Air Quality	Assess the construction and operation air quality impacts and ensure they meet the requirements of Council and/or the Environment Protection Authority	The report considers potential construction and operational impacts on air quality and concludes that activities can be managed such that impacts on the surrounding community are not significant.

This document has been prepared on behalf of **AA Crown Holdings Pty Ltd**:

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Northside Private Hospital, West Gosford

Air Quality Assessment

Addressee(s): AA Crown Holdings Pty Ltd

Report Reference: 20.1009.FR1V2

Date: 17 July 2020

Quality Control

Study	Status	Prepared by	Checked by	Authorised by
INTRODUCTION	Final	Northstar Air Quality	GCG, DWC	MD
THE DEVELOPMENT	Final	Northstar Air Quality	GCG, DWC	MD
LEGISLATION, REGULATION AND GUIDANCE	Final	Northstar Air Quality	GCG, DWC	MD
LAND SENSITIVITY	Final	Northstar Air Quality	GCG, DWC	MD
METHODOLOGY	Final	Northstar Air Quality	GCG, DWC	MD
ASSESSMENT	Final	Northstar Air Quality	GCG, DWC	MD
MITIGATION AND MONITORING	Final	Northstar Air Quality	GCG, DWC	MD
CONCLUSION	Final	Northstar Air Quality	GCG, DWC	MD

Report Status

Northstar References		Report Status	Report Reference	Version
Year	Job Number	(Draft: Final)	(R*x*)	(V*x*)
20	1009	F	R1	V2
Based upon the above, the specific reference for this version of the report is:				**20.1009.FR1V2**

Final Authority

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

Martin Doyle **17th July 2020**

Non-Technical Summary

AA Crown Holdings Pty Ltd has engaged Northstar Air Quality Pty Ltd to perform an air quality assessment for the proposed construction and operation of a hospital located at the intersection of Racecourse Road and Faunce Street West in West Gosford, NSW.

This air quality assessment forms part of the State Significant Development application under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The air quality assessment presents an assessment of the impacts of proposed activities at the development site, associated with both construction and operational phases.

Regarding potential construction impacts, these have been assessed using a published risk-based assessment methodology, which indicates that a range of mitigation measures can be applied during the minor construction phase to ensure that the risks (both health and amenity) to the surrounding community would not be significant.

A range of potential emissions sources have been identified during the operational phase which include emergency power generation, waste generation and storage, kitchen operations and traffic movements. The potential scale of each of these emission sources has been considered, and a range of emission control or management measures referenced or outlined. Inclusion of the appropriate process and emission controls would result in impacts on the surrounding community being insignificant.

Based on the findings of this assessment, air quality impacts during both the construction and operational phases can be managed such that impacts on the surrounding community are not significant.

Contents

Tables

Figures

1. INTRODUCTION

AA Crown Holdings Pty Ltd (Crown Holdings) has engaged Northstar Air Quality Pty Ltd (Northstar) to perform an air quality assessment (AQA) for the proposed construction and operation of Northside Private Hospital (the development). The Hospital is proposed to be located in the Northside Medical Precinct in West Gosford (Lot 2 DP 1226923) at the intersection of Racecourse Road and Faunce Street West (the development site).

This AQA forms part of the State Significant Development (SSD) application for the development under Part 4 of the *Environmental Planning and Assessment Act* 1979.

Secretary's Environmental Assessment Requirements (SEARs) have been provided for the development by the NSW Department of Planning and Environment (DPE, now Department of Planning, Industry & Environment [DPI&E]) on 5 April 2019 (SSD 10159). In relation to air quality, the SEARs state that the SSD must:

> ***"Assess the construction and operation air quality impacts and ensure they meet the requirements of Council and/or the Environment Protection Authority"***

The AQA presents an assessment of the potential impacts associated with both the construction and operational phase of the development. Regarding potential construction related impacts, these have been assessed using a published risk-based assessment methodology, and appropriate construction control measures have been proposed to manage that risk. Regarding potential operational impacts, the assessment has adopted a qualitative approach, identifying potential sources of emissions, and proposing control measures to minimise any identified potential impacts.

Further to the above, the policies, guidelines and plans which have been consulted during the performance of the AQA include:

- Gosford Development Control Plan 2013 (Central Coast Council, 2013);
- Civil Works Specification, Construction Specification (Central Coast Council, 2018);
- Building & Development on the Central Coast for land subject to Gosford Local Environmental Plan (Central Coast Council, 2014);
- Protection of the Environment Operations (Clean Air) Regulation 2002;
- Approved Methods for the Modelling and Assessment of Air Quality in NSW (NSW EPA, 2017);
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2006);
- Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006); and
- Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006).

It is noted that the NSW Environment Protection Authority (EPA) has provided comments indicating that the development does not perform activities which are listed in Schedule 1 of the Protection of the Environment Operations Act 1997 (POEO Act) and Central Coast Council would be the appropriate regulatory authority for matters under the POEO Act in respect of the development.

2. THE DEVELOPMENT

The following provides a description of the development and the potential emissions to air which would be anticipated during the construction and operational phases.

2.1 Environmental Setting

The development site is located at Lot 2 DP 1226923, Faunce Street West, West Gosford, NSW, within the Local Government Area (LGA) of Central Coast Council. A map illustrating the location of the development site is presented in **Figure 1**.

Figure 1 Development site location

Source: Northstar Air Quality

The development site is zoned as "Enterprise Corridor" (B6) as stated within the Gosford Local Environmental Plan (GLEP) 2014. The surrounding land uses are zoned as "Business Development" (B5) to the west, "Public Recreation" (RE1) to the north and south east. The nearest residential areas are to the south and east of the development site and are zoned accordingly as "General Residential" (R1).

2.2 Specific Construction Details

The hours of construction of the development are outlined in **Table 1**.

Table 1 Proposed construction hours

Activity	Construction hours
Construction activities (staffed)	7am to 6pm, Monday to Friday 8am to 4pm Saturday

Working hours have been taken from the Central Coast Council civil works specification Section 3.7.11, which states *"Where not specified in a Development Consent or required by other Authorities, working hours for works shall be restricted to Monday to Friday between 7.00am and 6.00pm and Saturday 8.00am to 4.00pm. No work shall take place on Sundays or public holidays."* (Central Coast Council, 2018). Crown Holdings may limit construction hours further.

The construction of the development is anticipated to be completed over a two-year period.

The development would be 43 metres (m) in height at the roof peak and would occupy a footprint of approximately 7 925 square metres (m^2). The total building volume to be constructed is estimated to be 219 668 cubic metres (m^3). All dimensions are approximated.

