cdot month^{-1}$ is presented in Table 17, although comparison of the incremental concentration with the incremental criterion of 2 $g \cdot m^{-2} \cdot month^{-1}$ 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.

Table 17 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
Criterion	2	-	4
Max. % of criterion	5.0%		51.3%
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

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

7.1.3. Maximum 24-Hour PM_{10} and $PM_{2.5}$

Table 18 overleaf presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the Proposal operations. No background concentrations are included within this table. The maximum incremental impacts are highlighted in **bold**.

Table 18 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
Criterion	50	25
Max. % of criterion	2.0%	3.4%
R1	0.5	0.4
R2	0.4	0.3
R3	0.5	0.4
R4	0.1	0.1
R5	1.0	0.9
R6	<0.1	<0.1
R7	0.4	0.3
R8	0.4	0.3
R9	0.2	0.2
R10	0.5	0.4
R11	0.4	0.3

The predicted incremental concentrations of PM_{10} and $PM_{2.5}$, are demonstrated to be minor (refer Table 18 above).

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the Proposal, with background included are presented in Table 19 and Table 20 (overleaf) respectively.

Results are presented in Table 19 and Table 20 for those receptors at which the greatest impacts have been predicted.

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.

For PM_{10}, the maximum cumulative impact (the left hand side of Table 19), and the maximum incremental impact (the right hand side of Table 19) is predicted at Receptor R5. These results demonstrate that even with the addition of background concentrations, the maximum 24-hour average PM_{10} criterion is not predicted to be in exceedance of the relevant criterion. A number of exceedances are indicated in the 'background' air quality data, and as discussed in Section 4.4, these were due to regional air quality episodes. Importantly, the operation of the Proposal is not predicted to result in any additional exceedances of that criterion.

Table 19 Summary of contemporaneous impact and background – PM_{10} – Receptor 5

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
22/11/2018	0.4	95.5	95.9	15/07/2018	1.0	12.1	13.1
21/11/2018	0.2	67.1	67.3	26/08/2018	1.0	17.7	18.7
19/03/2018	0.3	62.4	62.7	17/05/2018	0.9	17.6	18.5
18/07/2018	0.6	59.9	60.5	18/05/2018	0.9	21.2	22.1
15/02/2018	<0.1	53.2	53.3	4/08/2018	0.8	16.2	17.0
29/05/2018	0.3	47.4	47.7	26/06/2018	0.8	19.4	20.2
19/07/2018	0.3	45.6	45.9	22/06/2018	0.8	20.6	21.4
20/03/2018	<0.1	44.0	44.1	21/06/2018	0.8	18.5	19.3
15/04/2018	0.8	42.2	43.0	15/04/2018	0.8	42.2	43.0
2/12/2018	0.2	41.3	41.5	12/07/2018	0.8	19.5	20.3
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.			

For $PM_{2.5}$, the maximum cumulative impact (the left hand side of Table 20), and the maximum incremental impact (the right hand side of Table 20) is also predicted at Receptor R5. In this case, a minor exceedance of the maximum 24-hour average $PM_{2.5}$ criterion is predicted at the adjacent receptor 5. On that particular day (2 August 2018), the adopted background $PM_{2.5}$ concentration was already 98.8 % of the criterion, and the minor predicted increment (0.5 µg·m^{-3}, 2 % of the criterion) results in a minor exceedance of that criterion.

The exceedance has been examined and is driven by the movement and idling of trucks at the Proposal site. It is noted that these impacts are associated with the assumption that four trucks would be idling at the Proposal site on every hour of the day, which is a highly conservative approach, and not represent the 'likely' impacts.

Impacts could be reduced through the adoption of a no-idling policy, where possible, which would reduce emissions of fine particulate and consequently, impacts at the adjacent receptor. In addition, the location at which the minor exceedance is predicted is a data centre operation, and it is unlikely that a significant number of people would be at that location for a period of 24-hours. The risk of impact is subsequently reduced.

Table 20 Summary of contemporaneous impact and background – $PM_{2.5}$ – Receptor 5

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
29/05/2018	0.2	31.8	32.0	15/07/2018	0.9	5.9	6.8
2/08/2018	0.5	24.7	25.2	26/08/2018	0.8	7.8	8.6
27/05/2018	0.2	22.1	22.3	17/05/2018	0.7	6.1	6.8
8/05/2018	0.6	19.6	20.2	18/05/2018	0.7	9.2	9.9
15/04/2018	0.7	18.3	19.0	4/08/2018	0.7	5.0	5.7
5/11/2018	0.1	18.1	18.2	26/06/2018	0.7	9.9	10.6
19/03/2018	0.3	17.0	17.3	15/04/2018	0.7	18.3	19.0
18/09/2018	<0.1	16.5	16.6	21/06/2018	0.7	6.0	6.7
21/11/2018	0.2	16.0	16.2	25/04/2018	0.6	9.2	9.8
31/12/2018	<0.1	16.0	16.1	22/06/2018	0.6	9.0	9.6
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 PM_{10} concentrations associated with the Proposal are presented in Figure 8 to allow examination of the distribution of particulate matter in the area surrounding the Proposal.

The performance of the Proposal does not result in any additional exceedances of the maximum 24-hour PM_{10} particulate matter impact assessment criterion.

One minor exceedance of the maximum 24-hour $PM_{2.5}$ criterion is predicted at the adjacent datacentre (location R5), although a reduction in vehicle idling would reduce that impact.

