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Marrickville Customer Fulfilment Centre

Air Quality & Odour Risk Assessment

Addressee(s):	Woolworths Group Pty Ltd
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Quality Control

Study	Status	Prepared	Checked	Authorised
INTRODUCTION	Final	Northstar	NP, GCG, TS, CR	GCG
THE PROPOSAL	Final	Northstar	NP, GCG, TS, CR	GCG
LEGISLATION, REGULATION AND GUIDANCE	Final	Northstar	NP, GCG, TS, CR	GCG
EXISTING CONDITIONS	Final	Northstar	NP, GCG, TS, CR	GCG
CONSTRUCTION PHASE RISK ASSESSMENT	Final	Northstar	NP, GCG, TS, CR	GCG
OPERATIONAL PHASE RISK ASSESSMENT	Final	Northstar	NP, GCG, TS, CR	GCG
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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.

G. Graham **13th October 2020**

Non-Technical Summary

Northstar Air Quality Pty Ltd has been commissioned by Woolworths Group Limited to prepare this air quality and odour risk assessment report in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements, and in support of the SSD-10468 for the design, construction and operation of a warehouse and distribution centre with associated offices at 74 Edinburgh Road, Marrickville (the Site).

The warehouse will be fitted out for the purposes of a speculative warehouse(s) and Customer Fulfillment Centre which will service the inner west and city suburbs.

Construction phase activities will involve demolition works and earthworks, construction works and associated vehicle traffic. The associated risks of impacts from demolition, earthworks, construction, track-out and construction traffic have been assessed using the published guidance in *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management, and adapted by Northstar Air Quality for use in Australia. This methodology has been used in a similar context in numerous other similar Air Quality Risk Assessment studies. Reference has been made to the Protection of the Environment Operations (Clean Air) Regulation 2010 and the NSW EPA Approved Methods for the Modelling and Assessment on Air Pollutants in NSW, as appropriate.

That assessment showed there to be a high risk of dust soiling impacts during all construction activity and a high risk of health or nuisance impacts during demolition works. Health impacts for all other construction works were showed to exhibit a medium risk. Based upon that assessment, a range of mitigation measures are recommended to ensure that short-term impacts associated with construction activities are minimised. Furthermore, the assessment has assumed that construction activities across the entire Proposal site would be performed at one time, where in reality the construction activities may be staged.

The potential impacts associated with operational activities including a chicken rotisserie and bakery have been assessed using a risk-assessment approach adopted from ISO 31000:2018 and IEC 31010:2019. Northstar has used the risk assessment procedure to evaluate controls on kitchen exhaust emissions on numerous studies in NSW and Australia, including charcoal chicken grills, mixed food court emissions, breweries, distilleries and coffee roasters.

Road traffic emissions and road traffic idling emissions were not included in the risk assessment as calculations based on data provided in the Traffic and Access Assessment Report (Colston Budd Rogers and Kafes, 2020) indicates that traffic flows are not likely to result in any significant impacts.

The risk assessment found there to be a high risk of potential odour emissions generated from the chicken rotisserie and bakery operations, and a number of required mitigation methods have been determined, including recommendations for air pollution control to manage emissions of smoke and odour, and recommendations for the design of the emission points in compliance with AS 1668.2.

Based upon the assumptions presented in the report and the implementation of the recommended mitigation methods, the site is assessed as being capable to not give rise to significant air quality and odour impacts during the construction and operational phases associated with the Proposal.

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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
AADT	annual average daily traffic
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQMS	air quality monitoring station
AQRA	air quality risk assessment
BoM	Bureau of Meteorology
CFC	Customer Fulfillment Centre
CO	carbon monoxide
DPIE	Department of Planning, Industry and Environment
EPA	Environmental 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
mS	metres South
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
OU	odour unit
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 µm or less
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	volatile organic compounds

1. INTRODUCTION

Northstar Air Quality Pty Ltd has been commissioned by Woolworths Group Limited (the Applicant) to prepare this air quality and odour risk assessment report in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the SSD-10468 for the design, construction and operation of a warehouse and distribution centre with associated offices at 74 Edinburgh Road, Marrickville (the Site).

The warehouse will be fitted out for the purposes of a speculative warehouse(s) and Customer Fulfillment Centre which will service the inner west and city suburbs.

Specifically, this report addresses the following SEARs:

Table 1 Secretary's Environmental Assessment Requirements (SSD 10399)

Issue	Requirement	Addressed
6. Air Quality	Including: • a description of all potential sources of odour and emissions during the construction and operational phases of the development • an assessment of potential air quality impacts at surrounding receivers during construction and operation of the development, in accordance with the relevant Environment Protection Authority guidelines and, • details of any mitigation, management and monitoring measures required to prevent and/ or minimise emissions.	Section 2 Section 6, Section 6 Section 7

1.1. Purpose of the Report

The purpose of this report is to examine and identify potential air quality risks associated with the construction and operation of the Proposal, in accordance with the SEARS, and identify mitigation and monitoring requirements commensurate with those anticipated potential impacts.

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

- ISO 31000 Risk Management (ISO, 2018);
- 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; and,
- Protection of the Environment Operations (Clean Air) Regulation 2010.

1.2. Scope of Assessment

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

2. THE PROPOSAL

The following provides a description of the context, location, and scale of the Proposal, 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 Site is legally described as Lot 202 in DP 1133999, Lot 3 in DP 318232 and Lot 3 in DP 180969, commonly known as 74 Edinburgh Road, Marrickville (see **Figure 1**).

The Site has an area of approximately 27 315 square metres (m^2) and has frontages to both Edinburgh Road (north) and Sydney Steel Road (east).

The key elements within and surrounding the Site include:

- The Site is located within the industrial area of Marrickville and currently accommodates several large freestanding industrial buildings and associated car parking and loading areas;
- Vehicular access to the Site is via an existing entry and exit driveway at the Edinburgh Road frontage. Access is also available from Sydney Steel Road;
- The Site contains minimal vegetation which is fragmented by buildings and areas of hardstand surfaces. Vegetation is limited to scattered trees and shrubs within the Site and planted within the nature strip;
- Is located within 1km of Sydenham Railway Station, which is currently being upgraded as part of the Sydney Metro Chatswood to Bankstown metro line; and
- The Site is well positioned in terms of access to arterial and main roads, public transport modes of bus and rail, Sydney Airport and the retail centre of Marrickville.

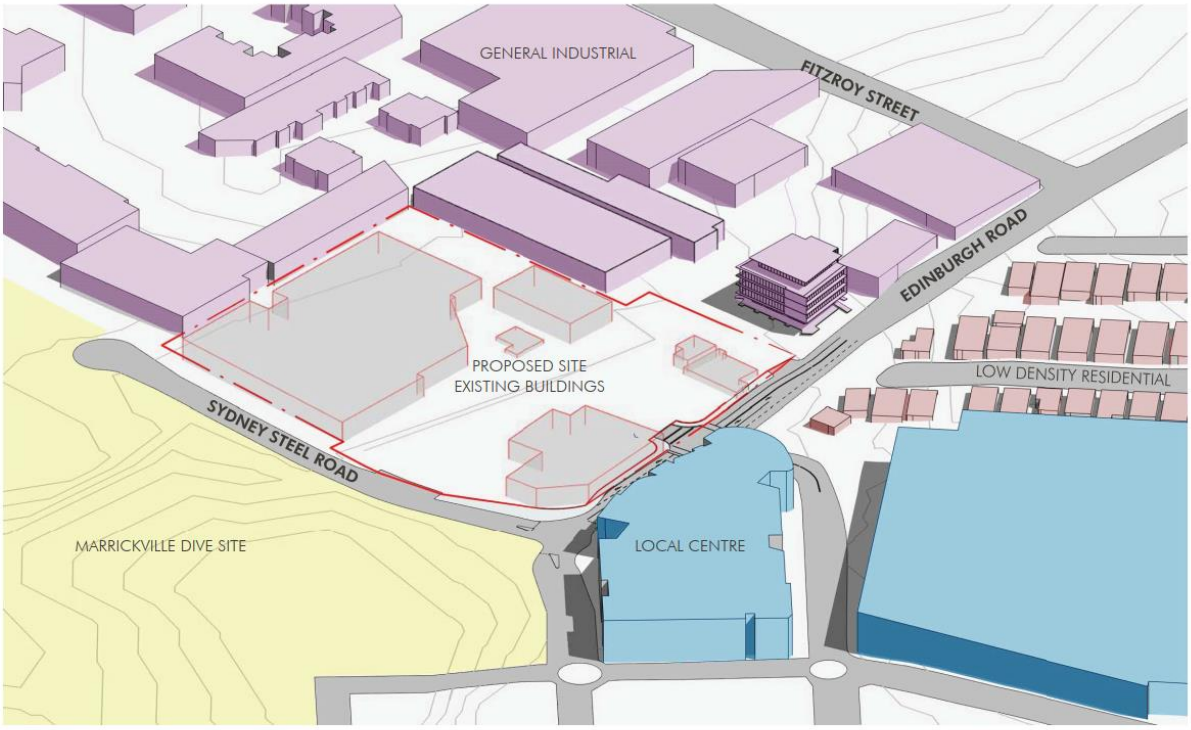
Figure 1 Aerial view of the Site

Source: Six Maps

2.2. Overview and Purpose

The existing development on the Proposal site includes six principal buildings, as illustrated in **Figure 2**.

Figure 2 Existing Site layout



Source: Nettleton Tribe

The Proposal includes the demolition of the existing structures and the construction and operation of new land uses, as illustrated in **Figure 3** and **Figure 4**.

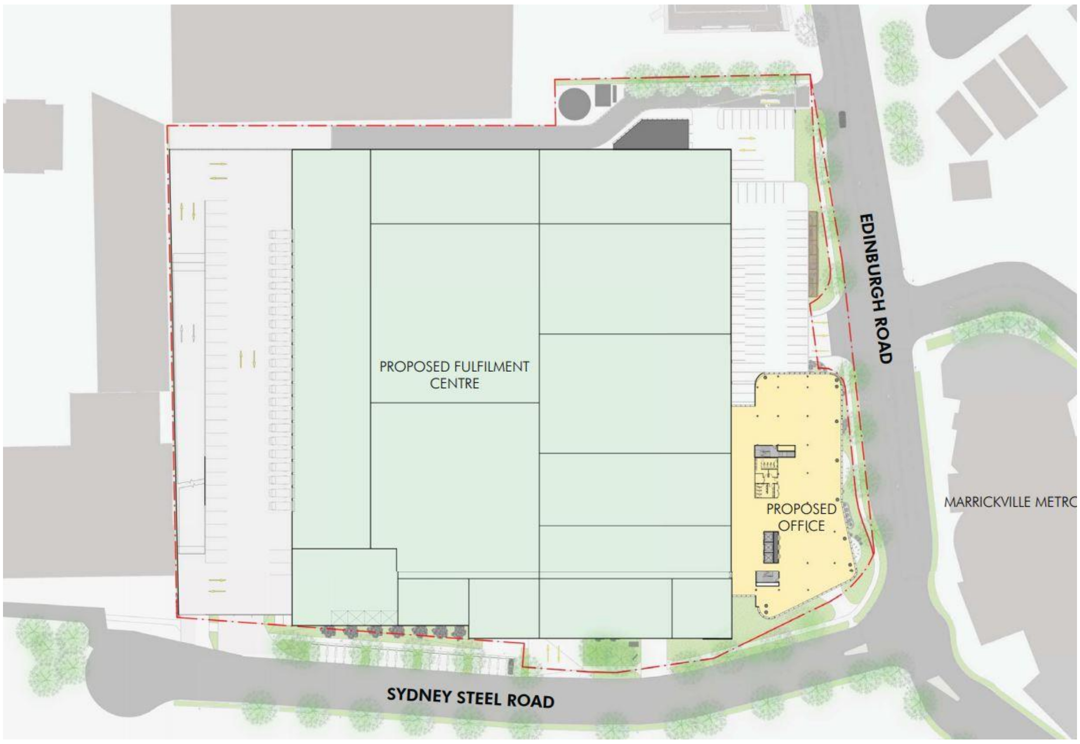
The Site has development consent for a Masters Home Improvement Centre, which includes a floor space of 13 337 m^2 and industrial units comprising a floor space of 4 267 m^2. In terms of this AQRA report, this is relevant to provide a benchmark of impacts and traffic flows associated with the approved development consent. This is discussed further in **Section 2.4.2**.