2.3 Specific Operational Details

The hours of operation of the development are outlined in **Table 2**.

Table 2 Proposed operational hours

Activity	Operational hours
Operational activities (staffed)	Hospital Ward – 24 hours a day, 7 days a week Day Surgery - 7am to 7pm, 7 days a week Retail Tenancy – 8am to 6pm, 7 days a week

The development includes the erection of an 10-storey private hospital which includes 8 floors comprising:

- medical suites;
- in-patient units;
- general practitioner clinics;
- radiology rooms;
- pathology room;
- conference room;
- nuclear medicine;
- intensive care unit; and,
- operating theatres.

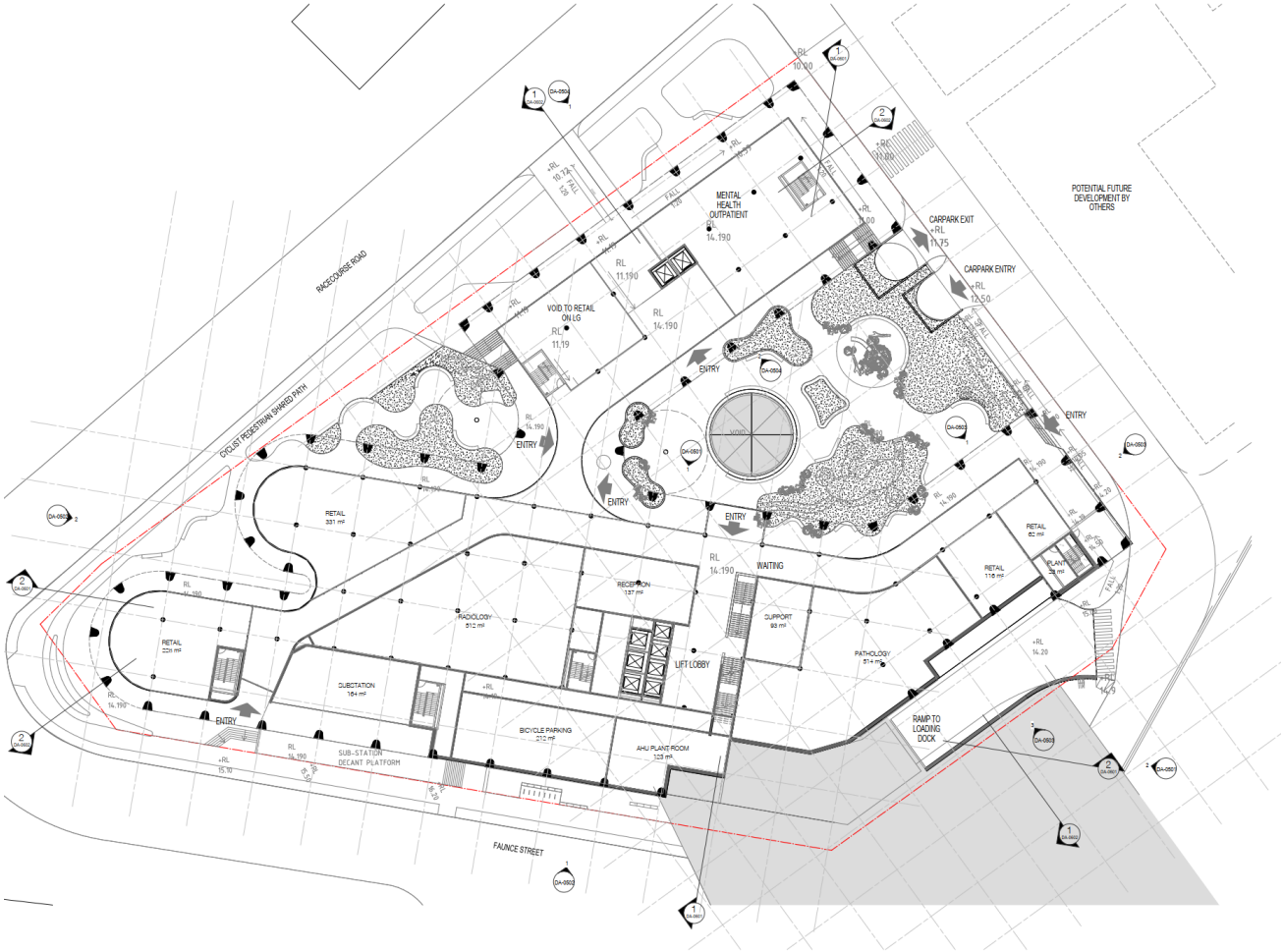
The development also incorporates 1 lower ground floor level comprising:

- parking;
- retail; and,
- a basement level comprising parking, waste storage and loading dock and plant.

Further to this, the development incorporates a mezzanine level car parking.

The ground floor plan of the development is presented in **Figure 2**.

Figure 2 Development site layout – ground floor



Source: Extract from 'Northside Private Hospital' from SJB Architects, Drawing number DA-0204 Revision 1 (10 July 2020)

2.4 Identified Potential for Emissions to Air

2.4.1 Construction Phase

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

- cranes;
- light vehicles;
- excavators;
- front end loaders;
- graders;
- heavy vehicles;
- drills;
- pneumatic hand or power tools;
- commercial vans; and,
- cherry pickers.

The methodology used in the construction phase air quality assessment is discussed in **Section 5.1** and **Appendix B**, and the assessment of the potential impacts upon local air quality resulting from construction activities is presented in **Section 6.1**.

The construction phase activities to be performed as part of the development are anticipated to have the potential to generate short-term emissions of particulates ('construction dust'). Generally, these are associated with uncontrolled (or 'fugitive') emissions and may typically be experienced by neighbours as amenity impacts, such as dust deposition and/or visible dust plumes, rather than associated with health-related impacts.

2.4.2 Operational Phase

During the operation of the development, the processes which may result in the emission of pollutants to air include:

- use of emergency power generation;
- management and disposal of waste materials (including medical wastes);
- cooking emissions from kitchens; and,
- vehicle movements.

The methodology used in the operational phase air quality assessment is discussed in **Section 5.2**, and the assessment of the potential impacts upon local air quality resulting from operational activities is presented in **Section 6.2**.

3. LEGISLATION, REGULATION AND GUIDANCE

3.1 NSW 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 Quality in NSW'* (the Approved Methods (NSW EPA, 2017)).

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the assessment criteria for the project.

The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, DoE and WHO).

The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW are presented in **Table 3**.