Figure 8 Predicted maximum incremental 24-hour PM_{10} impacts

Note 1: Criterion = 50 µg·m^{-3} (cumulative)

7.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO_2). The averaging periods associated with the criteria for these pollutants is 1-hour and an annual average, as specified in Table 3. The emissions adopted for this scenario, reflect the operational profile of the Proposal over those averaging periods (refer Section 5.2.2). It is noted that these impacts are associated with the assumption that four trucks would be idling at the Proposal site on every hour of the day, which is a highly conservative approach, designed to demonstrate compliance, and not represent the 'likely' impacts.

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 NO_2 and nitric oxide (NO), conversion of NO_X predictions to NO_2 concentrations may be performed. Within this assessment, the OLM method has been adopted as outlined in Section 5.2.3.

The predicted maximum 1-hour and annual average NO_2 concentrations resulting from the Proposal operations, are presented in Table 21.

Table 21 Predicted 1 hour and annual average nitrogen dioxide concentrations

Rec.	Nitrogen dioxide (NO_2) concentration ($\mu g{\cdot}m^{-3}$)					
	1 hour			Annual Average		
	Increment	Background	Cumulative	Increment	Background	Cumulative
Criterion	246			62		
Max. % of criterion	31%	31%	41%	15%	21%	36%
R1	27.4	60.2	87.6	2.3	12.9	15.2
R2	<0.1	75.2	75.3	1.9	12.9	14.8
R3	76.6	9.4	86.0	4.2	12.9	17.1
R4	<0.1	75.2	75.3	0.7	12.9	13.6
R5	39.7	62.0	101.7	9.2	12.9	22.1
R6	0.3	75.2	75.5	0.5	12.9	13.4
R7	23.6	75.2	98.8	2.4	12.9	15.3
R8	13.6	75.2	88.8	2.3	12.9	15.2
R9	16.3	60.2	76.5	1.2	12.9	14.1
R10	24.8	60.2	85.0	2.4	12.9	15.3
R11	13.4	69.6	82.9	1.7	12.9	14.6

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 – the neighbouring currently approved data centre) and for the pollutant with the highest predicted concentrations (1-hour maximum NO_2), predicted increments are shown to be less than 31 % of the relevant criterion as a result of the Proposal. 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.

A contour plot of the predicted maximum 1-hour incremental NO_2 impact is presented in Figure 9.

Figure 9 Predicted maximum incremental 1-hour NOx as NO_2 impacts

Note 1: Criterion = 246 µg·m^{-3} (cumulative)

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 with 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 earthworks, construction, and track-out. The identified risks are summarised in Section 6.4, and the mitigation measures identified to manage that risk are presented in Section 6.5. To manage the risks, the identified mitigation measures presented in Table 14 are anticipated to be implemented in the Construction Environmental Management Plan (CEMP)[4].

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 the achievement of all air quality criteria, even following the adoption of potential worst-case operating conditions. Accounting for the background air quality assumptions, and adopting worst-case assumptions in relation to truck idling, the assessment does not predict any additional exceedances of the respective criteria as a result of the operation of the Proposal, for the majority of pollutants assessed.

In the case of maximum 24-hour average $PM_{2.5}$ concentrations, one minor exceedance is predicted at the adjacent receptor R5 (a datacentre development), although this is predicted on a day of elevated particulate concentrations, with the background air quality already 98.8 % of the criterion. A minor incremental contribution associated with the Proposal results in a minor exceedance of the criterion. Given that this exceedance is predicted at the adjacent datacentre, it is not anticipated that populations would be present at that location for a period of 24-hours, and the subsequent risk of impact is reduced.

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

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 off-site impacts are minimised.

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 Charter Hall Holdings Pty Ltd, to perform an Air Quality Impact Assessment (AQIA) for the construction of a two-storey warehouse and distribution centre, ancillary office space, landscaping at ground and second floor levels, bicycle and car parking.

Construction phase activities will involve earthworks, construction works and associated vehicle traffic. The associated risks of impacts 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 in numerous other similar AQIA studies.

That assessment showed there to be a high risk of health or nuisance impacts associated with earthworks, construction works, and construction traffic should no mitigation measures be applied. 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, and this is documented in Section 5.2.2.

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 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.

All air quality criteria are predicted to be achieved, with the exception of one minor exceedance of the maximum 24-hour average $PM_{2.5}$ criterion. Good site management practices such as the observation of vehicle speeds, and minimisation of vehicle idling whilst on site, would be sufficient to ensure that this minor exceedance is not observed during Proposal operation.

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

10. REFERENCES

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NSW EPA. (2016). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.* NSW Environment Protection Authority.

USEPA. (2008). *Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks .*

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).

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
Sydney Airport – Station # 066037	BoM	331 173	6 242 272	3.2
Sydney Observatory Hill – Station # 066062	BoM	333 955	6 251 840	6.7
Canterbury Racecourse– Station # 066194	BoM	325 572	6 246 697	7.1

Figure A 1 Meteorological and air quality monitoring surrounding the Proposal site