The Proposed development will include a mix of industrial and warehouse uses covering a floor space of 27 315 m^2. Woolworths proposes to occupy the building for use as an online CFC comprising of warehouses, hardstand/car parking areas associated offices and infrastructure (loading areas and site access points). The CFC will comprise a distribution centre for the receival of bulk deliveries of goods, temporary storage and subsequent redistribution of the goods in home-delivery vans. The CFC will also include a commercial kitchen including a gas-fired chicken rotisserie for home-delivery and a bakery for the manufacture of baked goods for home-delivery.

Figure 3 Proposal Site layout (Ground Floor)

Source: Nettleton Tribe

Figure 4 Proposal Site layout (Level 2)



Source: Nettleton Tribe

2.3. Identification of Potential Emissions to Atmosphere

As specified in the SEARS (see **Table 1**) the assessment report is required to address the potential impacts associated with the construction and operational phases of the Proposal. Briefly the activities that may generate emissions to air during the development phases include:

- **Construction phase:** The construction phase will involve the demolition of the existing buildings and structures on-site, site clearance, establishment of new and/or realigned site services (including telecommunication, water, electricity and/or gas supplies) and the construction of the building as illustrated in **Figure 3** and **Figure 4**.

- **Operational phase**: The operational phase will involve the delivery of goods by semi-trailer, export of goods by medium rigid vehicles, vehicle traffic to/from the offices and other uses, and the preparation of foodstuffs in the CFC.

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

2.3.1. Construction Phase

Construction of the Proposal would involve demolition of existing structures (as illustrated in **Figure 2**), bulk earthworks (cut and fill), building and construction of new roads, pavements, services and hardstand, and construction of buildings, fit-out and commissioning.

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

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

Emissions to atmosphere associated with the above construction activities relate to construction dust (particulates) which, if not adequately controlled, may be experienced in the surrounding areas as an amenity impact (such as visible dust plumes, dust soiling and dirt track-out onto surrounding roads) and as health impacts.

Construction phase dust emissions tend to be larger size particulates, typically in the range of 30 microns (µm) to 10 µm, and particles of this size are typically experienced as amenity impacts rather than health impacts.

Road Traffic Emissions

With regard to emissions from road traffic, the assessment should consider the potential impact of emissions associated with the construction and operational phases. Where changes to construction and/or operational traffic is significant a quantitative assessment is typically performed. Operational phase traffic emissions are discussed in **Section 2.3.2**.

Road traffic exhaust emissions may include a range of air pollutants, including 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 volatile organic compounds (VOCs) (including benzene and 1,3-butadiene).

In regard to construction traffic, the Traffic and Access Report (Colston Budd Rogers and Kafes, 2020) states that it is anticipated that between 50 – 100 vehicles may be required during peak hours during the construction period:

> *Para 3.29* *The number of vehicles generated during the various stages of construction is likely to be up to some 50 to 100 vehicles per hour two-way at peak times. The effects of construction vehicle activity on the surrounding road network will therefore be less than the operational effects. Construction vehicles will access the site from Edinburgh Road and Sydney Steel Road.*

In relation to pollutant emissions associated with construction phase vehicle traffic, reference is made to the guidance used to assess construction phase impacts (IAQM, 2014) which states:

> *"Experience of assessing the exhaust emissions from on-site plant (also known as non-road mobile machinery or NRMM) and site traffic suggests that they are unlikely to make a significant impact on local air quality, and in the vast majority of cases they will not need to be quantitatively assessed. For site plant and on-site traffic, consideration should be given to the number of plant/vehicles and their operating hours and locations to assess whether a significant effect is likely to occur. For site traffic on the public highway, if it cannot be scoped out (for example by using the EPUK's criteria), then it should be assessed using the same methodology and significance criteria as operational traffic impacts. The impacts of exhaust emissions from on-site plant and site traffic are not considered further in this Guidance."*

In relation to construction traffic, any impacts are not likely to be significant and are not considered to warrant a quantitative assessment. A qualitative level of assessment has been performed and is discussed further in **Section 2.3.2**.

To minimise impacts of traffic during construction, construction traffic would be managed through controls imposed through the Construction Environment Management Plan, including the Construction Traffic Management Plan.

The methodology used to assess the risk of construction phase emissions is introduced in **Section 2.4.1** and provided in greater detail in **Appendix C**, and the assessment of risk is provided in **Section 5** and the identification of construction mitigation measures are identified in **Section 7.1**.

2.3.2. Operational Phase

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

- **Road traffic emissions**: Road traffic exhaust emissions from the movement of vehicles in and out of the Proposal site on paved road surfaces. These are associated with delivery vehicles performing delivery tasks, and cars for workers in the office spaces;
- **Road traffic idling emissions**: Road traffic exhaust emissions from vehicles idling at delivery and loading bays;
- **Commercial kitchen (chicken rotisserie)**: Emissions from the commercial cooking of chickens at the CFC; and
- **Commercial kitchen (bakery)**: Emissions from the commercial bakery in the CFC.

Road Traffic Emissions

With regard to emissions from road traffic, the assessment should consider the potential impact of emissions associated with the operational phase. Construction phase traffic emissions are discussed in **Section 2.3.1**. Where changes to traffic flow is determined to be significant a quantitative assessment is typically performed.

In regard to operational traffic, peak AM and PM traffic flows during operation of the Proposal are provided in table 3.1 of (Colston Budd Rogers and Kafes, 2020), which are noted to be over twice the flows anticipated during the construction phase. Conversion of the reported peak hourly values to annual average daily traffic (AADT) flows has been performed based on measured (2020) traffic flows on Enmore Road, Newtown (RMS traffic counter 02062, the closest measurement point to the Proposal) which indicates a relationship between peak AM traffic flows and AADT flows of 4.1 (i.e. AADT flow = AM peak flow ×4.1). Correspondingly, the calculated AADT flows on surrounding roads during operation, including the addition of the flows associated with the Proposal, are all anticipated to be <7 100 vehicles.

To evaluate the significance of the predicted changes in operational traffic flows, reference has been made to the Environmental Protection UK (EPUK) document "*Development Control: Planning for Air Quality (2010 Update)*" (EPUK, 2010) which has been referenced in lieu of any identified NSW or Australian guidance. The guidance provides threshold criteria for evaluating the significance of changes in traffic, as a traffic flow change of more than 5 % to 10 % on roads with AADT of >10 000 vehicles required to be assessed through quantitative methods (i.e. dispersion modelling).

The criteria outlined in EPUK (2010) provide a screening (i.e. qualitative) level of assessment which considers the potential for adverse air quality impacts based on traffic flows. As reported in (Colston Budd Rogers and Kafes, 2020), the anticipated changes in traffic do not exceed that threshold, and it is not considered likely that the impacts associated with the Proposal would lead to adverse impacts during the operational phase. In accordance with the adopted guidance a quantitative assessment is not required and the qualitative assessment screens that potential risk.

In relation to operational traffic, the qualitative assessment presented above suggests that any impacts are not likely to be significant. Impacts would be managed through the Operational Environment Management Plan, including a Traffic Management Plan. Impacts associated with traffic serving the Proposal are not considered further in this report.

Road Traffic Idling Emissions

The pollutants that may potentially be emitted to air are as detailed above in the 'road traffic emissions' subsection.

Idling emissions may vary from road traffic emissions by nature of the operation of the truck engines. Vehicle engines delivering goods to the warehouse will typically be hot, as they will have completed the journey to the Proposal site. Hot idling engines will tend to heat further whilst idling due to the low rate of air drawn through the radiator, and correspondingly emissions of NO_X may increase. As the engines are hot and consuming low rates of fuel, emissions of CO and PM will decrease.

Conversely, vehicle engine temperatures being loaded to deliver home-delivery orders may be cold (especially prior the first delivery run of the day), and emissions of NO_X will be relatively low, as compared to hot engine emissions. Whilst CO and PM emissions will be low due to the low fuel consumption rate, they may be higher than idling emissions from hot vehicles due to lower engine temperatures.

To manage the issue of impacts associated with idling road vehicle engine emissions (air emissions and noise), the Proponent has implemented a policy of <u>zero</u> engine idling at the Proposal site which will be strictly enforced. Upon arrival at the loading bays, vehicle engines will be immediately switched off and will only be switched on immediately prior to departure. Correspondingly, engine idling emissions have been proactively managed through imposition of management controls and have not been assessed further in this assessment.

Commercial Kitchen (Chicken Rotisserie & Bakery)

The Proposal also includes the operation of commercial kitchen activities including a chicken rotisserie and the operation of a bakery to manufacture small goods. Emissions from a commercial kitchen will vary rapidly and significantly in composition depending on the cooking processes being used. From an environmental perspective, emissions to atmosphere from kitchen exhaust ventilation systems are typically associated with odour and particulates (i.e. smoke).

Cooking processes may also give rise to emissions of a range of air pollutants associated with the combustion of fuel including NO_X, CO, CO_2 and a range of organics including VOCs, semi-volatile organic compounds (SVOC) and aldehydes. Generally, these pollutants may become a potential hazard to health within poorly ventilated kitchen spaces, and controlled extraction from kitchen exhaust ventilation systems provides control to the potential for exposure of workers. Emissions of these pollutants at the rates anticipated from commercial kitchens is not considered to be significant from an environmental perspective.

Odour is a complex mix of solid particles, aerosols and liquid droplets, and odour is an aggregated proxy measure for the control of all contributing solid phase and liquid phase emissions. The emissions of smoke and odour are generally inter-related, and in some cooking processes are so associated that they can be regarded as symptomatic of a general lack of exhaust treatment and control. In this context, the control of smoke is considered to be an intrinsic component of effective odour control as exposure to emissions of smoke may illicit an olfactometric response as well as an exposure to gaseous phase emissions. Effective odour control therefore must provide adequate control of smoke (particulates). Odour may also be produced through the cleaning of restaurant and kitchen areas.

With reference to the NPI *Emission Estimation Techniques Manual for Bread Manufacturing* ((NPI, 2003), it is noted that the principal emissions to air from the bakery would include VOCs, including ethyl acetate and ethanol. These emissions would be experienced as odour. There is no directly relating NPI guidance for the chicken rotisserie, although reference has been made NPI *Emission Estimation Techniques Manual for Meat Processing* (NPI, 1999) which include small good manufacturing, and this guidance identifies potential emissions of particulate matter (PM) and VOCs (which again would be experienced as odour).

Odour is well defined under the relevant legislation and regulations (see **Section 3**) and smoke is typically associated with visible plumes that may contain particulates, aerosols and vapour.

Impacts from kitchen exhaust ventilation systems are typically nuisance-related rather than health-related and performance standards are generally not intended to achieve a zero-emission standard but manage resultant impacts to an acceptable level. These are defined further as:

- **Odour**: Impacts from odorous air contaminants are typically nuisance-related rather than health-related. Odour performance goals guide decisions on odour management but are generally not intended to achieve "no odour" but to manage odour impacts to an acceptable level.
- **Smoke**: Impacts from particulate matter ('smoke') can be both nuisance and health related. Criteria related to the impacts associated with particulate matter are designed to protect both amenity and health, although the rate of particulate emissions from a commercial kitchen is not considered likely to result in any significant health impacts.

Further guidance on the legislative requirements for emission control are provided in **Section 3**.

The methodology used to assess the risk of operational phase emissions is introduced in **Section 2.4.2** and provided in greater detail in **Appendix D**, and the assessment of risk and identification of operational mitigation measures are identified in **Section 6**.

2.4. Methodology

2.4.1. 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, 2014). 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 5** (overleaf).

Figure 5 Construction phase impact risk assessment methodology

Step 1
- **SCREENING**
- A simple screening step accounting for separation distance between the sources and the receptors

Step 2
- **RISK FROM CONSTRUCTION ACTIVITIES**
- Assess risk from activities based on the scale and nature of the works, which determines the potential dust emission magnitude

Step 3
- **SENSITIVITY OF THE AREA**
- Assess risk of dust effects from activities based on the sensitivity of the area surrounding dust-generating activities

Step 4
- **RISK ASSESSMENT (PRE-MITIGATION)**
- Based upon Steps 2 and 3, determine risks associated with the construction activities

Step 5
- **IDENTIFY MITIGATION**
- Based upon the risks assessed at Step 4, identify appropriate mitigation measures to control the risks

Step 6
- **RISK ASSESSMENT (POST-MITIGATION)**
- Based upon the mitigation measures identified at Step 5, reassess risk

The assessment approach, as illustrated above in **Figure 5**, is detailed in **Appendix C**. Steps 1-4 (up to the "risk assessment (pre-mitigation)" are addressed in **Section 5**. Step 5 "identify mitigation" and Step 6 "risk assessment (post mitigation)" are discussed in **Section 7**.