Table 3 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units	Criterion
Particulates (as PM_{10})	24 hours	$\mu g \cdot m^{-3}$ (a)	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 Total Suspended Particulate [TSP])	1 year	$\mu g \cdot m^{-3}$	90
Deposited dust(d)	1 year	$g \cdot m^{-2} \cdot month^{-1}$(b)	2
		$g \cdot m^{-2} \cdot month^{-1}$(c)	4

Notes: (a): Micrograms per cubic metre of air
(b): Maximum increase in deposited dust level
(c): Maximum total deposited dust level
(d): Assessed as insoluble solids as defined by AS 3580.10.1

3.2 Odour Regulation and Control in NSW

The defining legislation applicable in NSW is provided under the *Protection of the Environment Operations Act* (1997) (POEO Act) and the *Protection of the Environment Operations (Clean Air) Regulation* (2010) (under the Act). However, the operations being performed at the Hospital are not scheduled under the POEO Act, and therefore do not require licencing by the NSW Environment Protection Authority.

The operations would be regulated by Council and the environmental management and resolution of any air pollution-based nuisance or off-site impacts caused by odour (or any other pollutant) from such premises is primarily the responsibility of the site operator. Further discussion of regulation under the POEO Act is provided in the following section.

The POEO Act is applicable to scheduled activities in NSW and emphasises the importance of preventing 'offensive odour'. Although the operations at the Hospital are non-scheduled activities under the POEO Regulations, they are regulated by Council and the principles contained within the POEO framework are applicable.

For reference, '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.*

4. LAND SENSITIVITY

Air quality assessments typically use a desk-top mapping study to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors refers to places at which humans may be present for a period representative of the averaging period for the pollutant being assessed (see **Section 3**). Typically, these locations are identified as residential properties although other sensitive land uses may include schools, medical centres, places of employment, recreational areas or ecologically sensitive locations.

A number of residential, educational, commercial and recreational locations surrounding the development site have been identified and these receptors have been adopted for use within this AQA as presented in **Table 4**.

Figure 3 Sensitive receptors surrounding the development

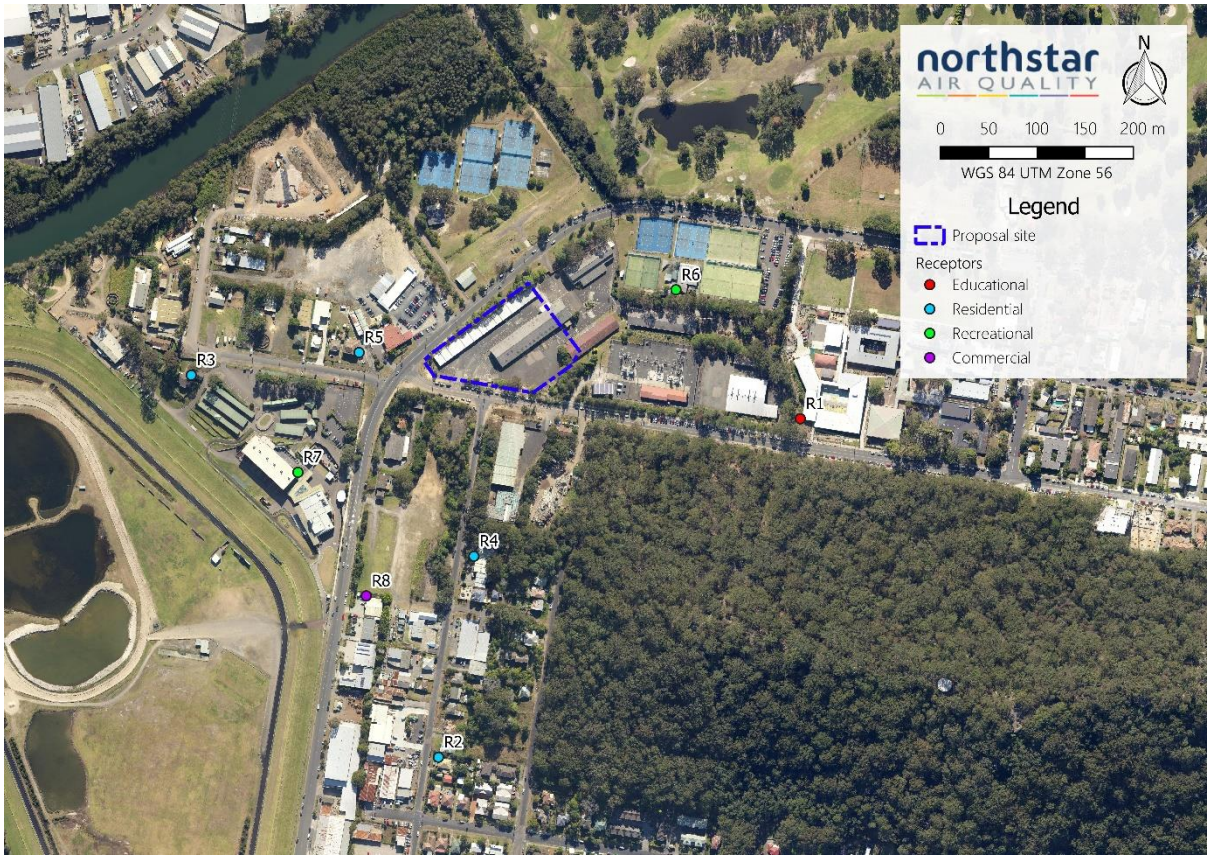


Table 4 is not intended to represent a definitive list of sensitive land uses, but a cross section of available locations that are used to characterise larger areas, or selected as they represent more sensitive locations which may represent people who are more susceptible to changes in air pollution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

Table 4 Discrete sensitive receptor locations used in the study

Rec. ID	Address	Land Use	Location (m, UTM 56)	
			Eastings	Northings
R1	Gosford Public School	Educational	345 035	6 300 756
R2	19 Young St, West Gosford	Residential	344 660	6 300 405
R3	2 Blackett St, West Gosford	Residential	344 404	6 300 801
R4	41 Young St, West Gosford	Residential	344 697	6 300 613
R5	18-20 Faunce St West, West Gosford	Residential	344 578	6 300 825
R6	Gosford Tennis Centre	Recreational	344 906	6 300 890
R7	The Entertainment Grounds	Recreational	344 514	6 300 700
R8	Carpet One West Gosford	Commercial	344 585	6 300 572

Any impacts resulting from the operation of the Hospital would also be required to be controlled to ensure that the occupants of the Hospital are not adversely affected.