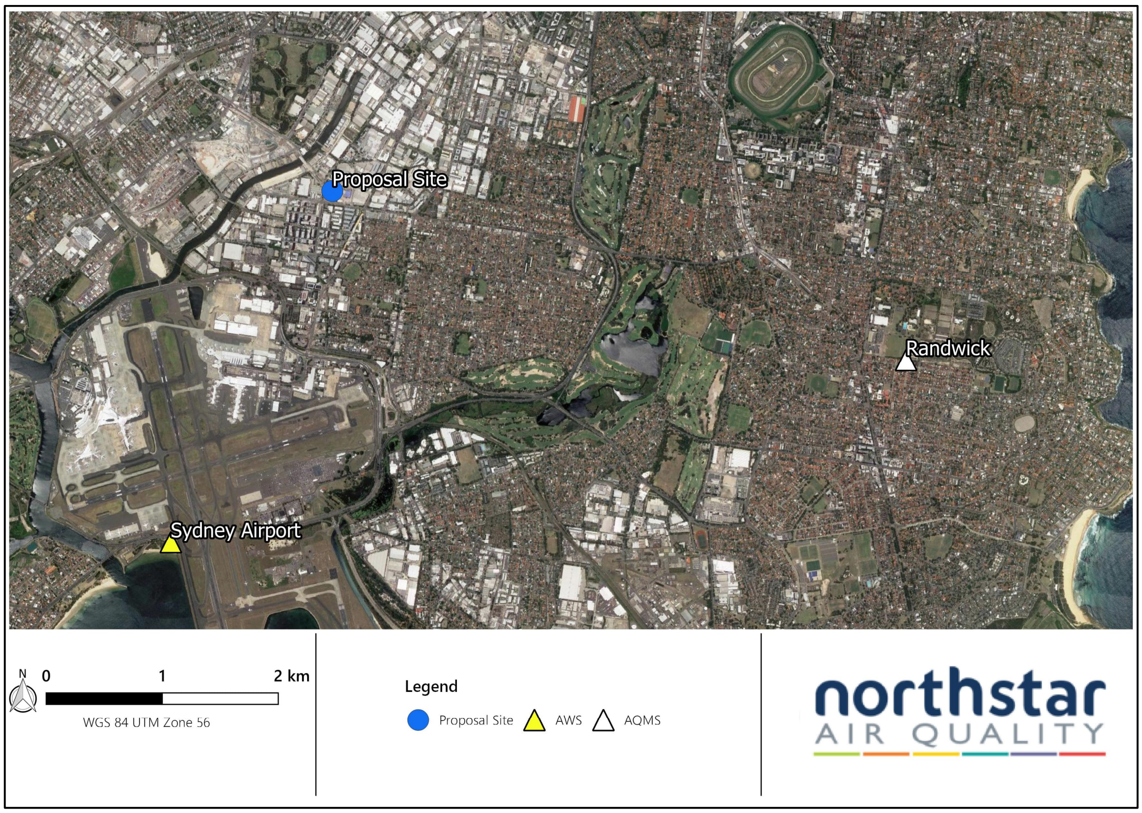


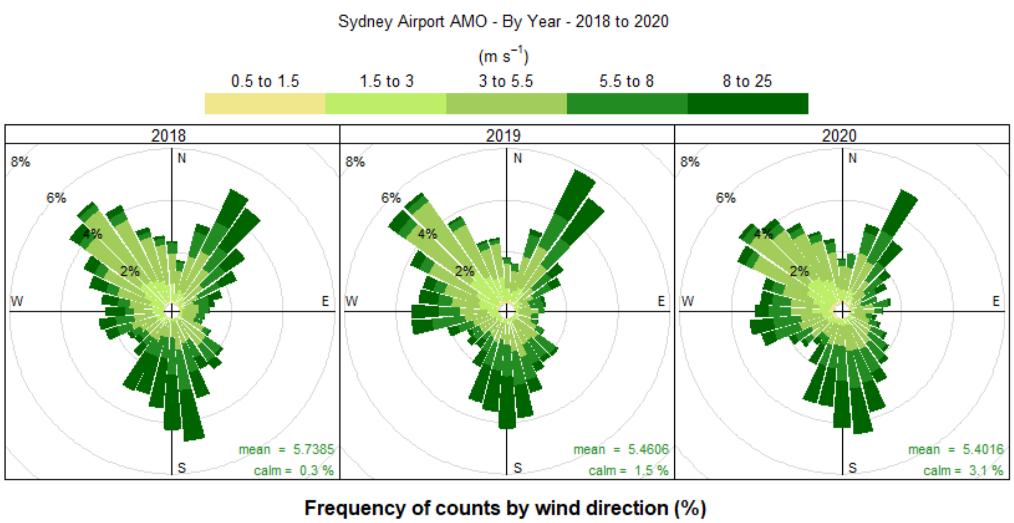
Image courtesy of Google Earth, adapted by Northstar Air Quality

Meteorological conditions at Sydney Airport AMO have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2018 to 2020) are presented in Figure A2.

The wind roses indicate that from 2018 to 2020, winds at Sydney Airport AMO are predominantly from north-westerly directions with north-easterly and south-westerly components evident.

The majority of wind speeds experienced at the Sydney Airport AMO between 2018 and 2020 are generally in the range 1.5 meters per second ($m \cdot s^{-1}$) to 8 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from south-easterly, south-westerly and north-easterly directions. Winds of this speed occur during 20.5 % of the observed hours during the years. Calm winds (< 0.5 $m \cdot s^{-1}$) are less common and occur during 1.6 % of hours across the years.

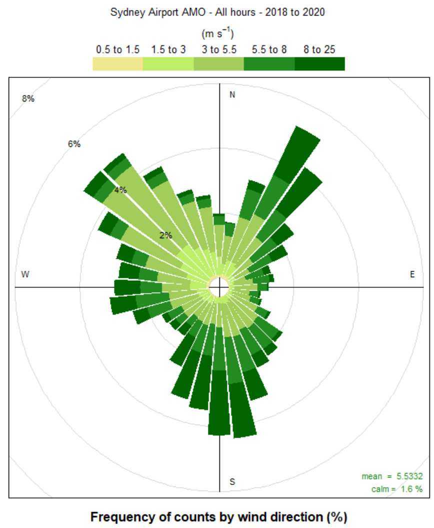
Figure A2 Annual wind roses 2018 to 2020, Sydney Airport AMO



Given the similarities in the wind distribution across the years examined, data for the year 2018 has been selected for further assessment. Presented in Figure A3 are the annual wind rose for the 2018 to 2020 period and the year 2018 and in Figure A4 the annual wind speed distribution for Sydney Airport AMO. These figures indicate that the distribution of wind speed and direction in 2018 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2018 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure A 3 Annual wind roses 2018 to 2020, and 2018 Sydney Airport AMO