2.4.2. Operational Phase

It is noted that standard assessment techniques including dispersion modelling studies are not necessarily the most appropriate assessment methodologies for evaluating the potential of small-scale batch processes to give rise to air quality impacts. In relation to this AQRA, this is related to emissions from the chicken rotisserie and the bakery. This limitation is due to a number of factors including:

- A lack of reliable and scalable emission factors to quantify emissions (i.e. a lack of published emission rates);

- A potential high degree of short-term variability in emissions from such processes;
- A potential high degree of control that may be applied through effective controls.

Due to the above well-documented technical constraints associated with modelling emissions from short-term batch processes, Northstar has performed this assessment in using a risk-assessment approach adopted from ISO 31000:2018 *Risk management — Guidelines* (International Organization for Standardization, 2018) and IEC 31010:2019 *Risk management — Risk assessment technique* (International Electrotechnical Commission, 2018). Northstar has used the risk assessment procedure to evaluate controls on kitchen exhaust emissions on numerous studies in NSW and Australia, including charcoal chicken grills, mixed food court emissions, breweries, distilleries and coffee roasters.

The use of a risk assessment methodology allows the risk of off-site air quality impacts to be identified, ranked, and evaluated against the requirements of achieving Best Available Techniques (BAT) for emissions control. Where the risk assessment identifies processes as requiring additional emissions control(s), the benchmarking of those processes allows the selection of controls specifically designed to manage those specific process risks, which provides a means to evaluate and identify effective and practical emissions control.

The risk assessment approach is detailed in **Appendix D** and essentially evaluates risk as a function (product) of receptor sensitivity and potential impact magnitude:

$$risk = sensitivity \times magnitude$$

To evaluate the assessment categories of sensitivity and magnitude, reference is made to the description of 'offensive odour' provided in the POEO Act (see **Section 3.1**) may be summarised as a function of five broad factors, called the FIDOL factors, namely:

- **Frequency:** indicates how often an odour is experienced. Exposure to relatively pleasant odours (such as a bakery, for example) may be perceived to be a nuisance (or 'offensive odour') if it is experienced too frequently, and conversely, a more unpleasant odour may be tolerated if it is experienced hardly ever.
- **Intensity:** indicates the relative strength of the odour;
- **Duration:** in parallel to frequency, duration is an important factor representing the length of time of which an odour exposure is observed;
- **Offensiveness:** indicates how pleasant / unpleasant an odour is to the population. Whilst individuals may express a personal opinion of acceptance to specific odours, it is generally accepted that some odours are more unpleasant than others due to their chemical composition and also a hazard identification function. The relative scale of typical pleasantness / unpleasantness is described as the odour's hedonic tone.
- **Location:** indicates the relationship between the odour experienced and the general perception of amenity that would be expected at that location. An odour that may be tolerated at an industrial site may be less tolerated at a healthcare centre, for example.

The first four factors (frequency, intensity, duration and offensiveness) are used to evaluate the magnitude of odour. The fifth factor (location) is used to evaluate the sensitivity component.

3. LEGISLATION, REGULATION AND GUIDANCE

Reference has been made to the following guidance, as specified in the SEARs (see **Section 1**):

- Protection of the Environment Operations (Clean Air) Regulation 2010 (which replaces the Protection of the Environment Operations (Clean Air) Regulation 2002)
- Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (DEC, 2007)
- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016)

The following specific guidance is noted as part of this study.

3.1. Protection of the Environment Operations Act

The *Protection of the Environment (Operations) Act* 1997 (POEO) is applicable to scheduled activities in NSW. Chapter 5, Part 5.4, Section 128 relates to the control of air emissions (emphasis added).

128 Standards of air impurities not to be exceeded

(1) The occupier of any premises must not carry on any activity, or operate any plant, in or on the premises in such a manner as to cause or permit the emission at any point specified in or determined in accordance with the regulations of air impurities in excess of—

(a) the standard of concentration and the rate, or

(b) the standard of concentration or the rate,

prescribed by the regulations in respect of any such activity or any such plant.

(1A) Subsection (1) applies only to emissions (point source emissions) released from a chimney, stack, pipe, vent or other similar kind of opening or release point.

(2) The occupier of any premises must carry on any activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution if—

(a) in the case of point source emissions—neither a standard of concentration nor a rate has been prescribed for the emissions for the purposes of subsection (1), or

(b) the emissions are not point source emissions…

Section 129 provides the requirements for the control of emissions of odour from licenced activities.

129 Emission of odours from premises licensed for scheduled activities

(1) The occupier of any premises at which scheduled activities are carried on under the authority conferred by a licence must not cause or permit the emission of any offensive odour from the premises to which the licence applies…

It is noted that the Proposal does not include any activities defined as a scheduled activity under the POEO Act, although the general principals of air pollution minimisation also apply to non-scheduled activities.

Impacts from odorous air contaminants are often nuisance-related rather than health-related. Odour performance goals guide decisions on odour management but are generally not intended to achieve "no odour", but manage odour impacts to an acceptable level.

The term 'offensive odour' is defined within the POEO Act as:

> *an odour:*
>
> *(a) that, by reason of its strength, nature, duration, character or quality, or the time at which it is emitted, or any other circumstances:*
>
> > *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
> >
> > *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
>
> *(b) that is of a strength, nature, duration, character or quality prescribed by the regulations or that is emitted at a time, or in other circumstances, prescribed by the regulations.*

As discussed in **Section 2.4.2**, the definitions provided in the POEO Act to define odour (strength, nature, duration, character or quality) have been used to determine the risk, through the FIDOL factors, which essentially are the same metrics.

3.2. Local Government Act

Section 125 of the *Local Government Act* (1993) provides Council with authority to manage nuisance, including emissions to air from unscheduled activities.

> ***125 Abatement of public nuisances***
>
> *A council may abate a public nuisance or order a person responsible for a public nuisance to abate it.*
>
> *Note :*
>
> *"Abatement" means the summary removal or remedying of a nuisance (the physical removal or suppression of a nuisance) by an injured party without having recourse to legal proceedings.*
>
> *"Nuisance" consists of interference with the enjoyment of public or private rights in a variety of ways. A nuisance is "public" if it materially affects the reasonable comfort and convenience of a sufficient class of people to constitute the public or a section of the public. For example, any wrongful or negligent act or omission in a public road that interferes with the full, safe and convenient use by the public of their right of passage is a public nuisance.*

It is noted that the definition of nuisance under the *Local Government Act* (1993) (which includes odour) is very similar in intent to the definition of 'offensive odour' provided under the *POEO Act* (1997).

3.3. 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 AQRA, 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.

3.4. Ambient Air Quality Standards

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 AQRA.

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. It is noted that this information is provided for context only, and is not used in this AQRA.

Table 2 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units[e]	Criterion	Notes
Nitrogen dioxide (NO_2)	1 hour	$\mu g \cdot m^{-3}$ [a]	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	

Pollutant	Averaging period	Units[e]	Criterion	Notes
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
(e) Gas volumes are expressed at 25°C (298 K) and at an absolute pressure of 1 atmosphere (101.325 kPa)

3.5. Separation Distance Guidance

The NSW EPA do not have published separation distance guidelines. It is noted that the ACT Environment, Planning and Sustainable Development Directorate have released a recently reviewed separation distance guideline for air emissions in November 2018, and subsequently provides the most contemporary reference in regard to separation distances (ACT EPSDD, 2018), and provides the following separation distances relevant to the Proposal:

Table 3 Separation distances for proposed activities

Activity or Process	Separation Distance Requirement	Separation Distance (m)
Warehousing and distribution	Not specified	N/A
Chicken rotisserie	Not specified	N/A
Bakery	$>40\ t \cdot day^{-1}$	100

As specified in (ACT EPSDD, 2018), for bakery production rates are less than the threshold of 40 $t \cdot day^{-1}$ no separation distances are specified. For activities below the threshold activity rates it is recommended that there be no visible discharge of dust or emission of odours offensive to humans, beyond the boundary of the premises, subject to the adoption of Best Available Technology Economically Achievable (BATEA). ACT EPSDD (2018) do not provide separation distances for activities associated with the chicken rotisserie and distribution centre operations.

The function of the odour component of the assessment is therefore to identify potential odour emissions from the processes performed at the Proposal site, evaluate the potential to give rise to offensive odour impacts and to identify practical and reasonable steps to prevent or minimise those impacts.

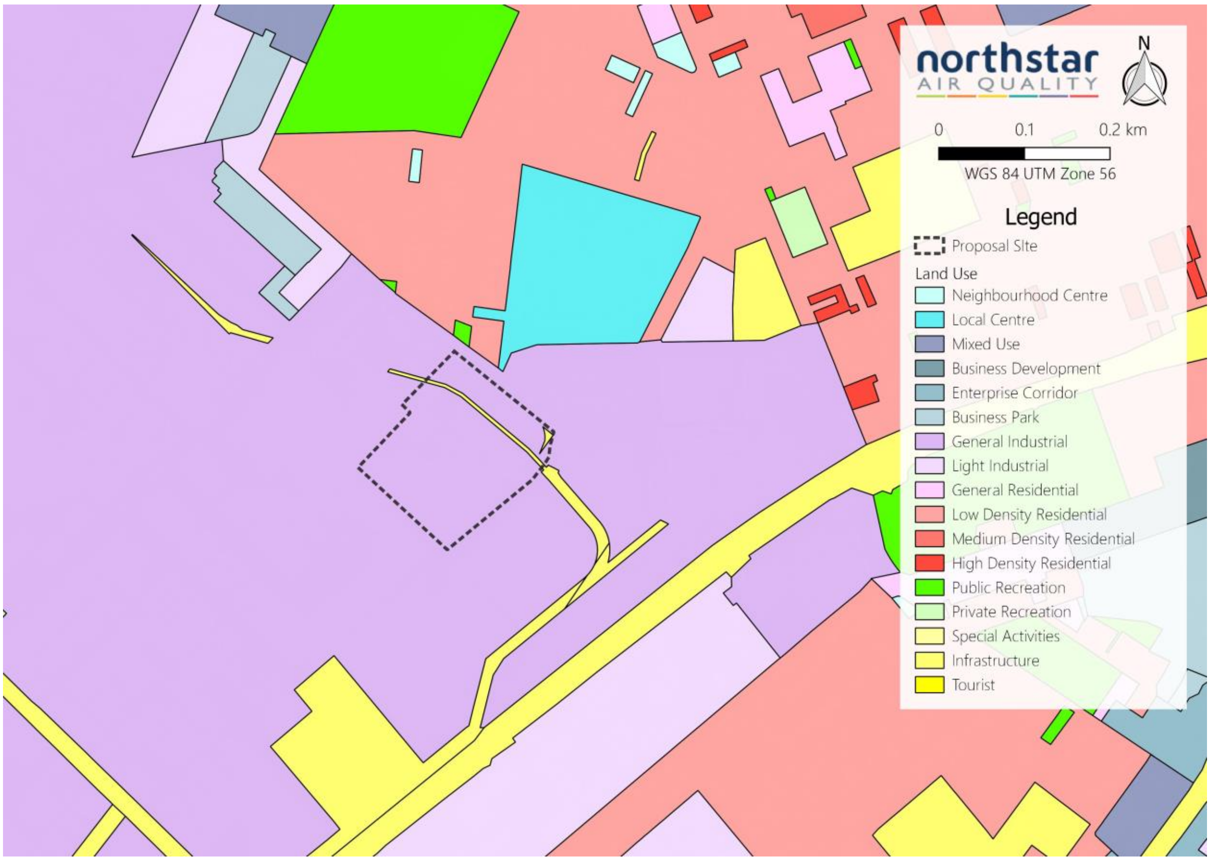
4. EXISTING CONDITIONS

4.1. Surrounding Land Sensitivity

4.1.1. Land Use Zoning

The land use surrounding the Proposal site is zoned within the Inner West LGA. The current land use zoning is illustrated in **Figure 6** below.

Figure 6 Current land use zoning



Source: Northstar Air Quality

The land on which the Proposal site is situated on is currently zoned as both IN1 (General Industrial) and SP2 (Infrastructure). Lands to the immediate north are zoned as R2 (Low Density Residential), B2 (Local Centre) and RE1 (Public Recreation). Lands to the immediate east are zoned as IN1, SP2, R2 and IN2 (Light Industrial). Lands to the immediate south and west are zoned as IN1, IN2 and SP2.