5. METHODOLOGY

5.1 Construction Phase Assessment

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 scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts.

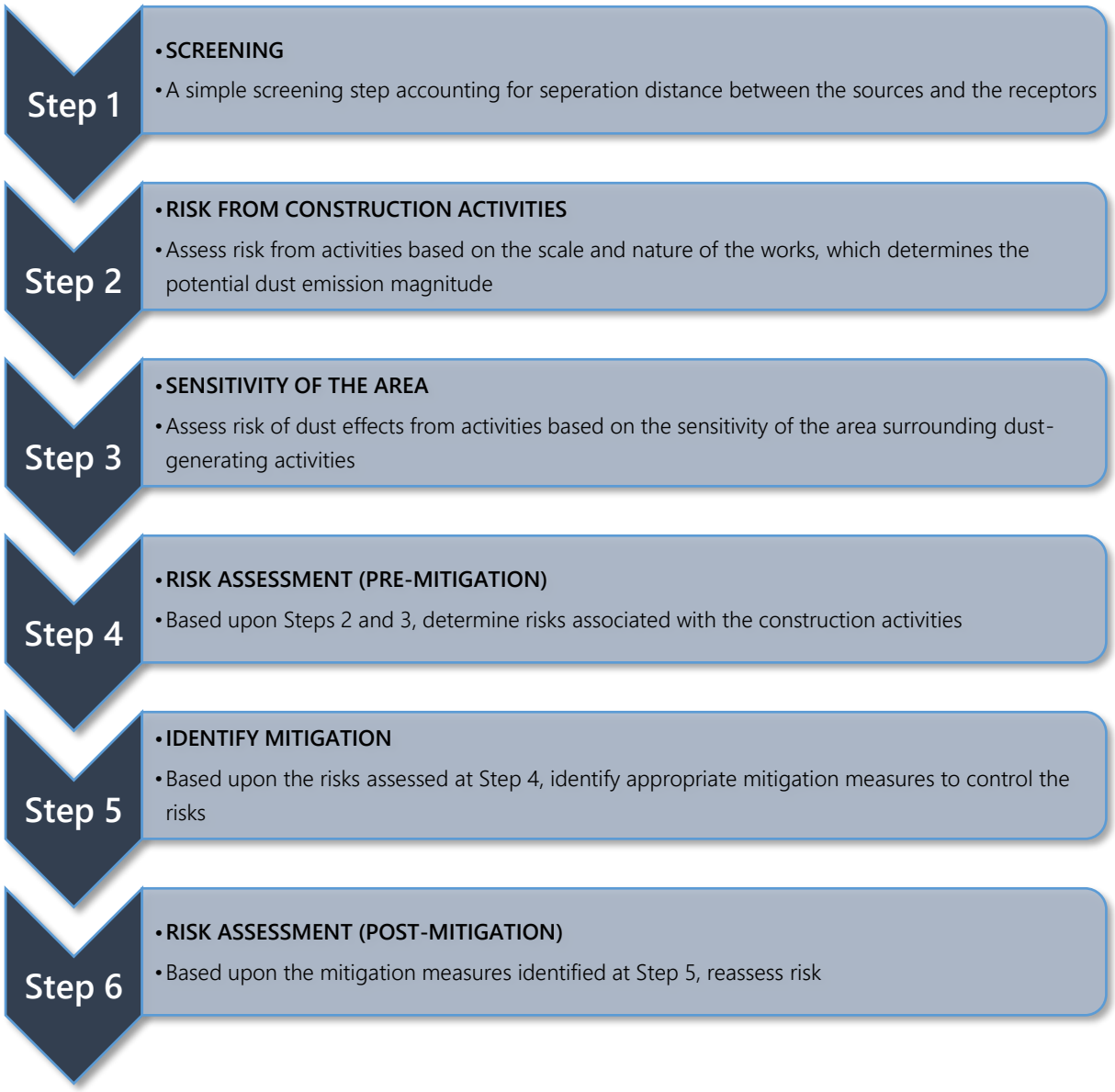
Modelling of dust from development construction is generally not considered appropriate, as there is a lack of reliable emission factors from construction activities upon which to make predictive assessments, and the rates would vary significantly depending upon local conditions and the construction management practices employed. In lieu of a modelling assessment, the construction phase impacts associated with the development 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 (Institute of Air Quality Management, 2016)[1]. Reference should be made to **Appendix B** for the full 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 4**.

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

Figure 4 Construction phase impact risk assessment methodology



The assessment approach is detailed in **Appendix B**.

5.2 Operational Phase Assessment

The assessment of operational phase impacts has been performed using a qualitative approach. The assessment relies upon management plans provided for the development, namely:

- Waste Management Plan (MRA, 2019); and

- Traffic Impact Assessment (TRAFFIX, 2019)

The proposed management measures outlined within those plans and assessments is discussed in relation to air quality and odour impacts and their suitability to minimise adverse impacts at sensitive receptor locations (including within the Hospital).

Impacts associated with emergency power generation have been considered with reference to the POEO Act, and provisions included within the Act for emergency electricity generation.

Impacts associated with odour associated with cooking, in either the Hospital kitchen or within any retail tenancies is discussed with consideration of Australian Standard requirements, and appropriate odour management measures are proposed.

6. ASSESSMENT

The following sections of the report present the results of the construction phase and operational phase air quality assessments.

6.1 Construction Phase Assessment

The following presents the results of the construction phase dust assessment.

6.1.1 Step 1: Screening Based on Separation Distance

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

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

Table 5 presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table 5 Construction phase impact screening criteria distances

Rec	Location	Land Use	Screening Distance (m)		
			Boundary (350m)	Site Entrance (500m)	Construction route (50m)
R1	Gosford Public School	educational	239	361	358
R2	19 Young St, West Gosford	residential	389	392	126
R3	2 Blackett St, West Gosford	residential	241	273	192
R4	41 Young St, West Gosford	residential	178	185	129
R5	18-20 Faunce St West, West Gosford	residential	67	102	45
R6	Gosford Tennis Centre	recreational	118	248	245
R7	The Entertainment Grounds	recreational	174	189	63
R8	Carpet One West Gosford	commercial	239	243	25

With reference to **Table 5**, a number of sensitive receptors are noted to be within the screening distance boundaries and therefore require further assessment as summarised in **Table 6**.