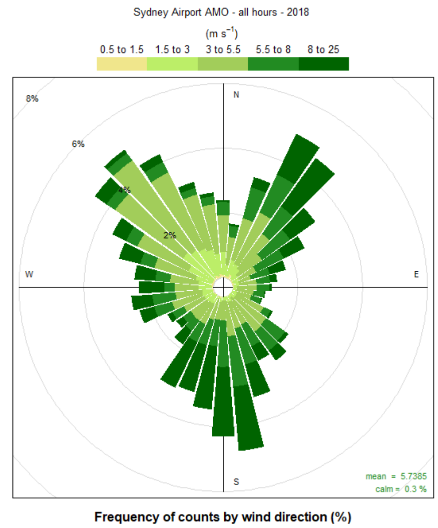
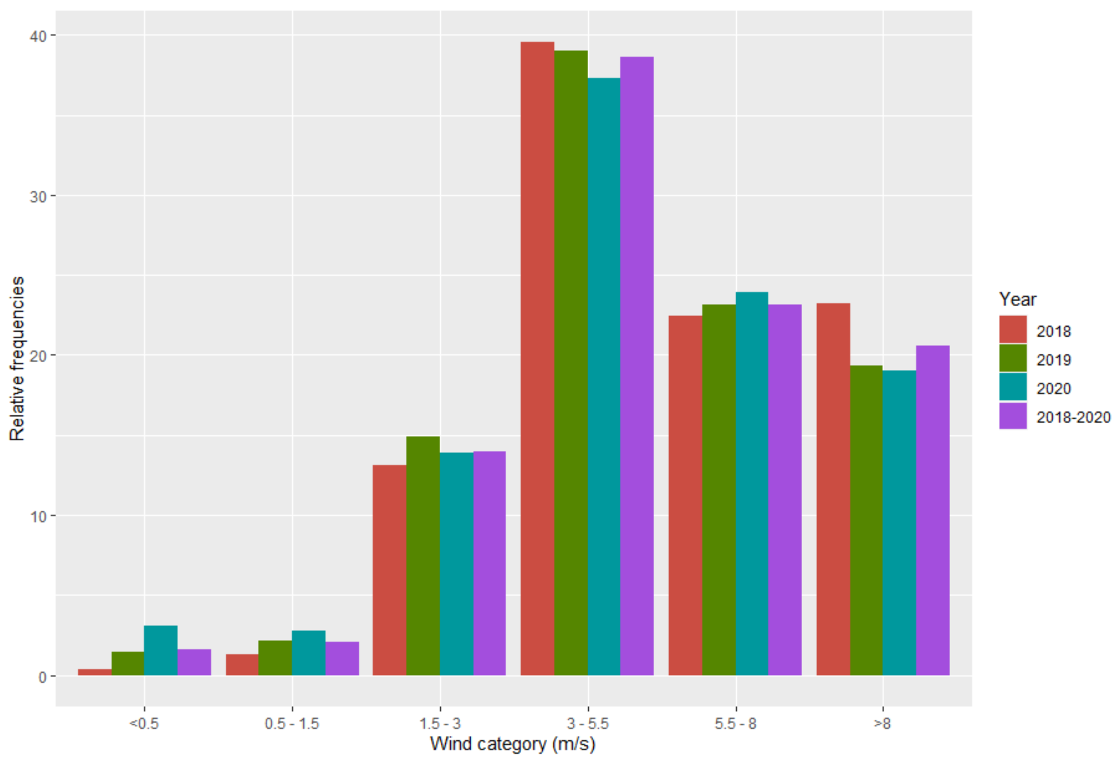


Figure A 4 Annual wind speed distribution 2018 to 2020, Sydney Airport AMO



Meteorological Processing

The BoM and DPIE 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.

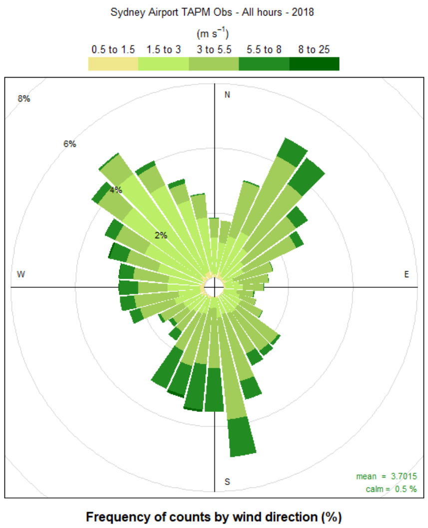
The parameters used in TAPM modelling are presented in Table A2. It is noted that an initial TAPM modelling run provided wind roses which did not validate well against observations at Sydney Airport AWS. Given the poor validation, that initial TAPM modelling run has not been used in this AQIA. Subsequently, a second TAPM run was performed which used observations at Sydney Airport AWS to 'nudge' model predictions towards those observations, and this has been used in this AQIA. To validate model outputs, a comparison of the TAPM generated meteorological data, and that observed at the Sydney Airport AMO and at the Canterbury Racecourse AWS has been performed and is presented in Figure A5.