4.1.2. Discrete Receptor Locations

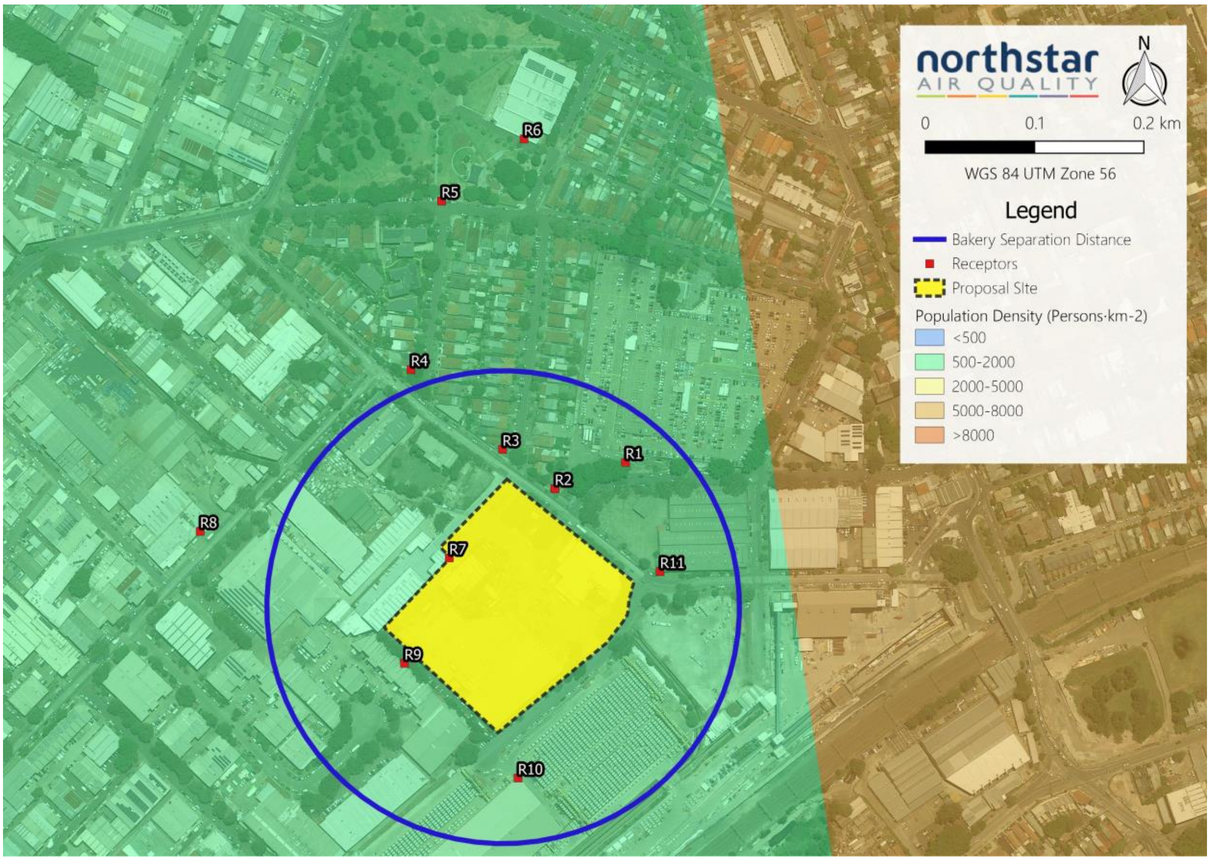
To ensure that the selection of discrete receptors for the AQRA are reflective of the locations in which the population of the area surrounding the Proposal site reside, population-density data has been examined. Population-density data based on the 2016 census, have been obtained from the Australian 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 is presented in **Figure 7**.

Figure 7 Population density and sensitive receptors surrounding the Proposal site



Source: Image courtesy of Google Maps and data sourced from the ABS

The Proposal site and receptors are located in an area of 'low' population density (500-2 000 persons·km^{-2}), which would be expected given the largely industrial activities of the immediate area. **Figure 7** shows that seven identified sensitive receptors are located within the separation distance of the bakery (100 m). All other receptors have still been included in this study as separation distances for other activities performed at the Proposal site have not been determined.

In accordance with the requirements of the NSW EPA, several receptors have been identified and the receptors adopted for use within this AQRA are presented in **Table 4**. This selection is derived from the information presented in **Figure 6** and **Figure 7**.

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	Location (UTM)	
			mE	mS
R1	34 Victoria Road, Marrickville	Commercial	330 906	6 246 581
R2	65 Edinburgh Road, Marrickville	Residential	330 841	6 246 556
R3	2 Bourne Street, Marrickville	Residential	330 793	6 246 591
R4	4 Leicester Street, Marrickville	Residential	330 708	6 246 662
R5	Enmore Park, Marrickville	Recreational	330 733	6 246 816
R6	Llewellyn Street, Marrickville	Aquatic Centre	330 808	6 246 874
R7	76 Edinburgh Road, Marrickville	Industrial	330 746	6 246 491
R8	1 Chapel Street, Marrickville	Industrial	330 517	6 246 511
R9	10-14 Lilian Fowler Place, Marrickville	Commercial	330 707	6 246 394
R10	1 Sydney Steel Road, Marrickville	Industrial	330 812	6 246 292
R11	20 Sidmore Street, Marrickville	Industrial	330 939	6 246 482

Note: The requirements of this AQRA 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.

The closest residential property is approximately 20 metres (m) from the Proposal site boundary to the north, on Edinburgh Road, Marrickville (R2).

The site is bounded by existing warehouse and industrial facilities, and is also in close proximity to other industrial development towards the west with residential areas to the north and northwest. To the north of the site is the Marrickville Metro, a large retail complex with rooftop parking.

The Marrickville dive site is located to the east of the Proposal site and is currently operating to support the construction of the Southwest and Sydney Metro projects.

4.2. Topography

The elevation of the Proposal site is approximately 5m Australian Height Datum (AHD). The topography between the Proposal site and nearest sensitive receptor locations, is uncomplicated.

4.3. Meteorology

The meteorology experienced within an area, can govern the generation (in the case of wind-dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorological conditions surrounding the Proposal site, have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at a number of surrounding Automatic Weather Stations (AWS). Meteorology is also measured by DPIE at a number of Air Quality Monitoring Station (AQMS) surrounding the Proposal site (refer **Section 4.4**), the closest being Earlwood AQMS located approximately 3.4 km from the Proposal site.

A summary of the prevailing meteorological conditions at Earlwood AQMS is presented in **Appendix A**.

Seven meteorological stations are located within a 10 km radius of the Proposal site (BoM and DPIE operated), and three are located with a 5 km radius. A summary of the relevant AWS is provided in **Table 5** below (listed by proximity) and also displayed in **Figure 8** overleaf.

Table 5 Details of meteorological monitoring surrounding the Proposal site

Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Earlwood AQMS	DPIE	327 553	6 245 391	3.4
Sydney Airport AMO	BoM	331 159	6 242 269	4.1
Ashfield Bowling Club	BoM	327 458	6 249 025	4.3

Figure 8 Location of Earlwood AQMS relevant to the Proposal site

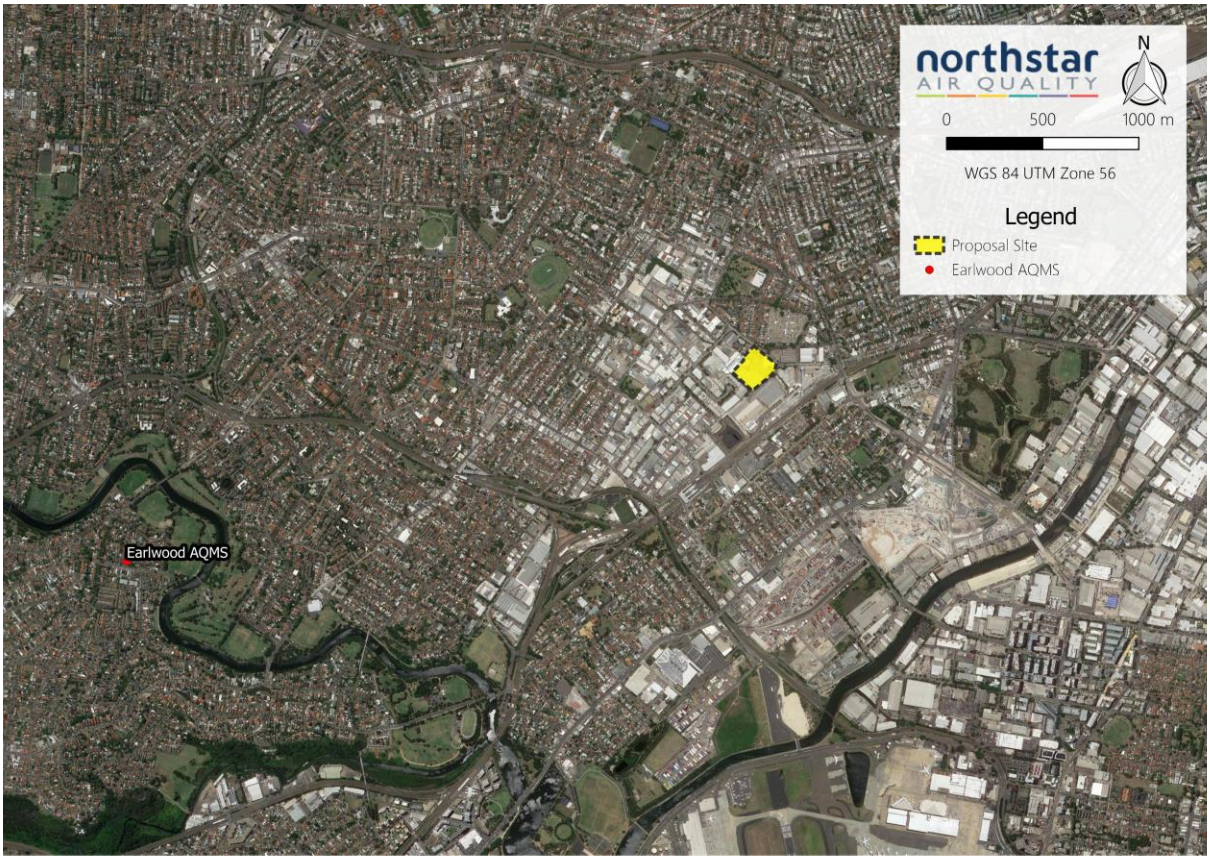


Image courtesy of Google Earth

The meteorological conditions measured at Earlwood AQMS are presented in **Appendix A**.

4.4. Air Quality

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

When assessing the impact of any particular source of emissions on the potential air quality at a location, the impact of all other sources of an individual pollutant, should also be assessed. This 'background' (sometimes called 'baseline') air quality 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** and presented in **Figure 8**.

Table 6 Closest DPIE AQMS to the Proposal site

AQMS Location	Data Availability	Distance to Site (km)	Screening Parameters			
			Measurements			
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Earlwood AQMS	1978-2020	3.4	✓	✓	×	✓
Cook and Phillip	2019-2020	5.8	✓	✓	×	✓
Randwick	1995-2020	7.1	✓	✓	×	✓

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

Appendix B provides a summary of the background air quality monitoring data collected at the Earlwood AQMS, and a summary of the air quality monitoring data and assumptions are presented in **Table 7**. This data is provided for context only.

Table 7 Summary of background air quality used in the AQRA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP) (derived from PM_{10})	Annual $\mu g \cdot m^{-3}$	39.3	Estimated on a TSP:PM_{10} ratio of 2.0551 : 1
Particles (as PM_{10}) (Earlwood)	24-hour $\mu g \cdot m^{-3}$	Daily Varying	The 24-hour maximum for PM_{10} in 2018 was 129.4 $\mu g.m^{-3}$
	Annual $\mu g \cdot m^{-3}$	19.1	
Particles (as $PM_{2.5}$) (Earlwood)	24-hour $\mu g \cdot m^{-3}$	Daily Varying	The 24-hour maximum for $PM_{2.5}$ in 2018 was 86.2 $\mu g.m^{-3}$
	Annual $\mu g \cdot m^{-3}$	8.4	
Dust deposition	Annual $g \cdot m^{-2} \cdot month^{-1}$	2.0	Difference in NSW DPIE maximum allowable and incremental impact criterion
Nitrogen dioxide (NO_2) (Earlwood)	1-hour $\mu g \cdot m^{-3}$	6.7	Hourly max 1-hr average in 2018
	Annual $\mu g \cdot m^{-3}$	1	Annual average in 2018

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

Particle levels increased across NSW due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning. Most hazardous particle days (92 %) were due to smoke from large hazard reduction burns from April to August (RFS, 2018), and some forest fires. The most extensive dust storm event occurred from 21 to 23 November 2018 (inclusive), when particle levels at many of the sites in the NSW air quality monitoring network exceeded the PM_{10} national standard. (DPIE, 2019).