Table 6 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 screening distance
Earthworks	350 m from boundary 500 m from site entrance		
Construction	350 m from boundary 500 m from site entrance		
Construction Traffic	50 m from roadside		
Trackout	100 m from site entrance	screened	Trackout screened as receptors > 100m from site entrance

6.1.2 Step 2: Impact Magnitude

The footprint of the site which is to be affected is estimated as being approximately 88 m × 90 m = 7 920 m^2 (0.79 hectares [ha]).

The development will involve demolition of five buildings, equating to approximately 1 605 m^3 of demolition waste within the site (MRA, 2019). The total earthworks for the Hospital site area is 7 920 m^2. The total construction within the Hospital site will be 1 building, equating to 219 668 m^3 (refer to **Section 2.2**).

The assumed supply route around the Hospital site during construction works may be up to 295 m in two-way length. It is anticipated that five heavy vehicle movements would be required each day to service the site. For the purposes of the assessment, the route for construction traffic to/from the site is assumed to be along arterial roads, heading southbound along Racecourse Rd towards Central Coast Highway.

Based upon the above assumptions and the assessment criteria presented in **Appendix B**, the dust emission magnitudes are as presented in **Table 7**.

Table 7 Construction phase impact categorisation of dust emission magnitude

Activity	Dust Emission Magnitude
Demolition	small
Earthworks and enabling works	medium
Construction	large
Track-out	N/A
Construction traffic routes	large

6.1.3 Step 3: Sensitivity of an Area

Based on the criteria listed in **Appendix B**, the land use value of the area surrounding the development site is concluded to be *high* for health impacts and for dust soiling, based upon the following assumptions:

- the distance between the receptors and the site,
- the nature of receptors surrounding the site, and
- the background annual average PM_{10} concentration of 16.1 $\mu g \cdot m^{-3}$ as reported at the NSW DPI&E Wyong air quality monitoring station (AQMS) for 2017. Data collected at the Wyong AQMS has been selected as it best represents the background air quality in the area relative to the Hospital site. The year has been selected as it is the most representative of the long-term median when compared to a longer-term dataset of measurements collected at Wyong AQMS (2014 to 2018).

Using the classifications shown in **Appendix B**, the sensitivity of the surrounding area to (i) health effects and (ii) dust soiling may be identified.

The dust soiling sensitivity of the area is assessed as being *low* because of the type of receptors and their distance from the Hospital site. The human health sensitivity of the area is also assessed as being *low*, for the same reasons stated above, including the influence of annual average PM_{10} for the surrounding area.

6.1.4 Step 4: Risk (Pre-Mitigation)

Given the dust magnitudes for the various construction phase activities (Step 2) as shown in **Table 7**, and that the sensitivity of the identified receptors (Step 3) is classified as *low* for dust soiling, and *low* for health effects, the resulting risk of air quality impacts (without mitigation) is as presented in **Table 8**.

Table 8 Risk of air quality impacts from construction activities

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

Note: "Neg". stands for Negligible

The preliminary risk assessment summarised in **Table 8** indicates that with no mitigation measures there is a *low risk* of human health effects and dust soiling (amenity) impacts associated with construction phase activities.

This preliminary risk assessment is used to identify appropriate construction-phase mitigation controls to be applied to those activities during the construction phase.

6.1.5 Step 5: Identified Mitigation

The following represents a selection of mitigation measures recommended by the IAQM methodology for the criteria stated above. Those clearly not relevant have been removed.

Table 9 lists the relevant mitigation measures identified, and have been presented as follows:

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

Table 9 Site-specific construction-phase management measures

Identified Mitigation	Unmitigated Risk	
1	Communications	Low
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	N
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H
1.2	Display the head or regional office contact information.	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	D
2	Site Management	Low
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.	N
3	Monitoring	Low
3.1	Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary.	D
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to the local authority when asked.	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H
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
4	Preparing and Maintaining the Site	Low
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

Identified Mitigation	Unmitigated Risk	
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
4.4	Avoid site runoff of water or mud.	H
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	D
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
4.7	Cover, seed or fence stockpiles to prevent wind erosion	D
5	**Operating Vehicle/Machinery and Sustainable Travel**	**Low**
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·h-1 on surfaced and 15 km·h-1 on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	D
5.5	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	N
5.6	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	N
6	**Operations**	**Low**
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	H
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	H
6.3	Use enclosed chutes and conveyors and covered skips	H
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	H
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	D
7	**Waste Management**	**Low**
7.1	Avoid bonfires and burning of waste materials.	H
8	**Measures Specific to Demolition**	**Low**

Identified Mitigation	Unmitigated Risk	
8.1	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	D
8.2	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	H
8.3	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	H
8.4	Bag and remove any biological debris or damp down such material before demolition.	H
8.5	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	N
8.6	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	N
8.7	Only remove the cover in small areas during work and not all at once	N
9	**Measures Specific to Construction**	**Low**
9.1	Avoid scabbling (roughening of concrete surfaces) if possible	D
9.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	D
9.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N
9.4	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust	N
10	**Measures Specific to Track-Out**	**Low**
10.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D
10.2	Avoid dry sweeping of large areas.	D
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D
10.6	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.	N
10.7	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	D
10.8	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	N

Identified Mitigation	Unmitigated Risk	
10.9	Access gates to be located at least 10 m from receptors where possible.	N
11	**Specific Measures to Construction Traffic (adapted)**	**Low**
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D

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

6.1.6 Step 6: Risk (Post-Mitigation)

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

Given the size of the construction works to be performed at the development site, the distance to sensitive receptors and the activities to be performed, residual risks associated with fugitive dust emissions from the development post-mitigation are anticipated to be 'not significant'.

6.2 Operational Phase Assessment

The assessment of operational phase impacts has been performed using a qualitative approach as discussed in **Section 5.2**.

6.2.1 Emergency Power Generation

Products of combustion (primarily particulate matter, sulphur dioxide and oxides of nitrogen) can be generated through fuel combustion during power generation.

It is anticipated that the development will include a stand-by generator to provide power in the event of unexpected electricity supply failure. It has been confirmed that the activities to be performed as part of the development are not scheduled activities under the POEO Act (refer **Section 1**), and therefore the provisions under Schedule 1, Part 1, Section 17 (electricity generation) are not applicable.

Furthermore, the requirements of the POEO (Clean Air) Regulation 2010 specifically exempt stationary reciprocating internal combustion engines from air impurity standards for nitrogen dioxide and nitric oxide if the plant is used for a total of not more than 200 hours per year.

Measures can be implemented to ensure that the operation of the stand-by generator does not impact upon the surrounding environment when in use:

- ensure that regular maintenance is performed to confirm that any generator is operating at peak efficiency; and,
- provide an exhaust stack of appropriate height to ensure that any emissions are not entrained into the building wake and allow dilution and dispersion of any emitted plume.