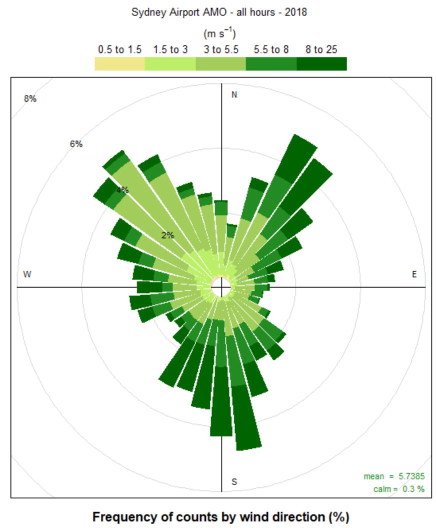
Table A2 Meteorological parameters used for this study

TAPM v 4.0.5	
Modelling period	1 January 2018 to 31 December 2018
Centre of analysis	335,993 mE, 6,241,045 mN (UTM Coordinates)
Number of grid points	25 × 25 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	Sydney Airport AMO

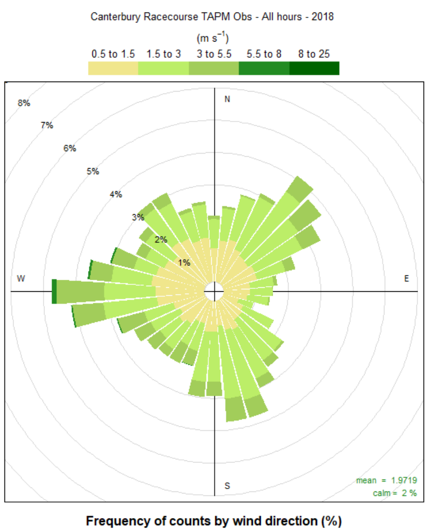
Figure A5 Modelled and observed meteorological data – Sydney Airport 2018

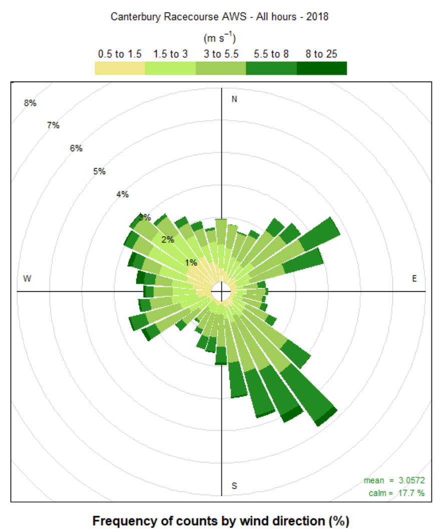
TAPM generated windrose	Observations at Sydney Airport AMO





TAPM generated windrose	Observations at Canterbury Racecourse AWS

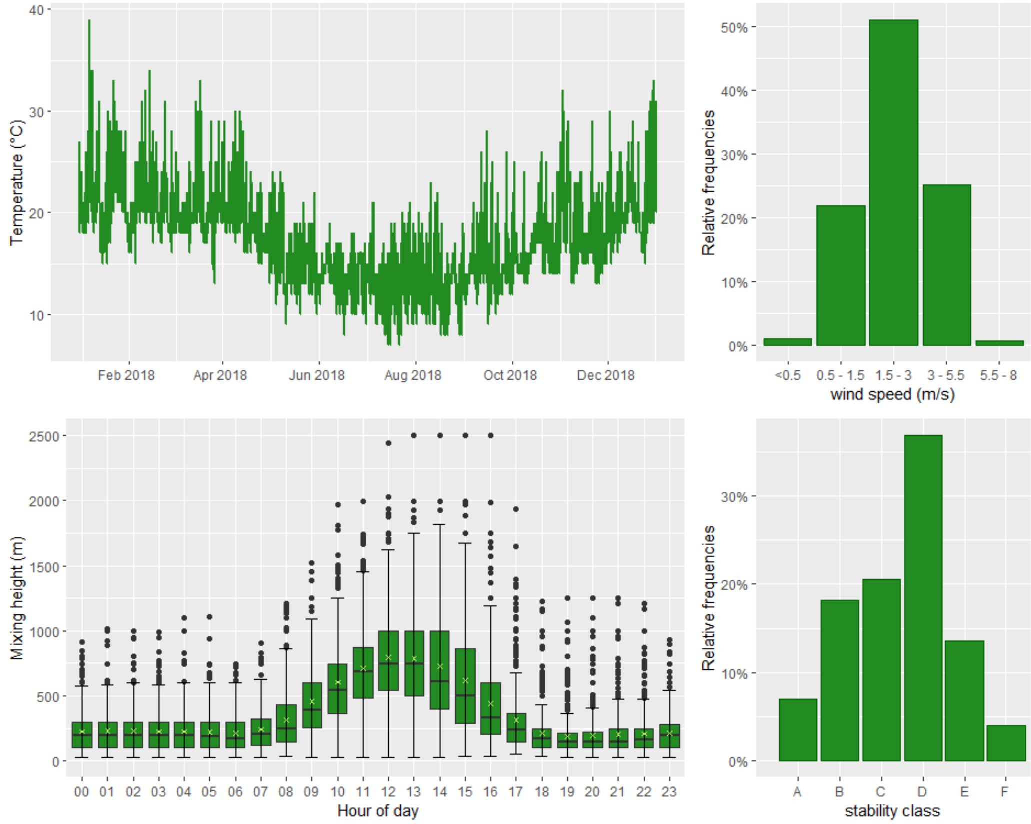




As generally required by the NSW EPA the following provides a summary of the modelled meteorological dataset. Given the nature of the pollutant emission sources at the Proposal site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirculation potential 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 in Figure A6.