5. CONSTRUCTION PHASE RISK ASSESSMENT

The methodology used to assess construction phase risk is discussed in **Section 2.4.1** 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.**

5.1. Screening Based on Separation Distance

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

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

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

Table 8 overleaf presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table 8 Construction phase impact screening criteria distances

Rec	Location	Land Use	Screening Distance (m)		
			Boundary (350m)	Site Entrance (500m)	Construction route (50m)
R1	34 Victoria Road, Marrickville	Commercial	82	102	74
R2	65 Edinburgh Road, Marrickville	Residential	20	35	10
R3	2 Bourne Street, Marrickville	Residential	29	37	11
R4	4 Leicester Street, Marrickville	Residential	136	146	22
R5	Enmore Park, Marrickville	Recreational	264	273	170
R6	Llewellyn Street, Marrickville	Aquatic Centre	315	323	258
R7	76 Edinburgh Road, Marrickville	Industrial	<10	86	94
R8	1 Chapel Street, Marrickville	Industrial	190	290	211
R9	10-14 Lilian Fowler Place, Marrickville	Commercial	11	102	120
R10	1 Sydney Steel Road, Marrickville	Industrial	45	51	39
R11	20 Sidmore Street, Marrickville	Industrial	26	152	13

With reference to **Table 8**, sensitive receptors are noted to be within the screening distance thresholds and therefore require further risk assessment as summarised in **Table 9**.

Table 9 Application of Step 1 Screening

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

5.2. Impact Magnitude

The footprint of the Proposal site (the area affected) is estimated as being approximately 28 000 m^2 (2.8 hectares (ha)) in area.

The Proposal would involve demolition of the current buildings and structures on the Proposal site, earthworks for the Proposal site area and the construction of the structure as illustrated in **Figure 3** and **Figure 4**.

The estimated demolition building volume is >50 000 m^3 in volume and the estimated proposed building volume is approximately >100 000 m^3.

As discussed in **Section 2.3.1**, approximately 50 – 100 construction vehicles may be required at peak hours during construction works. Construction vehicles will access the site from Edinburgh Road and Sydney Steel Road.

Based upon the above assumptions and the assessment criteria presented in **Appendix C**, the dust emission magnitudes are as presented in **Table 10**.

Table 10 Construction phase impact categorisation of dust emission magnitude

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

5.3. Sensitivity of an Area

5.3.1. 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.

5.3.2. 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 and dust soiling may be identified as being *high*. The assumed existing background annual average PM_{10} concentrations, as measured at Earlwood AQMS (see **Table 7**) was 19.1 $\mu g{\cdot}m^{-3}$, which, along with the land use value calculated above, classifies the sensitivity of the area as *medium* for dust health impacts and *high* for dust soiling effects.

5.4. Risk (Pre-Mitigation)

Given the sensitivity of the identified receptors is classified as *high* for dust soiling, and *medium* for health effects, and the dust emission magnitudes for the various construction phase activities as shown in **Table 10**, the resulting risk of air quality impacts (without mitigation) is as presented in **Table 11**.

Table 11 Risk of air quality impacts from construction activities

Impact	Sensitivity of Area	Dust Emission Magnitude					Preliminary Risk				
		Demolition	Earthworks	Construction	Track-out	Const. Traffic	Demolition	Earthworks	Construction	Track-out	Const. Traffic
Dust Soiling	High	Large	Large	Large	Large	Large	High	High	High	High	High
Human Health	Med	Large	Large	Large	Large	Large	High	Med	Med	Med	Med

Note: med. = medium, scr. = screened

The risks summarised in **Table 11** show that there is a *high* risk of adverse dust soiling and human health (associated with demolition activities) impacts based upon no mitigation. Human health impacts associated with all other activities have been identified as *medium* risk if no mitigation measures were to be applied to control emissions associated with construction-phase activities.

The risk assessment therefore provides recommendations for construction phase mitigation, which are presented in **Section 7.1.2**.

6. OPERATIONAL PHASE RISK ASSESSMENT

6.1. Sensitivity of Receptors

To determine the sensitivity of receptors, reference is made to the receptors identified in **Section 4.1.2** and the methodology presented in **Appendix D**. The following sensitivities have been determined:

Table 12 Sensitivity of receptors

Receptor ID	Property	Land use	Distance from site (m)	Sensitivity
R1	34 Victoria Road, Marrickville	Commercial	82	High
R2	65 Edinburgh Road, Marrickville	Residential	20	Very High
R3	2 Bourne Street, Marrickville	Residential	29	Very High
R4	4 Leicester Street, Marrickville	Residential	136	Very High
R5	Enmore Park, Marrickville	Recreational	264	High
R6	Llewellyn Street, Marrickville	Aquatic Centre	315	High
R7	76 Edinburgh Road, Marrickville	Industrial	1	Medium
R8	1 Chapel Street, Marrickville	Industrial	190	Medium
R9	10-14 Lilian Fowler Place, Marrickville	Commercial	11	High
R10	1 Sydney Steel Road, Marrickville	Industrial	45	Medium
R11	20 Sidmore Street, Marrickville	Industrial	26	Medium

6.2. Impact Magnitude

In the context of the risk assessment methodology, impact magnitude relates to the definitions presented in **Appendix D** and is described on a scale from major to negligible.

As outlined in **Section 3.1**, the definition of 'offensive odour' under the POEO Act can be determined through various factors including the strength, nature, duration, character or quality of that odour.

In regulatory terms, the characteristics that may be controlled include the following (FIDOL factors, as discussed in **Section 2.4.2**):

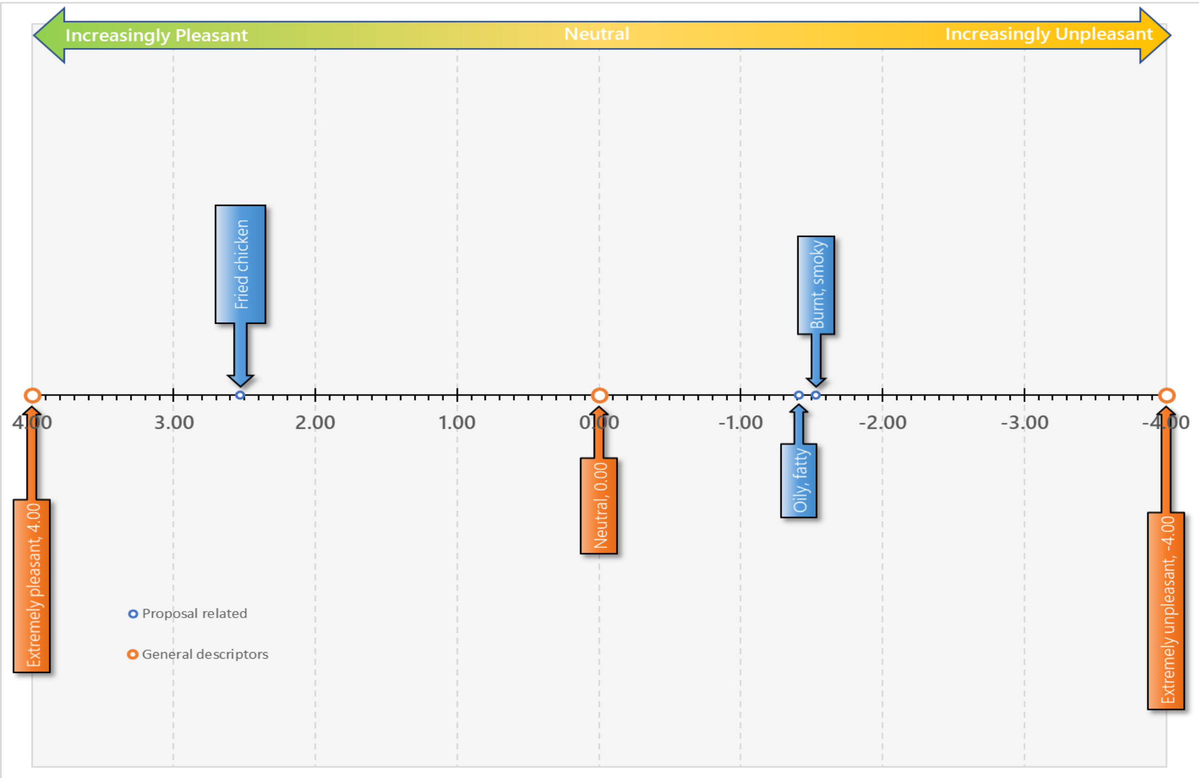
- Frequency;
- Intensity;
- Duration;
- Offensiveness; and
- Location

The following sections identify and discuss the magnitude in terms of those factors.

6.2.1. Commercial Kitchen (Chicken Rotisserie)

The character ('pleasantness') of chicken cooking odour is highly variable, and may be experienced as a relatively pleasant odour (fried chicken hedonic tone +2.53) to reasonably unpleasant (oily/fatty hedonic tone -1.41 and burnt/fatty hedonic tone -1.53) depending upon the person experiencing the odour, and the degree of grease control. How the hedonic tone of chicken rotisserie sits on the Dravniek scale (see **Appendix D**) is illustrated in **Figure 9**.

Figure 9 Offensiveness (hedonic tone) of odour from a commercial kitchen (chicken rotisserie)



Based upon the information presented in the report, the following magnitude is assessed with reference to the FIDOL factors.

Table 13 Magnitude – odour from commercial kitchen (chicken rotisserie)

Odour Characteristic	Comments	Potential Impact Magnitude
Frequency (F)	Likely to be numerous times per day	Slight to moderate
Intensity (I)	Rotisserie throughput unknown	Moderate to major
Duration (D)	Cooking frequency unknown, likely to be an hour per batch	Moderate

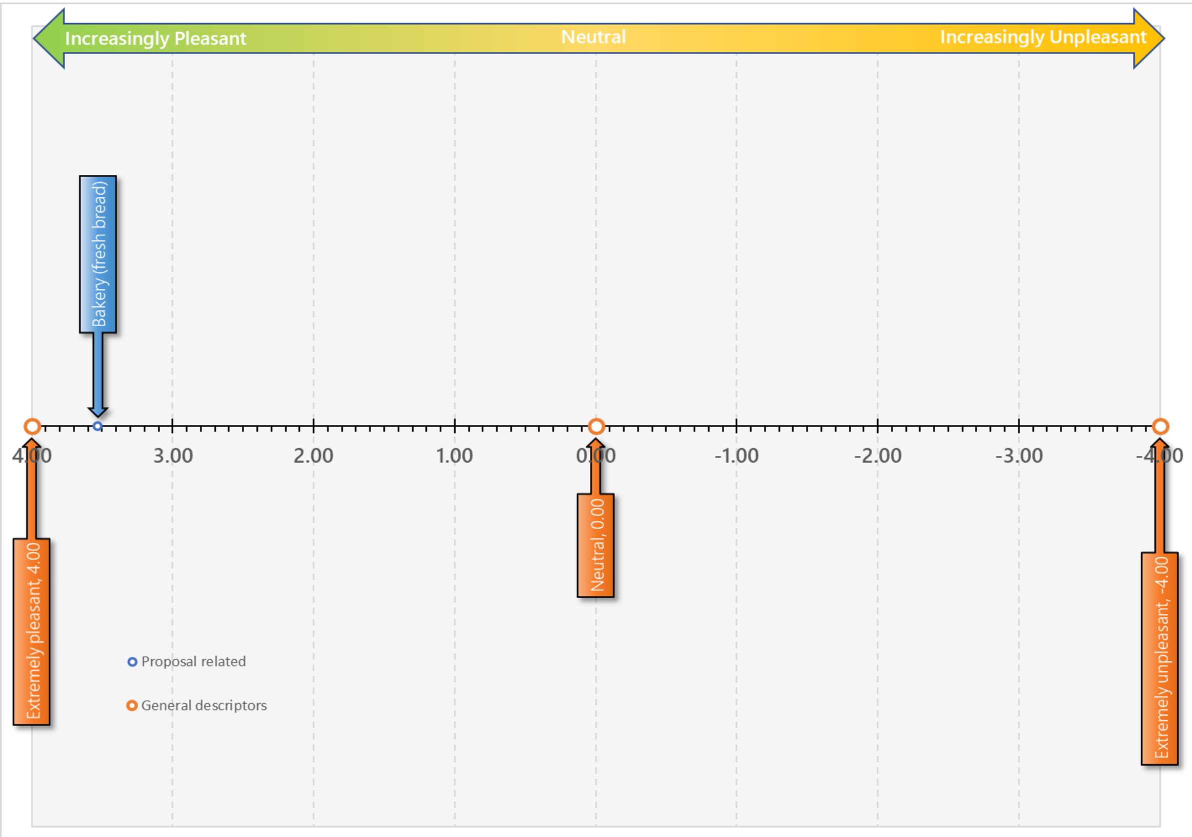
Odour Characteristic	Comments	Potential Impact Magnitude
Offensiveness (O)	Hedonic tone moderately pleasant +2.53 to moderately unpleasant -1.53	Slight
Location (L)	Not used – location is used to assess odour sensitivity	

Given the characteristics of odour emissions from the chicken rotisserie, the pre-mitigated magnitude of odour emissions is conservatively assessed as being *major*, as a consequence of the potential intensity. The magnitude is considered potentially likely to result in odour nuisance complaints, and potentially resulting in regulatory action. In this instance, that is considered likely to include Council odour enforcement action.