Given that the generator would be operating during emergencies only and for less than 200 hours per year (< 3% of hours in a year), and also assuming that all precautions are taken during operation as outlined above, impacts associated with the operation would be anticipated to be insignificant.

6.2.2 Waste Generation

According to the Waste Management Plan (WMP) produced for the development (MRA, 2019), a range of wastes may be generated during regular activities from the use of:

- operating theatres;
- intensive care unit;
- inpatient unit wards;
- hospital kitchen;
- ground floor retail units (including food and beverage, pharmacy and general retail use); and,
- hospital front and back of house.

Several types of waste including special, liquid, hazardous, restricted solid and general (putrescible and non-putrescible) solid waste may be generated through the above activities. Some or all of those wastes may be odorous and may include (but not be limited to) human tissue, bulk body fluids or blood, and food waste.

As detailed in (MRA, 2019), a single waste storage and recycling space will be made available on the lower ground floor of the proposed development. This area is sized to sufficiently accommodate the range of waste materials expected to be generated throughout regular operations.

It is proposed that clinical, hazardous and low-level radioactive waste would be managed separately to general solid waste (putrescible and non-putrescible) to ensure general waste streams are not contaminated with potentially hazardous materials.

Waste storage areas will be sited away from areas of high pedestrian traffic and be enclosed to minimise odour and amenity impacts. Potentially odorous materials may also be refrigerated prior to disposal.

Should the requirements of the WMP be followed, impacts associated with odour from waste materials generated during the operation of the Hospital would be anticipated to be negligible.

6.2.3 Kitchen Operations

The potential for odour impacts resulting from kitchen operations may be associated with:

- transportation of raw materials;
- storing and handling of raw materials;
- food preparation;
- cleaning;
- cooking food products;
- packaging food products for consumption by the public or Hospital residents; and,
- management of waste materials (considered in **Section 6.2.2**).

Emissions from a commercial kitchen will vary rapidly and significantly in composition depending on the cooking processes being performed. Food products being prepared in a kitchen undergo an oxidation process, with water vapour, grease and smoke being driven off as a function of cooking. From an environmental perspective, emissions to atmosphere from kitchen exhaust ventilation systems are typically associated with odour and smoke.

Cooking processes also give rise to emissions of a range of air pollutants including oxides of nitrogen, carbon monoxide, carbon dioxide, and a range of organics including volatile organic compounds, semi-volatile organic compounds and aldehydes. Generally, these pollutants may become a potential hazard to health within poorly ventilated kitchen spaces, and controlled discharge from kitchen exhaust ventilation systems control the potential for exposure. Emissions of these pollutants is not considered to be significant from an environmental perspective.

The generation of solid particulates includes emissions of burnt and unburnt fragments of solid fuel (such as charcoal) and food fragments. 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 particulates and smoke 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 particulates is considered to be an intrinsic component of effective odour control as exposure to emissions of smoke (solid phase emissions) may illicit an olfactometric response as well as an exposure to gaseous phase emissions. Effective odour control therefore must provide adequate control of particulates.

Based on experience, the greatest risks associated with odour impacts from kitchen operations are associated with the cooking of food products. These risks are increased when certain cooking types are performed (e.g. high grease, high heat such as solid fuel charcoal grill).

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:

- **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" and 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.

Australian Standard (AS) 1668.2-2012 ('the use of ventilation and airconditioning in buildings') contains a number of requirements relating to exhaust ventilation including the types of effluent requiring exhaust, the removal of effluent, kitchen exhaust hood arrangements for various cooking process types, kitchen exhaust hood airflow and discharges to atmosphere.

Presented in **Table 10** are the seven 'types' of cooking processes outlined in AS 1668.2-2012 which may give rise to emissions of odour, grease and smoke. Given the nature of the development, it is not anticipated that cooking types 5 and/or 6 would be operated. However, cooking types 3 and 4 may be operated, which would potentially give rise to high grease and odour impacts if not appropriately mitigated.

Table 10 Cooking types and potential for grease, smoke and odour

Cooking process type (as per AS 1668.2:2012)	Example	Potential for			Operated within kitchen?
		Grease	Smoke	Odour	
Type 1 – Non-grease producing equipment	-	Low	Low	Low	Yes
Type 2 – Low-grease, medium heat producing equipment	Griddles, ranges, conventional fryers, tilting skillets, steam kettle and gas ovens	Medium	Low	Medium - High	Yes
Type 3 – High-grease, low heat producing equipment	Electric deep fat fryers, grooved griddles, hot tops and hot top ranges	High	Medium	High - Very High	Yes
Type 4 – High-grease, medium heat producing equipment	Countertop barbeques and gas deep fat fryers	High – Very High	Low – Medium	Very High	Possible (deep fat fryers)
Type 5 – High-grease, high heat producing equipment	Salamanders and open flame charcoal equipment utilising solid fuel	Very High	High – Very High	High – Very High	No
Type 6 – Oriental cooking tables and/or woks	Oriental cooking tables and/or woks	High	Medium	High	No
Type 7 – Bread ovens and steam-producing combination ovens	Bread ovens and steam producing combination ovens	Low	Low	Medium	Yes

Reference is made to the NSW EPA Local Government Air Quality Toolkit - Air quality guidance note – Food outlets (NSW EPA, 2017), and the UK DEFRA Guidance on the Control of Odour and Noise from Commercial Kitchen Exhaust Systems (DEFRA, 2005) which make the recommendations for odour control relating to the cooking of food products as outlined in **Table 11**.

How these recommendations would be addressed by the operator are also outlined in **Table 11**, noting where a process (e.g. air pollution control device) or management (e.g. maintenance schedule) response is required and adopted.

The design of the mechanical air ventilation and management system to be installed at the development site has not yet been finalised. The system would be necessarily be designed based upon the requirements of AS 1668.2-2012 and, based on the findings of this assessment would be required to include a level of odour and particulate control, including a combination of the following:

- Grease arrestors/traps to prevent grease from obstructing particulate filters;
- Particulate filtration, removing a range of particle sizes through e.g. electrostatic precipitation (ESP), panel filters, bag filters, and/or HEPA filters (multistage filter packs);

- UV-C lamps or other ozone generating equipment producing ozone which oxidise volatile organic compounds (odour); and,
- Activated carbon filters to remove excess ozone and fine particles.