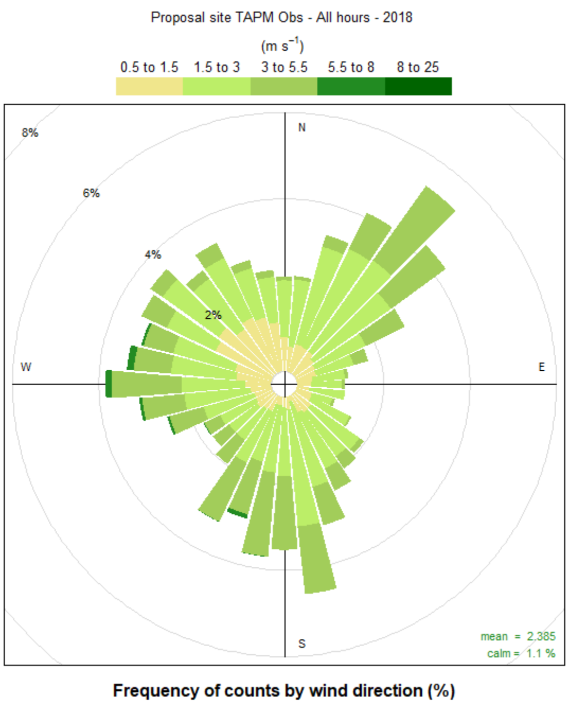
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure A6 Annual temperature, mixing height and wind speed distribution – Proposal site 2018



The modelled wind speed and direction at the Proposal site during 2018 are presented in Figure A7.

Figure A7 Predicted wind speed and direction – Proposal site 2018



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 Department of Planning, Industry and Environment (DPIE) at five air quality monitoring station (AQMS) within a 10 km radius of the Proposal site. Details of the monitoring performed at these AQMS is presented in Table B1 and Figure A1.

Table B1 Details of Closest AQMS Surrounding the Site

AQMS Location	Distance to Site (km)	Screening Parameters				
		2018 Data	Measurements			
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Randwick	3.6	✓	✓	✓	×	✓
Earlwood	9.4	✓	✓	✓	×	✓

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

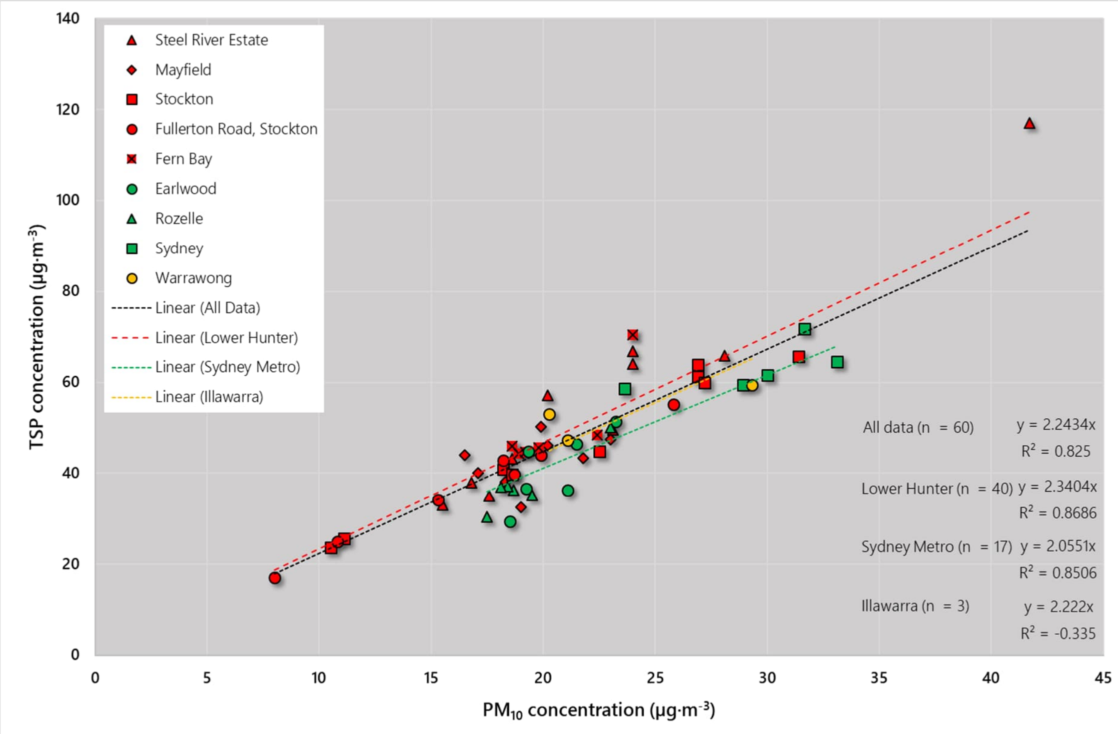
Summary statistics for PM_{10}, $PM_{2.5}$ and NO_2 data are presented in Table B2.

Concentrations of TSP are not measured by the NSW DPIE at any AQMS surrounding the Proposal site. An analysis of co-located measurements of TSP and PM_{10} 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:PM_{10} ratio of 2.0551 : 1 (i.e. PM_{10} represents ~48 % of TSP) is appropriate to be applied to measurements in the Sydney Metro area.

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 PM_{10} 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 $g{\cdot}m^{-2}{\cdot}month^{-1}$ as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of 2 $g{\cdot}m^{-2}{\cdot}month^{-1}$ (the total allowable deposition being 4 $g{\cdot}m^{-2}{\cdot}month^{-1}$).

A summary of background air quality data for the site for the year 2018 (consistent with the selected meteorological period) is presented in Table B2.

Graphs presenting the daily varying PM_{10}, $PM_{2.5}$ and NO_2 data recorded at Randwick AQMS in 2018 are presented in Figure B2, Figure B3 and Figure B4 respectively.