6.2.2. Commercial Kitchen (Bakery)

The character ('pleasantness') of bakery odour is considered to be highly pleasant (bakery hedonic tone +3.53). How the hedonic tone of chicken rotisserie sits on the Dravniek scale (see **Appendix D**) is illustrated in **Figure 10**.

Figure 10 Offensiveness (hedonic tone) of odour from a commercial kitchen (bakery)



Based upon the information presented in the report, the following magnitude is assessed with reference to the FIDOL factors.

Table 14 Magnitude – odour from commercial kitchen (bakery)

Odour Characteristic	Comments	Potential Impact Magnitude
Frequency (F)	Likely to be several times per day	Slight to moderate
Intensity (I)	Bakery throughput unknown	Moderate
Duration (D)	Cooking frequency unknown, likely to be less than an hour per batch	Moderate
Offensiveness (O)	Hedonic tone highly pleasant +3.53	Negligible
Location (L)	Not used – location is used to assess odour sensitivity	

Given the characteristics of odour emissions from the bakery, the pre-mitigated magnitude of odour emissions is conservatively assessed as being *moderate*, as a consequence of the potential frequency, intensity and/or duration. The magnitude is considered potentially likely to result in odour nuisance complaints, and potentially resulting in regulatory action.

6.3. Pre-Mitigated Risk

Based upon the foregoing information, the pre-mitigated risk is assessed as following:

Table 15 Pre-mitigated risk - odour from commercial kitchen (chicken rotisserie and bakery)

Sensitivity of Receptors		Impact Magnitude		Pre-mitigated risk	Outcome
Location	Assessment	Process	Assessment		
Various locations	Very High	Chicken Rotisserie	Major	High	Requires mitigation
		Bakery	Moderate	High	Requires mitigation

7. MITIGATION, MONITORING AND RESIDUAL RISK

7.1. Construction Phase

7.1.1. Assessed Risk (Pre-Mitigation)

The potential impacts associated with construction phase activities has been performed using a risk-based assessment procedure.

The published procedure, assesses risk associated with various construction-phase activities, including demolition, earthworks, construction and track-out. The identified risks are summarised in **Section 5.4**, and the mitigation measures identified to manage that risk are presented in **Section 7.1.2**.

7.1.2. Identified Mitigation

To manage the risks, the identified mitigation measures presented in **Table 16** are anticipated to be implemented in the Construction Environmental Management Plan (CEMP)[1].

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

Table 16 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).

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

Table 16 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
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H
1.2	Display the head or regional office contact information.	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	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

Identified Mitigation		Unmitigated Risk
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
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

Identified Mitigation		Unmitigated Risk
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 Demolition**	**High**
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).	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
8.3	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	H
8.4	Bag and remove any biological debris or damp down such material before demolition.	H
8.5	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	H
8.6	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	H
8.7	Only remove the cover in small areas during work and not all at once	H
9	**Measures Specific to Construction**	**High**
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	H
8.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	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

Identified Mitigation		Unmitigated Risk
8.4	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust	D
10	**Measures Specific to Track-Out**	**High**
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.	H
10.2	Avoid dry sweeping of large areas.	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
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.	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).	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.	H
10.9	Access gates to be located at least 10 m from receptors where possible.	H
11	**Specific Measures to Construction Traffic (adapted)**	**High**
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	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), N = not required (although can be voluntarily implemented)

7.1.3. Residual Risk (Post-Mitigation)

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

Given the size of the Proposal site, the distance to sensitive receptors and of the activities to be performed, residual impacts associated with fugitive dust emissions from the Proposal, would be anticipated to be '*negligible*' for all activities.

7.1.4. Monitoring

The site-specific management measures outlined in **Section 7.1.2** identify a number of monitoring methods to reduce air quality impacts experienced by proximate receptors. These methods are listed below:

- Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to visibly observe dust levels, record inspection results, and make the log available to the local authority upon request. This should include periodic inspection of dust soiling on off-site surfaces such as street furniture, cars and window sills within 100 m of site boundary;
- Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to Council when requested;
- Increase the frequency of site inspections by the nominated accountable person when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions;
- Record all inspections of haul routes and any subsequent action in a site log book.
- 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;
- 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.

7.2. Operational Phase Mitigation

7.2.1. Assessed Risk (Pre-Mitigation)

As presented in **Section 6.3**, the pre-mitigated risk is assessed as being *high* for both the chicken rotisserie and bakery odour emissions.

7.2.2. Identified Mitigation

Based upon the assumptions presented in the risk assessment, both commercial kitchen operations assessed require additional mitigation.

- Provision of grease arrestors at the points of extraction from the chicken rotisserie within the ductwork in the kitchen. This is required to minimise the risk of grease dropping out, and condensing from, the airflow and causing subsequent odour (and fire risk) issues in the extraction system.
- Filtration (e.g. cartridge filtration) to remove particulates (smoke) and reduce odorants in aerosols from both processes.
- Odour treatment (e.g. ozone injection, ultra-violet treatment, carbon adsorption) to neutralise gaseous odour (i.e. VOC components) from both processes.
- Vertical discharge to atmosphere at a minimum velocity as prescribed in AS 1668.2-2012 *The Use of Ventilation and Airconditioning in Buildings - Mechanical Ventilation in Buildings* from both processes. Both processes will require independent discharge points
- Vertical discharge to atmosphere at emission heights and locations as prescribed in AS 1668.2.
- Operation of the above systems in accordance with the manufacturer's instructions.
- Maintenance of a stock of spare components to minimise the risk of odour nuisance as a result of equipment failure / breakthrough for all systems

7.2.3. Residual Risk (Post Mitigation)

Based upon the above mitigation, the magnitude of impacts would be reduced to slight, which corresponds to "*potential impact may be tolerated*", and "*potential slight magnitude of impacts is not likely to generate nuisance complaints*".

Table 17 Post-mitigated risk - odour from commercial kitchen (chicken rotisserie and bakery)

Sensitivity of Receptors		Impact Magnitude		Pre-mitigated risk	Outcome
Location	Assessment	Process	Assessment		
Various locations	Very High	Chicken Rotisserie	Slight	Medium	Manage risk
		Bakery	Slight	Medium	Manage risk

7.2.4. Monitoring

Ongoing monitoring of the commercial kitchen extraction and discharge systems is recommended. It is recommended that the following monitoring actions are implemented:

- Frequent checking (at least daily) of the condition of the mitigation measures identified, including:
  - Checking for positive airflow at the extraction hood face and extraction fan performance.
  - Checking and cleaning of grease arrestors.
  - Checking of condition of cartridge filters, ensuring there is no visible breakthrough or filter media failure.
  - Checking of the condition and operation of odour control devices (e.g. ozone injection, ultra-violet treatment, carbon adsorption).

- Replacement of media or system components as required to maintain control efficiencies.
- Recording inspection and maintenance activities.
- Development of an air quality (odour and smoke) complaint management procedure, and recording all actions taken to resolve complaints. An example of a complaint record form is provided at **Appendix E**, which may be adapted for use if required.

8. CONCLUSION

Northstar Air Quality was engaged by Woolworths Group Pty Ltd, to perform an Air Quality Risk Assessment (AQRA) for the construction and operation of a Customer Fulfillment Centre, associated offices and hardstand/car parking areas.

Construction phase activities will involve demolition works and earthworks, construction works and associated vehicle traffic. The associated risks of impacts from demolition, earthworks, construction, track-out and construction traffic have been assessed using the published guidance in *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (IAQM), and adapted by Northstar Air Quality for use in Australia. This methodology has been used in a similar context in numerous other similar AQRA studies.

That assessment showed there to be a high risk of dust soiling impacts during all construction activity and a high risk of health or nuisance impacts during demolition works. Health impacts for all other construction works were showed to exhibit a medium risk. Based upon that assessment, a range of mitigation measures are recommended to ensure that short-term impacts associated with construction activities are minimised. Furthermore, the assessment has assumed that construction activities across the entire Proposal site would be performed at one time, where in reality the construction activities may be staged.

The potential impacts associated with operational activities including a chicken rotisserie and bakery have been assessed using a risk-assessment approach adopted from ISO 31000:2018 and IEC 31010:2019.

Road traffic emissions and road traffic idling emissions were not included in the risk assessment as calculations based on data provided in the Traffic and Access Assessment Report (Colston Budd Rogers and Kafes, 2020) indicates that traffic flows are not likely to result in any significant impacts.

The risk assessment found there to be a high risk of potential odour emissions generated from the chicken rotisserie and bakery operations, and a number of required mitigation methods have been determined, including recommendations for air pollution control to manage emissions of smoke and odour, and recommendations for the design of the emission points in compliance with AS 1668.2.

Based upon the assumptions presented in the report and the implementation of the recommended mitigation methods, the site is assessed as being capable to not give rise to significant air quality and odour impacts during the construction and operational phases associated with the Proposal.

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Appendix A

Meteorology

As discussed in **Section 4.3** the meteorology surrounding the Proposal site has been observed to characterise the existing conditions of the area. The meteorological monitoring has been based on measurements taken at a number of surrounding automatic weather stations (AWS) operated by the Bureau of Meteorology (BoM). Meteorology is also measured by the NSW Department of Planning, Industry and Environment (DPIE) at a number of Air Quality Monitoring Station (AQMS) surrounding the Proposal site (refer **Section 4.4**).

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

Table A1 Details of the meteorological monitoring surrounding the Proposal site

Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Earlwood AQMS	DPIE	327 553	6 245 391	3.4
Sydney Airport AMO	BoM	331 159	6 242 269	4.1
Ashfield Bowling Club	BoM	327 458	6 249 025	4.3