A staged system would be designed to progressively remove odour and particulate matter (which in itself will further remove odour adsorbed onto particles). The addition of the supplementary controls (such as UV-C lamps and activated carbon filters) would ensure that odour from the cooking processes are adequately controlled, where required.

A multi-phase filtration system outlined above can be considered to be at the higher end of air pollution control devices installed at commercial kitchen premises. Given the number of elements which are required to work in concert, it would be critical that the system is maintained and managed in accordance with the manufacturers specifications.

Table 11 Air pollution control for cooking of food products - requirement and response

Requirement	Control type		Further Details (as appropriate)
	Process	Management	
Odour sources such as cooking areas to be suitably ventilated. Cooking emissions to be captured and discharged at a suitable height so as to not cause an odour nuisance.	☑		Cooking areas would be ventilated in accordance with relevant Australian Standards. Vertical discharges will be at a minimum of 2 m above roof height.
Exhaust stacks to be vented at a height clear of downwash effects from the building in which the activity is located and adjacent buildings and a minimum of 3 m above the highest point of the building roof ridge line or above that of any higher adjacent building within 50 m. This is also in agreement with Australian Standard (AS) 1668.2-2012 (the use of ventilation and air conditioning in buildings) which also includes the requirement for discharges to be not less than 6 m from a property boundary, any outdoor air intake or any natural ventilation device or opening.	☑		As above. In addition, all discharges will be located at a minimum of 6 m from the property boundary.
Reference should also be made to AS1668.2-2012 which prescribes the relevant exhaust air flow rate for cooking process types, based on the length of the canopy/hood.	☑		Confirmation should be sought from the mechanical engineer that all cooking appliances are installed and serviced in accordance with AS1668.2-2012
Odorous exhaust gases to be treated by activated carbon adsorbers, before exhaust gases are discharged to atmosphere. Ventilation system to be equipped with efficient filtration equipment to remove particles and aerosols from the cooking exhaust before it enters the activated carbon adsorbers.	☑		Multi-phase control system to be installed to remove grease, particulates and odour, as required
Activated carbon adsorbers to be checked regularly for odour 'breakthrough' (and the filter changed once breakthrough has been reached).		☑	A management system should be operated which includes a control system to identify when filters are dirty/overloaded.

Requirement	Control type		Further Details (as appropriate)
	Process	Management	
Spent activated carbon to be disposed of to landfills which are licensed and approved to accept this type of waste material.		☑	An approved waste contractor would be engaged to remove all spent activated carbon (and other filtration units).
NSW EPA recommends that exhaust stack gases be vented with a design exit velocity of at least 10 $m \cdot s^{-1}$ without any impediment to vertical discharge (NSW EPA, 2017). AS1668.2-2012 recommends vertical exit velocities for air discharges of 5 $m \cdot s^{-1}$.	☑		The exhaust velocity will be evaluated following operation and assessed on each occasion following annual maintenance of the exhaust units.
The particulate filtration system installed (for example, a filter or grit arrestor in the cooking ventilation system) to be maintained in efficient working order at all times.	☑	☑	A management system should be operated which includes a control system to identify when filters are dirty/overloaded. The units would be maintained in accordance with the manufacturer's specifications.
The ventilation system used for collection of emissions (e.g. fume hood) to be maintained in efficient working order at all times. Material accumulated on the inside of the hood and ductwork (e.g. fats from cooking) to be checked and removed periodically.	☑	☑	Visible and accessible ductwork and hoods will be cleaned at the end of each shift.
Grease traps installed in the cooking systems to be maintained in efficient working order at all times.	☑	☑	Grease traps will be inspected and cleaned/maintained at the end of each working day.
All activities, including housekeeping, to be carried out according to industry best practice.		☑	

The operation and maintenance of odour controls requires the operator or manager of the site to nominate a named **Responsible Person** for each operating period. The nominated Responsible Person (and his/her delegates) will be sufficiently experienced and trained to enable effective management of the Process Controls and have sufficient authority to proactively manage commercial operations to ensure emissions are not offensive (see **Section 3**).

Process Controls

The Responsible Person will be responsible for ensuring that the identified Process Controls are implemented, and in the event that factors arise that compromise the efficacy of the Process Controls that actions are taken to (a) remedy the deficiency and (b) provoke operational controls (such as reduced or curtailed kitchen activities) to reduce the rate and frequency of odour emissions.

- Ventilation: the ventilation and extraction system is operated in accordance with the requirements stipulated by the Mechanical Engineer.
- Ventilation hoods: the ventilation hoods will be adequately maintained and operated during all kitchen activity periods.
- Cooking appliances service: in accordance with AS 1668.2.
- Cleaning: all kitchen surfaces, including the ventilation hoods and grit arrestors, will be cleaned daily and sufficiently to prevent the accumulation of grease or soot.
- Grease traps: grease traps will be inspected and cleaned/maintained at the end of each working day.
- Emission control: the emissions are discharged vertically, at a height of (at least) 3 m above roof ridge line or any adjacent building within 50 m and not less than 6 m from the property boundary and at an efflux velocity of at least 5 $m \cdot s^{-1}$.
- Odour control device: the installed odour control device is operated during all kitchen activity periods and operated in accordance with the manufacturer's instructions.

Management Controls

- Odour control device (operation): the responsible person will be responsible for periodically checking that the odour control device is operating in accordance with the manufacturer's instructions and without alarms to detect the breakthrough, saturation or failure of all components (e.g. filters, lamps).
- Odour control device (consumables): the responsible person will be responsible for maintaining sufficient stocks of spare consumables for the odour control device (e.g. filters, lamps) and for the replacement of consumables at/before failure.

- Cleaning: the responsible person will be responsible for the inspection and 'sign-off' that daily / periodic cleaning activities have been performed, including the ventilation hoods, grit arrestors and grease traps.
- Records: the responsible person will be responsible for the recording of the performance of all tasks, such that it may be demonstrated to Council upon request.
- Odour complaints: the responsible person will be responsible for the maintenance of an odour complaint log.

6.2.4 Traffic Movements

A traffic impact assessment (TIA) has been provided for the development (TRAFFIX, 2019) which considers existing traffic conditions in the area and those which may be experienced during the operation of the development.

The current land use at the Hospital site accommodates a portion of the former West Gosford Ausgrid depot. The TIA estimates that 36 vehicle trips in each of the morning and afternoon peak hours are generated by the current land use.

The TIA also provides an estimation of the trip generation during Hospital operations being 115 vehicle trips per hour in the morning peak period and 143 vehicle trips per hour in the afternoon peak period.