Table B2 Summary of Background Air Quality Data (Randwick 2018)

Pollutant	NO_2 (µg·m-3)	TSP (µg·m^{-3})	PM_{10} (µg·m^{-3})	$PM_{2.5}$ (µg·m^{-3})
Averaging Period	1h	Annual	24-Hour	24-Hour
Data Points (number)	8025	359	359	337
Mean	12.4	43.6	21.2	7.6
Standard Deviation	15.0	-	9.3	3.6
Skew[1]	1.2	-	2.6	1.9
Kurtosis[2]	0.7	-	13.7	7.1
Minimum	-3.8	-	5.9	1.8
Percentiles (µg·m^{-3})				
1	-1.9	-	8.0	2.5
5	-1.9	-	10.7	3.5
10	0.0	-	12.1	3.9
25	0.0	-	15.2	5.2
50	5.6	-	19.7	7.0
75	20.7	-	25.0	9.3
90	37.6	-	32.0	12.4
95	45.1	-	35.8	13.8
97	48.9	-	38.7	15.1
98	50.8	-	43.7	16.6
99	56.4	-	56.0	19.1
Maximum	75.2	43.6	95.5	31.8
Data Capture (%)	91.6	98.4	98.4	92.3

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.

Figure B2 PM_{10} measurements, Randwick 2018

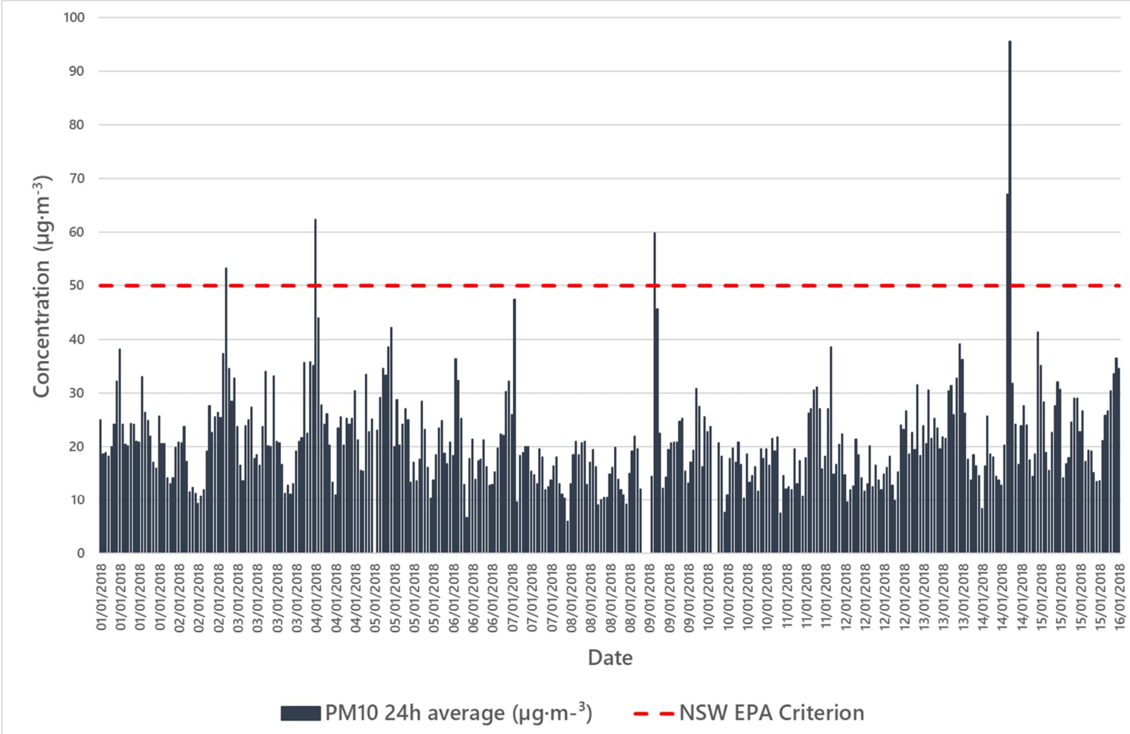


Figure B3 $PM_{2.5}$ measurements, Randwick 2018

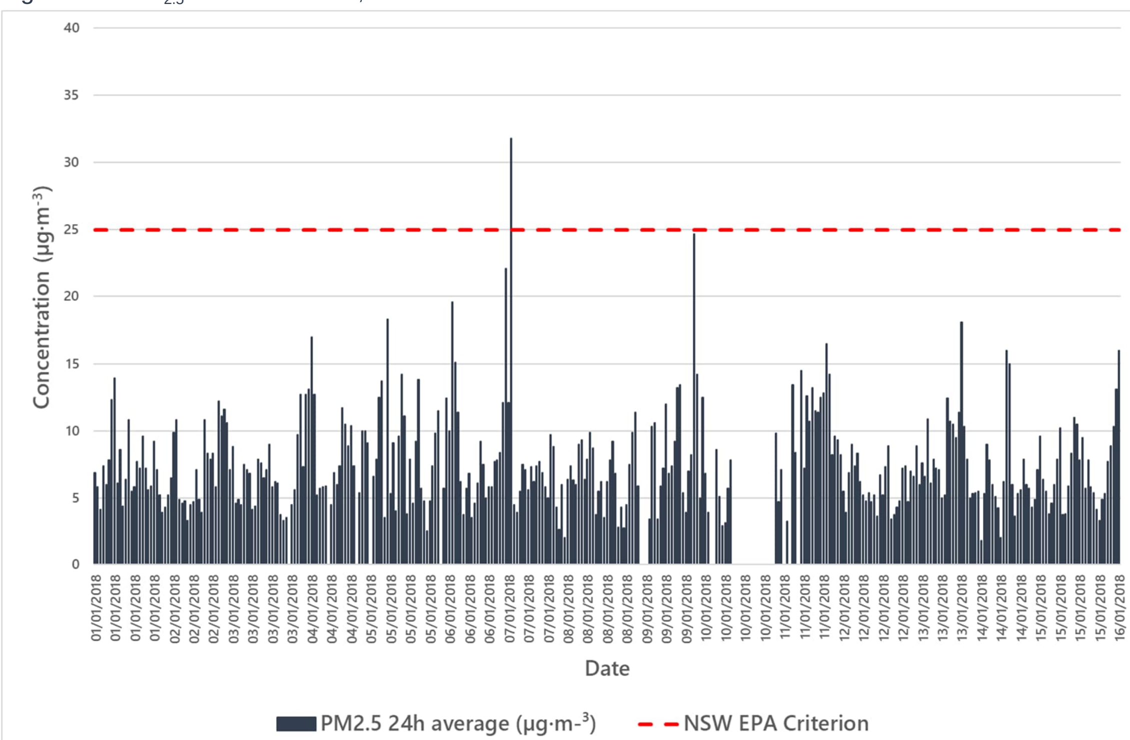
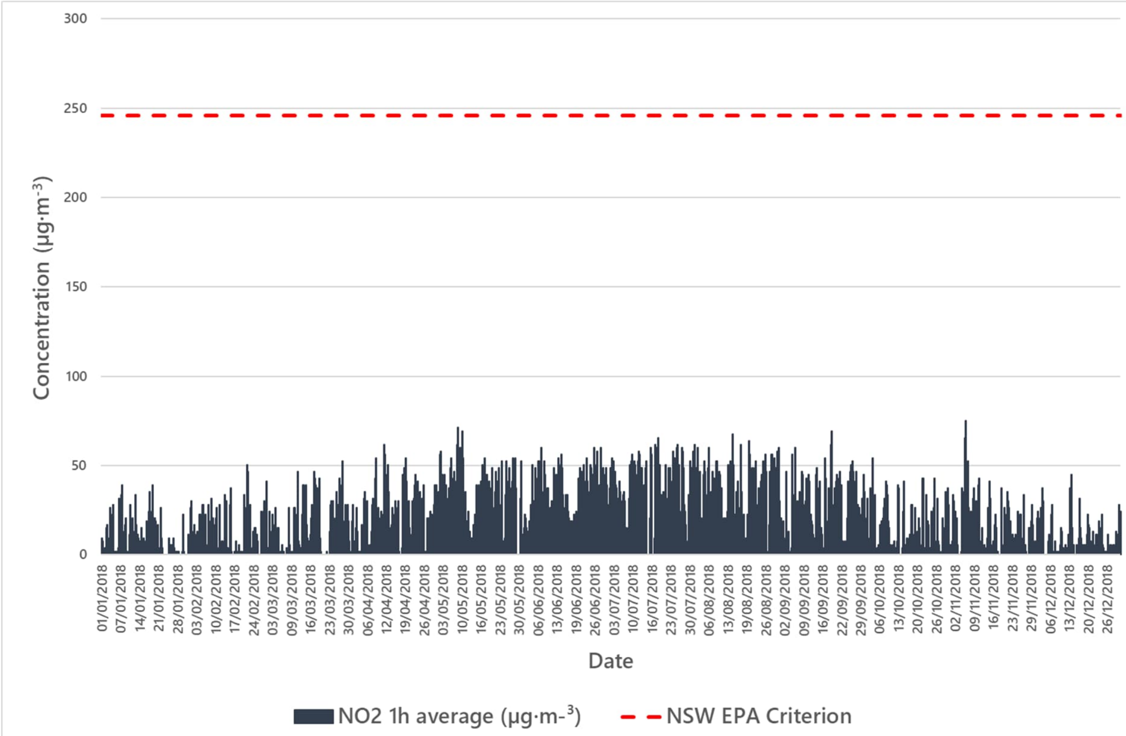


Figure B4 NO_2 measurements, Randwick 2018



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:

- PM_{10} criterion: an amended criterion representing the annual average PM_{10} 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 four 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	• >50 000 m^3	• 20 000 m^3 to 50 000 m^3	• <10 000 m^3
Earthworks traffic - total area	• >10 000 m^2	• 2 500 m^2 to 10 000 m^2	• <2 500 m^2
Earthworks traffic - 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)
Earthworks traffic - material moved	• >100 000 t	• 20 000 t to 100 000 t	• <20 000 t
Construction traffic - total building volume	• 100 000 m^3	• 25 000 m^3 to 100 000 m^3	• <25 000 m^3
Total traffic - heavy vehicles movements per day when compared to existing heavy vehicle traffic	• >50% of heavy vehicle movement contribution by Proposal	• 10% to 50% of heavy vehicle movement contribution by Proposal	• <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 PM_{10}, 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	• Locations where the public are exposed over a time period relevant to the air quality objective for PM_{10} (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). *Examples: Residential properties, hospitals, schools and residential care homes.*	• Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10} (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). *Examples: Office and shop workers, but would generally not include workers occupationally exposed to PM_{10}.*	• Locations where human exposure is transient. *Examples: Public footpaths, playing fields, parks and shopping street.*

Value	High Land Use Value	Medium Land Use Value	Low Land Use Value
Dust soiling	• 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. *Examples: Dwellings, museums, medium and long term car parks and car showrooms.*	• 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. *Examples: Parks and places of work.*	• 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. *Examples: Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.*

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 PM_{10} 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 PM_{10} (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 ($\mu g \cdot m^{-3}$)	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 $km \cdot h^{-1}$ on surfaced and 15 $km \cdot h^{-1}$ 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
5.5	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	N	H	H
5.6	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			
9.1	Avoid scabbling (roughening of concrete surfaces) if possible	D	D	H
9.2	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
9.3	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
9.4	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).