Figure A1 Location of Earlwood AQMS relevant to the Proposal site

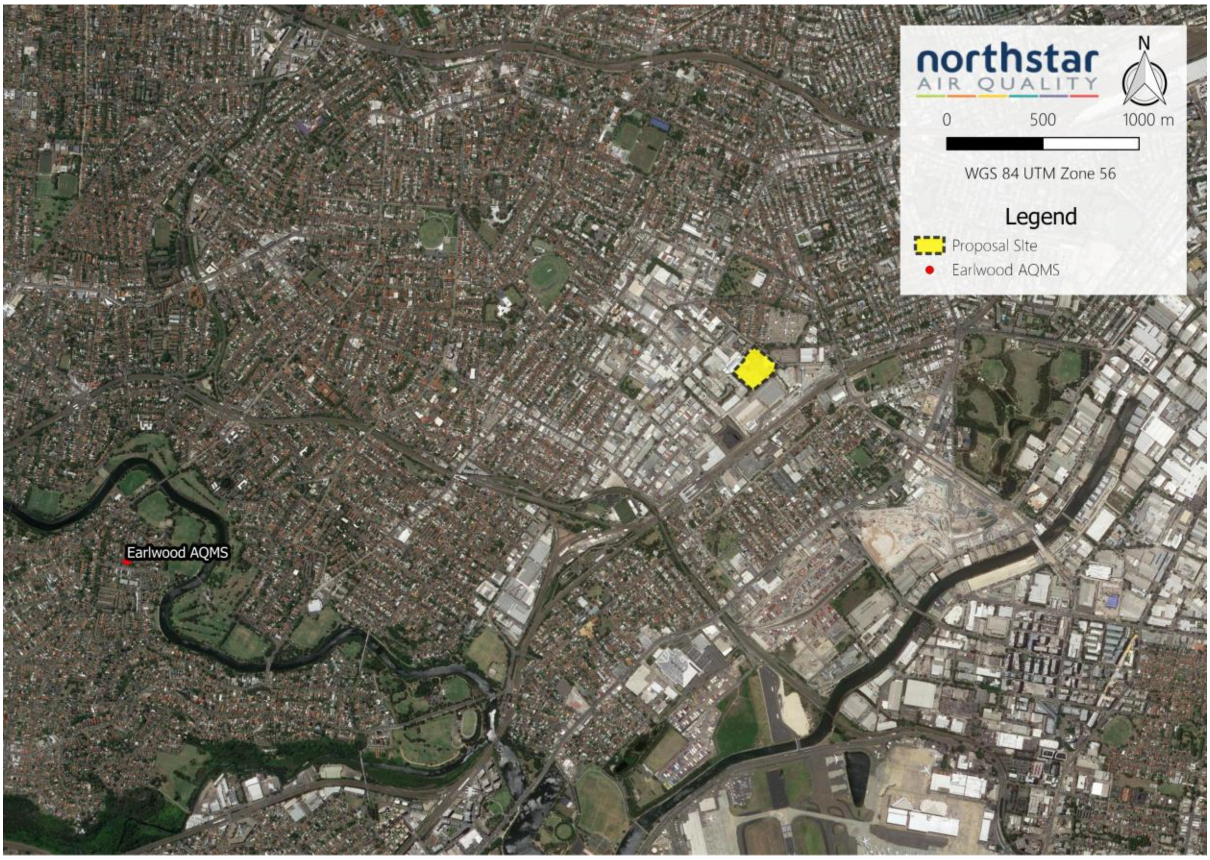
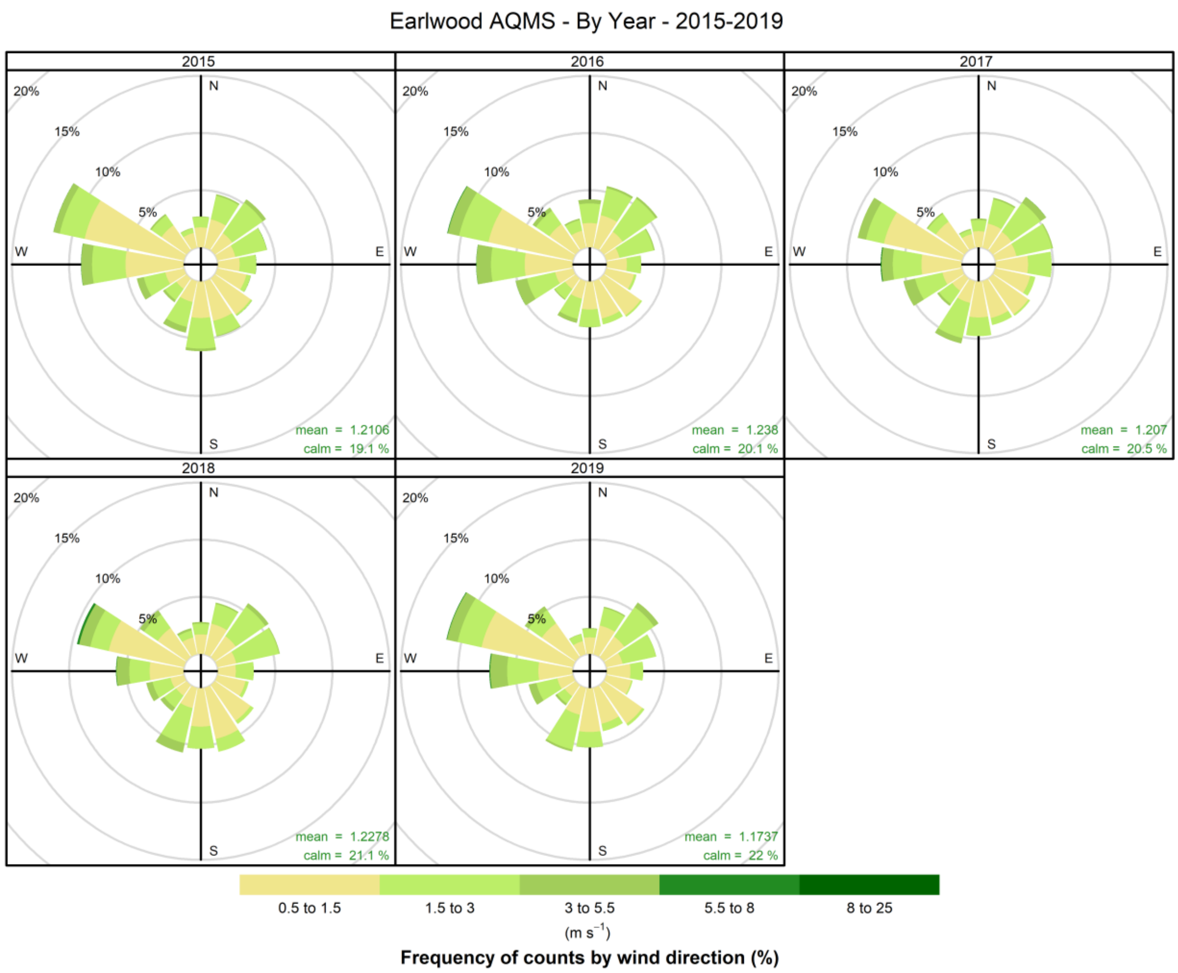


Image courtesy of Google Earth

Meteorological conditions at Earlwood AQMS was chosen for further investigation due to its location relative to the Proposal site. This site has been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent 5 years of data (2015 to 2019) are presented in **Figure A2.**

Figure A2 Annual wind roses 2015 to 2019, Earlwood AQMS



The wind roses indicate that from 2015 to 2019, winds at Earlwood AQMS show similar patterns across the years, with no predominant wind direction.

The majority of wind speeds experienced at Earlwood AQMS over the 5-year period, 2015 to 2019 are generally in the range <0.5 metres per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from a north westerly direction. Winds of this speed are not frequent, occurring <0.1% of the observed hours over the 5-year period, at Earlwood. Calm winds (<0.5 $m \cdot s^{-1}$) occur during 20.5 % of hours on average across the 5-year period.

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Appendix B

Background Air Quality Data

Air quality data presented in this Appendix is not used in a quantitative manner in the AQRA, and is provided for context only.

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 three 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**.

Table B1 Details of Closest AQMS Surrounding the Site

AQMS Location	Data Availability	Distance to Site (km)	Screening Parameters			
			Measurements			
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Earlwood	1978-2020	3.4	✓	✓	×	✓
Cook and Phillip	2019-2020	5.8	✓	✓	×	✓
Randwick	1995-2020	7.1	✓	✓	×	✓

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

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

Table B2 PM_{10} and $PM_{2.5}$ statistics 2015-2019

AQMS	Earlwood	
Years	2015-2019	
Pollutant	PM_{10}	$PM_{2.5}$
Averaging Period	24-hour	24-hour
Data Points (number)	16147.0	15335.0
Mean (µg·m^{-3})	16.9	8.4
Standard Deviation (µg·m^{-3})	10.1	7.4
Skew[1]	2.8	2.7
Kurtosis[2]	23.3	19.2
Minimum (µg·m^{-3})	-7.3	-2.5
Percentiles (µg·m-3)		
25	10.1	3.7
50	15.1	6.8
75	21.4	11.1
90	29.0	16.9
95	34.3	22.2
99	48.1	35.0
Maximum	80.7	148.3
Data Capture (%)	98.6	93.6

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

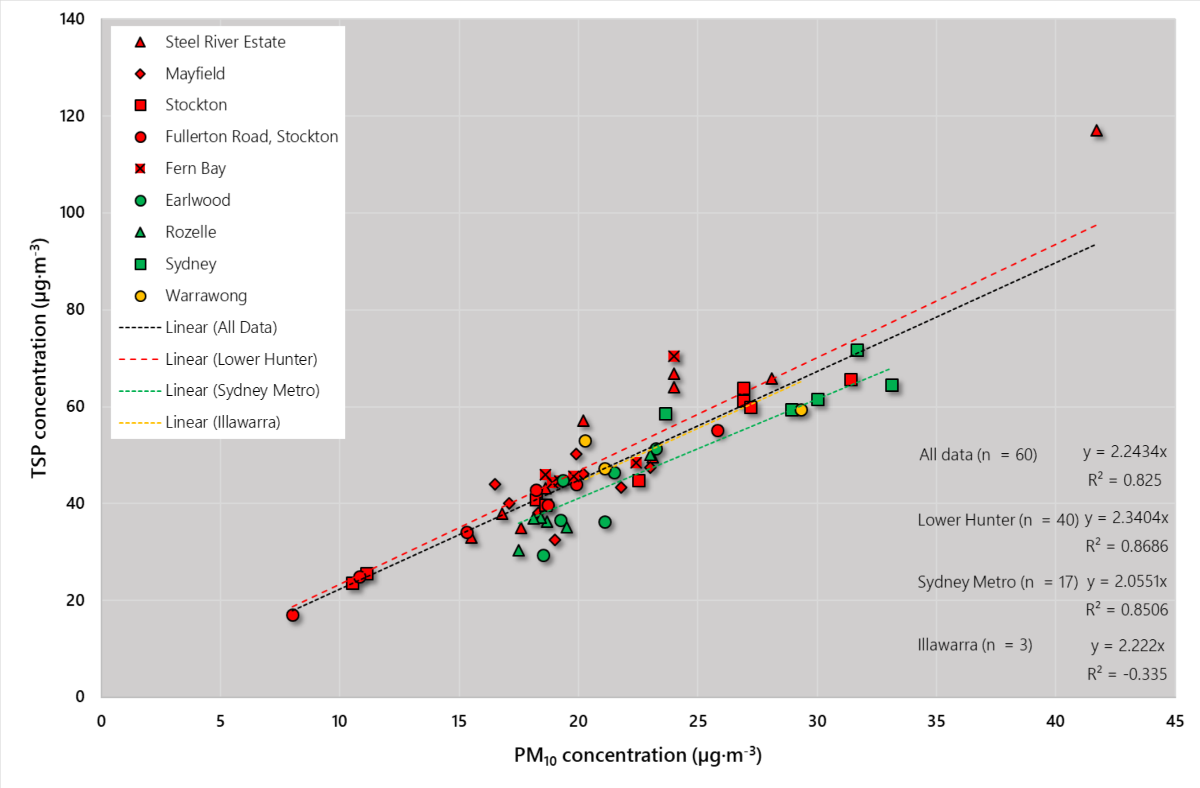
2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Concentrations of TSP are not measured by the NSW 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.

In the absence of any more specific information, this ratio has been adopted within this AQRA. 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 years 2015-2019 is presented in **Table B3**.

Graphs presenting the daily varying PM_{10} and $PM_{2.5}$ data recorded at Earlwood for the years 2015-2019 are presented in **Figure B2** and **Figure B3**, respectively.