Racecourse Road and all roads immediately surrounding the Hospital site are not identified as busy roads (<20 000 annual average daily traffic (AADT) flow) according the NSW Roads and Maritime Services (RMS) Traffic Volume Maps for noise assessment under the State Environmental Planning Policy (SEPP) for Infrastructure. Air quality issues are therefore not anticipated to be a current issue of concern and the additional traffic visiting or leaving the Hospital (up to 107 additional trips in the afternoon peak hour) would not be sufficient to result in any adverse air quality impacts at surrounding sensitive locations.

To minimise air quality issues, the smooth flow of traffic through the entry/exit should be maximised where possible and the frequency and duration of queuing / idling traffic should be minimised. During peak periods or during unexpected delays, the use of signs to encourage the switching off of engines could be considered. Furthermore, contractors who deliver or pick up goods from the Hospital could be encouraged to use their most fuel efficient or newest vehicles.

7. MITIGATION AND MONITORING

7.1 Air Quality

7.1.1 Construction Phase

Based on the findings of the construction phase air quality assessment, with no mitigation measures there is a *low risk* of human health and adverse dust soiling (amenity) effects associated with construction phase activities. The risks are primarily associated with earthworks, construction activities and trackout.

A range of mitigation and management measures are presented in **Section 6.1.5**, which would result in the risks associated with construction to be reduced to *'not significant'*.

7.1.2 Operational Phase

Impacts on air quality associated with emergency power generation, waste generation and storage, kitchen operations and traffic movements have been considered. It is not anticipated that any of these operations would result in significant impacts which cannot be managed.

In relation to emergency power generation, it is recommended that regular maintenance of the generator is performed to ensure that it operates at peak efficiency when required. It is also recommended that an exhaust stack is appropriately sized to ensure that any emissions are provided sufficient opportunity to be dispersed and not entrained within the building wake.

The waste management plan provided for the Hospital includes a range of measures which should ensure that amenity impacts associated with odour are minimised. No further measures are likely to be required to minimise these risks.

Cooking processes of certain types have the potential to result in amenity (odour) and health issues if not appropriately managed. However, the application of an appropriate multi-phase odour, grease and smoke control system, designed in accordance with the relevant Australian Standards would ensure that any potential impacts can be appropriately managed. Should a range of management and process controls be implemented, any impacts on surrounding sensitive receptors (including users of the Hospital) should be insignificant.

The increase in traffic flows at the development site are not likely to result in any air quality issues. However, to minimise the potential for any issues, the smooth flow of traffic through the entry and exit should be prioritised. The frequency and duration of queuing / idling traffic should also be minimised. During peak periods or during unexpected delays, the use of signs to encourage the switching off of engines could be considered.

8. CONCLUSION

AA Crown Holdings Pty Ltd has engaged Northstar Air Quality Pty Ltd to perform an air quality assessment for the proposed construction of a hospital located at the intersection of Racecourse Road and Faunce Street West in West Gosford, NSW.

This air quality assessment forms part of the State Significant Development application under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The air quality assessment presents an assessment of the impacts of the proposed operations at the development site, associated with both construction and operational phases.

Regarding potential construction impacts, these have been assessed using a published risk-based assessment methodology, which indicates that a range of mitigation measures can be applied during the minor construction phase to ensure that the risks (both health and amenity) to the surrounding community would not be significant.

A range of potential emissions sources have been identified during the operational phase which include emergency power generation, waste generation and storage, kitchen operations and traffic movements. The potential scale of each of these emission sources has been considered, and a range of emission control or management measures referenced or outlined. Inclusion of the appropriate process and emission controls would result in impacts on the surrounding community being insignificant.

Based on the findings of this assessment, air quality impacts during both the construction and operational phases can be managed such that impacts on the surrounding community are not significant.

9. REFERENCES

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APPENDIX A

Report Units and Common Abbreviations

Units Used in the Report

All units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units. In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol. For example:

- 50 micrograms per cubic metre would be presented as 50 $\mu g \cdot m^{-3}$ and not 50 $\mu g/m^3$; and,
- 0.2 kilograms per hectare per hour would be presented as 0.2 $kg \cdot ha^{-1} \cdot hr^{-1}$ and not 0.2 kg/ha/hr.

Table A1 Common Abbreviations

Abbreviation	Term
AADT	annual average daily traffic
ABS	Australian Bureau of Statistics
ACH	air changes per hour
AHD	Australian height datum
AQA	air quality assessment
AQMS	air quality monitoring station
AWS	automated weather station
BoM	Bureau of Meteorology
°C	degrees Celsius
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCP	Development Control Plan
DPE	NSW Department of Planning and Environment
EETM	emission estimation technique manual
EPA	Environmental Protection Authority
F	fluoride
FEL	front end loader
GDA	Geocentric Datum of Australia
GHG	Greenhouse gas
GIS	geographical information system
HCL	hydrogen chloride
HF	hydrogen fluoride
K	kelvin (-273°C = 0 K, ±1°C = ±1 K)
kW	kilowatt
MGA	Map Grid of Australia

Abbreviation	Term
$mg \cdot m^{-3}$	milligram per cubic metre of air
$mg \cdot Nm^{-3}$	milligram per normalised cubic metre of air
$\mu g \cdot m^{-3}$	microgram per cubic metre of air
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NO	nitric oxide
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
O_3	ozone
ODT	odour detection level
OEH	NSW Office of Environment and Heritage
OIA	odour impact assessment
OU	odour unit
Pa	Pascals
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
SEE	Statement of Environmental Effects
SO_X	oxides of sulphur
SO_2	sulphur dioxide
SSD	State Significant Development
STP	standard temperature and pressure (273.15 K, 101.3 kPa)
TAPM	The Air Pollution Model
TPM	total particulate matter
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VKT	vehicle kilometres travelled
VOC	volatile organic compounds

APPENDIX B

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 five risk profiles of: "demolition", "earthworks", "construction" and "track-out". 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:

Table B1 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
Track-out (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 receptor 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.

Table B2 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.

Table B3 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

Table B4 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.

Table B5 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

Table B6 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

Table B7 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

Table B8 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

Table B9 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 Proposal or activity:

Table B10 Potential mitigation measures

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

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

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

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
8.5	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	N	D	H
8.6	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	N	D	H
8.7	Only remove the cover in small areas during work and not all at once	N	D	H
9	**Measures Specific to Construction**			
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	D	D	H
8.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	D	H	H
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and 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)**			
11.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
11.2	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N	D	H
11.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D	H	H
11.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H	H	H
11.5	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).