Table B3 Summary of Background Air Quality Data (Earlwood 2015-2019)

Pollutant	TSP ($\mu g \cdot m^{-3}$)	PM_{10} ($\mu g \cdot m^{-3}$)	$PM_{2.5}$ ($\mu g \cdot m^{-3}$)	NO_2 ($\mu g \cdot m^{-3}$)
Averaging Period	Annual	24-Hour	24-Hour	1-Hour
Data Points (number)	1799	1799	1757	40661
Mean	39.3	19.1	8.4	1.0
Standard Deviation	-	10.0	6.2	0.8
Skew[1]	-	3.7	5.1	0.9
Kurtosis[2]	-	25.6	44.9	0.5
Minimum	39.3	2.7	1.4	-0.3
Percentiles ($\mu g \cdot m^{-3}$)				
25	-	13.0	4.9	0.3
50	-	17.2	7.0	0.7
75	-	22.7	10.1	0.1
90	-	28.8	13.8	2.1
95	-	33.4	16.8	2.5
99	-	56.3	31.0	3.1
Maximum	39.3	129.4	86.2	6.7
Data Capture (%)	98.6	98.4	96.1	92.8

Figure B2 PM$_{10}$ Measurements, Earlwood 2015-2019

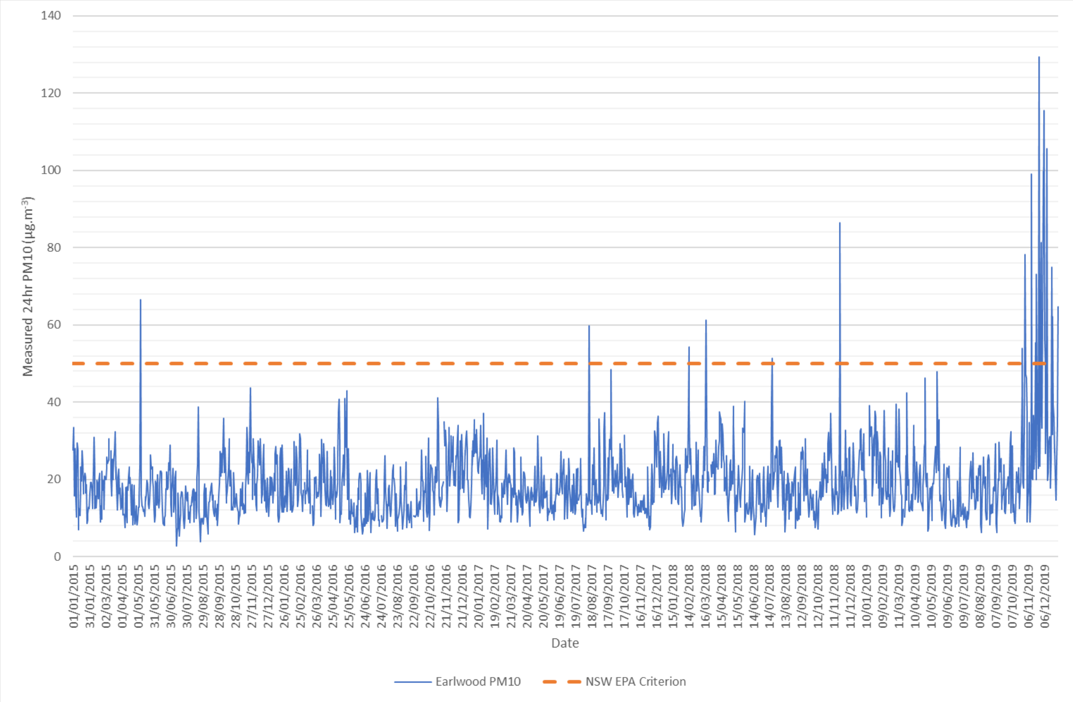
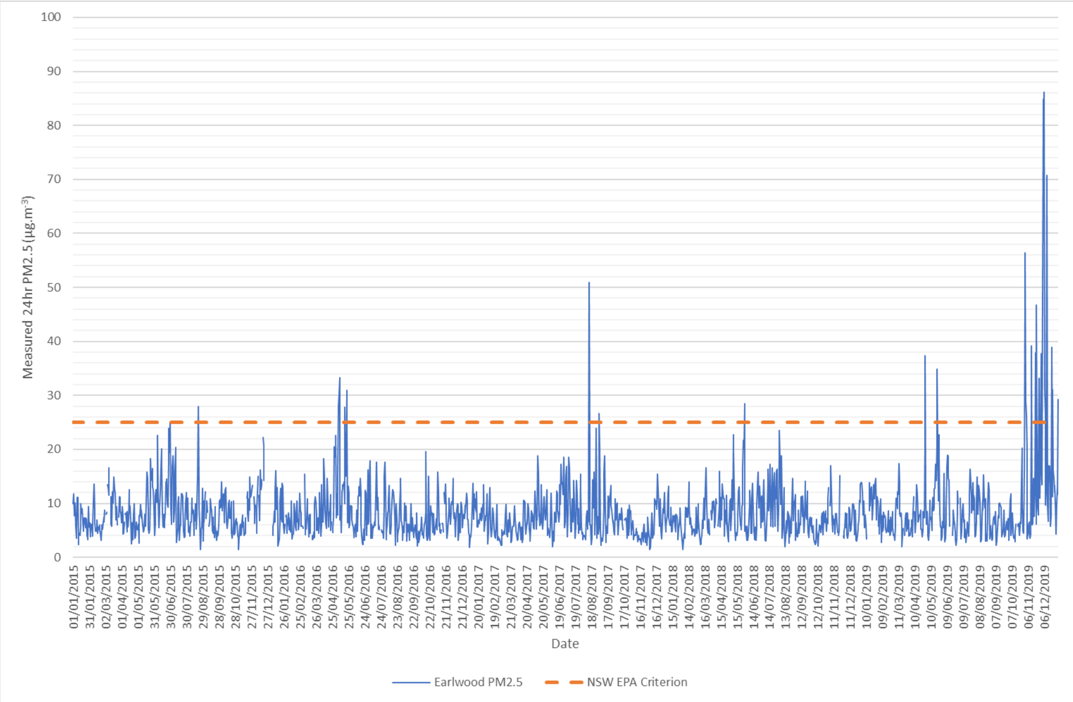


Figure B3 PM$_{2.5}$ Measurements, Earlwood 2015-2019



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

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

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

Step 6 – Risk Assessment (post-mitigation)

Following Step 5, the residual impact is then determined.

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

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Appendix D

Operational Phase Risk Assessment Methodology

Provided below is the summary for the risk assessment methodology used for the operational phase of this assessment. It is based upon the definitions provided under ISO 31000.

The risk assessment presented in this report is performed in two stages:

- **Step 1: Pre-mitigated risk:** This is used to identify any significant risks and identify the need to control;
- **Step 2: Control and mitigation:** An examination of what constitutes best available technology (BAT) for emissions control for that process.

The risk assessment procedure adopted in this instance uses the determinations of:

- sensitivity of receptors; and
- impact magnitude; to derive
- risk.

These terms are defined and discussed in the following subsections.

Sensitivity of Receptors

Sensitivity terminology may vary depending upon the environmental effect, but generally this may be described in accordance with a scale from 'very high' to 'low', as defined below.

With regard to odour impacts, sensitivity relates to the Location factor (F I D O **L**).

Methodology - sensitivity of receptors

Sensitivity		Descriptions
4	Very high	• Receptors are highly sensitive to changes in the air quality / odour environment. • Areas may be typified by extended (day-long) exposure times and/or an expectation of high amenity values. • Typical examples may include residential areas, health care facilities, retirement homes
3	High	• Receptors have a high sensitivity to changes in the air quality / odour environment. • Areas may be typified by working-day exposure times and/or an expectation of high amenity values. • Typical examples may include commercial zones, recreation facilities, schools, high-end office space (banking etc).

Sensitivity		Descriptions
2	Medium	• Receptors have a medium sensitivity to changes in the air quality / odour environment. • Areas may be typified by up to working-day exposure times and an expectation of reasonable amenity values commensurate with the land-uses. • Typical examples may include agricultural and environmental conservation spaces, industrial zones.
1	Low	• Receptors have a low sensitivity to changes in the air quality / odour environment. • Areas may be typified by short-term exposure times and a low expectation of amenity values. • Typical examples may include infrastructure land uses, open and undeveloped land.

Impact Magnitude

Impact magnitude is a descriptor for the predicted scale of change to the odour environment that may be attributed to the operation of the Proposal, and is evaluated on a scale from 'major' to 'negligible' as defined below.

With regard to odour impacts, magnitude relates to the Frequency, Intensity, Duration and Offensiveness factors (**F I D O** L).

Methodology - impact magnitude

Magnitude		Descriptions
4	Major	Potential impact magnitude may cause statutory objectives / standards to be exceeded. Potential major magnitude of impacts may generate nuisance complaints, resulting in regulatory action.
3	Moderate	Potential impact may give rise to a perceivable health and/or amenity impact. Potential moderate magnitude of impacts may generate nuisance complaints, likely to require management but not result in regulatory action.
2	Slight	Potential impact may be tolerated. Potential slight magnitude of impacts is not likely to generate nuisance complaints.
1	Negligible	Potential impact magnitude is unlikely to cause significant consequences. Potential negligible magnitude of impacts is unlikely to generate nuisance complaints and is likely to only be perceptible within the site boundary.

The assessment of magnitude with regard to offensiveness references the Dravniek index from -4 (unpleasant) through 0 (neutral) to +4 (pleasant) (Andrew Dravnieks, 1984). The Dravniek index is commonly used to evaluate the hedonic tone (offensiveness) of odour.

Risk

The risk matrix provided illustrates how the definition of the impact magnitude and sensitivity of receptors interact to produce impact risk (composite risk index). For example, an odour impact of slight magnitude at a medium sensitive receptor location would be determined to be of medium risk (significance).

Methodology – odour risk matrix

Sensitivity \ Magnitude	Negligible (1)	Slight (2)	Moderate (3)	Major (4)
Very High (4)	Medium (4)	Medium (8)	High (12)	High (16)
High (3)	Medium (3)	Medium (6)	Medium (9)	High (12)
Medium (2)	Low (2)	Medium (4)	Medium (6)	Medium (8)
Low (1)	Low (1)	Low (2)	Medium (3)	Medium (4)

The 'risk' derived through this methodology is presented on a simplified three-point scale:

High	A high risk that requires management, through changes to impact magnitude and/or sensitivity
Medium	An intermediate risk, and recommendations are to reduce risk as low as practicable through changes to impact magnitude and/or sensitivity
Low	No further management required, although risks should be managed

The relative risk is provided as a dimensionless product of the defined values attributed to receptor sensitivity and impact magnitude.

The determined risk (significance) may be used to highlight the relative environmental risk and to highlight the general requirement for the application of controls and mitigation. It is noted that the above approach is designed to provide an overall impact risk and is not intended to represent the defining determination for the requirement for mitigation and control. The determined risk methodology is not designed to exclude impacts with a lower determined significance from receiving mitigation and control treatments, in accordance with the principle of reducing environmental impacts to maximum extent practicable.

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Appendix E

Example Odour Complaint Record

Complainant Contact Details			
Date and time complaint received			
Contact details for complainant			
Complaint Details			
Date and time start	/ / : am|pm		
Date and time stop	/ / : am|pm		
Location(s) of the odour			
Description of the odour			
Persistence *see note 1*	☐ Constant ☐ Intermittent		
Intensity (odour) *see note 2*	☐ 6 extremely strong	☐ 4 strong	☐ 2 weak
☐ generally ☐ at its worst	☐ 5 very strong	☐ 3 distinct	☐ 1 very weak
Prevailing weather conditions at the time of the complaint			
General description (dry, rain, windy, still etc)			
Temperature			
General wind direction *see note 3*			
General wind strength *see note 4*			
Operational details, actions, resolution			
Operations during complaint			
Identified causes			
Actions taken			
Cause resolved	☐ Yes ☐ No		
Follow up required	☐ Yes ☐ No		
Complainant informed of outcome	☐ Yes ☐ No		
Signed			
Date	/ /		

Notes

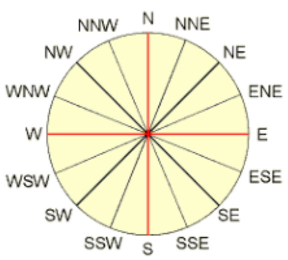
1. Persistence. Please record the descriptor that best describes the extent of the observation:

- Constantly: air quality impact was observed virtually constantly between the stated start and stop times
- Intermittently: odour was observed intermittently between the stated start and stop times

2. Odour Intensity. Using the scale below, estimate how intense the odour was generally or at its worst (as appropriate)

6	**Extremely strong:** Overpowering odour triggering a physical reaction (i.e. gaging, eyes watering etc.) or an involuntary action (i.e. turning away from odour, covering nose etc.).	3	**Distinct:** Mid way between a weak and strong odour, this is a clearly defined odour, immediately recognisable and tolerable.
5	**Very strong:** A strong odour that may initiate an involuntary action that you subsequently control. Odour is barely tolerable and exposure is uncomfortable	2	**Weak:** This is a clearly defined odour (i.e. without uncertainty/guessing), immediately recognisable but not yet strong enough to be considered distinct and readily tolerable.
4	**Strong:** A clearly defined odour that is immediately recognisable and is tolerable but mildly uncomfortable.	1	**Very weak:** A very faint odour. The VDI definition of a very weak odour requires the odour to be clearly defined without uncertainty or guessing involved.

3. Wind Direction.



Compass Points

4. Wind Strength

0	Calm	Calm. Smoke rises vertically
1	Light air	Wind motion visible on smoke
2	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	Gentle breeze	Leaves and smaller twigs in constant motion
4	Moderate breeze	Dust and loose paper raised. Small branches move
5	Fresh breeze	Moderate branches move. Small trees begin to sway.
6	Strong breeze	Large branches in motion. Overhead wires whistle. Umbrella use is difficult. Empty rubbish bins tip.
7+	Near gale	Wind effects greater than above